8-2023

Determinants of Market Participation among Milk Producers in Kyrgyzstan

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Determinants of Market Participation among
Milk Producers in Kyrgyzstan

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Agricultural Economics

by

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Samarkand Veterinary Medicine Institute
Bachelor of Science in Accounting and Audit, 2019

August 2023
University of Arkansas

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Abstract

This study explores the key factors that drive milk producers to enter the milk market as sellers in Kyrgyzstan. The study utilizes the Life in Kyrgyzstan dataset, a nationally representative survey that tracks 3,000 households and 8,000 individuals throughout Kyrgyzstan. The results were analyzed with two different models: Heckman's two-stage and the double hurdle models. The results show that regional location, ethnic group origin, risk awareness, dependency ratio, vehicle ownership, total value of assets, distance to agro market, and family shock occurrence significantly impact both market participation and the volume of milk sales. The findings hold great significance in establishing effective interventions that empower rural smallholder farmers in Kyrgyzstan and neighboring countries to engage in the market actively.

Acknowledgments

Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Agricultural Economics issued by the University of Arkansas (United States of America) and the joint academic degree of International Master of Science in Rural Development from Ghent University (Belgium), Agrocampus Ouest (France), Humboldt University of Berlin (Germany), Slovak University of Agriculture in Nitra (Slovakia), University of Pisa (Italy) and University of Córdoba (Spain) in collaboration with Can Tho University (Vietnam), Escuela Superior Politécnica del Litoral (Ecuador), Nanjing Agricultural University (China), University of Agricultural Science Bengaluru (India), University of Pretoria (South-Africa) and University of Arkansas (United States of America).

This thesis was elaborated and defended at the University of Arkansas within the framework of the European Erasmus Mundus Joint Master Degree International Master of Science in Rural Development (Course N° 2019 - 1507 / 001 - 001) and the EU-US Cooperation Programme in Higher Education and Vocational Training (Transatlantic Degree Consortia Projects) nr. 2008-1745/001 – 001 CPT-USTRAN and the Fund for the Improvement of Postsecondary Education (EU-US Atlantis Program grant P116J080034, U.S. Department of Education). However, the contents of the thesis do not necessarily represent the policy of the supporting agencies, and you should not assume endorsement by the supporting agencies.

Dedication

I would like to dedicate this thesis to my parents, for their unwavering love, support, and encouragement throughout my academic journey. Their sacrifices, guidance, and constant motivation have been a driving force behind my success. I am forever grateful for their love and support. Without them, this achievement would not have been possible.

I am also thankful for the guidance and support of my professors during this program, who have been always eager to teach me something new. Special thanks to

Dr. Speelman, Dr. Ahrendsen, and Dr. Park for their help in completing this research and supporting me during my academic journey over the last two years.

In addition, I would like to express my gratitude to my uncle, Dr. Sanaev, for his motivation and practical support, who has always encouraged me to study more. His support and belief in me have been invaluable in helping me reach this point. Thank you all for being a part of my academic journey and for helping me achieve my goals.

Table of contents

1. Introduction

1.1.Background

Three quarters of the poorest in the world reside in rural regions and mainly depend on agricultural activities such as farming, aquaculture, and livestock rearing for sustenance and income (Voegele, 2014). Agriculture has always been a crucial aspect of the livelihoods of people in developing countries, and it has the potential to significantly improve their lives by increasing income and decreasing hunger and poverty (Feed the Future Innovation Lab for Markets, Risk, and Resilience, n.d.).

According to Micevska and Rahut (2008), over 97% of households rely on subsistence agriculture as their primary source of livelihood, with participation in agricultural and related activities being widespread. Agriculture markets with poor infrastructure in developing countries are constrained by limited input and output markets, which impede rural families' potential to improve their livelihoods (Feed the Future Innovation Lab for Markets, Risk, and Resilence, n.d.). Consequently, sometimes, rural households may benefit from decreasing their agricultural pursuits and pursuing non-agricultural employment opportunities for greater profitability although it may not be guaranteed (Micevska & Rahut, 2008).

Market participation by small farmers has been identified as a critical factor for development (Barrett, 2008). Braun et al. (1994) also suggested that encouraging subsistence farmers to participate in the market is a critical factor for driving agricultural transformation in developing nations. However, market participation also presents challenges for farmers, including market risks, access to finance, and inadequate infrastructure (Reyes et al., 2012). Farmers may face price volatility, low demand for their products, and difficulties in accessing markets. Even on some cases, farmers may also face high transaction costs, making it difficult to

sell their products profitably (Sigei et al., 2014). Previous studies indicated that farmers who own small plots of land in developing countries often do not directly engage in the markets for their products (Reardon et al., 2009; Regasa Megerssa et al., 2020; Sigei et al., 2014). This fact might be attributed to the costly nature of trading between different markets, as well as limited access to better technologies and productive resources for households with lower incomes (Barrett, 2008).

Studies by Barrett (2010), Burke et al. (2015), Olwande et al. (2015), and Regasa Megerssa et al. (2020) tried to identify what factors determine direct market participation by using small-scale farmers or households with various products in developing countries. These studies have provided reasonable understandings of the determinants of market participation by small-scale farmers. We often, however, face difficulties in generalizing these factors impacting market sales participation due to the varied cultures of producers across different regions of the world. There is a lack of research on the market participation of agricultural producers in Central Asian countries. As we discussed the advantages of market participation for improving the livelihoods of smallholder farmers, it is crucial to gain insights into the determinants of market participation to develop effective strategies that enhance smallholder farmers' participation in economically important value chains.

In this regard, the objective of this paper is to find out factors that impact on dairy market participation by using household level survey data in Kyrgyzstan. We chose milk producers due to the significance of milk in meeting more than 50% of the nutritional needs of the Kyrgyz and its cultural importance in the local cuisine (Smanalieva et al., 2022). In addition, Kyrgyz cuisine has been influenced by the cuisines of its neighbors, such as Uzbek, Uyghur, and Russia, with

some adaptations to local culture (Smanalieva et al., 2022). Therefore, the findings of this research may also have relevance and applicability to these neighboring nations.

Kyrgyzstan is a country located in the interior of the Asian continent, occupying a land area of 199,951 square kilometers and hosting a population of about 7 million inhabitants in 2022, with over 60% of them living in rural areas (Republic, 2023). Due to its predominantly mountainous terrain, which accounts for over 90 percent of its landmass and is characterized by high-altitude steppes and glaciers, a significant portion of the country's territory is uninhabitable (Food and Agriculture Organization (FAO), 2020). Although agricultural land accounts for almost a third of the Kyrgyz Republic's territory (32.8 percent), forests cover about 13 percent, and only a small fraction of the agricultural land is suitable for permanent crops or cultivation (National Statistical Committee of the Kyrgyz Republic, 2017). As a reflection of the Kyrgyz's nomadic herding lifestyle, the majority of their agricultural land consists of permanent meadows and pastureland, comprising 85 percent of the agricultural land or 48 percent of the total territory (FAO, 2020). Similar to other developing countries, agriculture is a crucial part of the economy in Kyrgyzstan, serving as one of the main sources of employment in rural regions and playing a vital role in ensuring food security for the significant rural populace (FAO, 2016). The agricultural sector in Kyrgyzstan underwent significant changes during the Soviet era, with livestock rearing and some crop production being prioritized (Fitzherbert, 2006). Livestock farming, particularly small ruminants, and cattle rearing was an occupation that drew upon the Kyrgyz's traditional skills and knowledge (FAO, 2020). The Soviet government introduced fine-wool sheep to replace hardy local breeds, and new practices, such as using imported feed to support large herds on collective farms, were also adopted; however, these practices led to the degradation and over-grazing of pasturelands, as well as the loss of traditional livestock breeds

(Fitzherbert, 2006). After the independence of Kyrgyzstan in 1991, Kyrgyzstan's agricultural landscape changed significantly with the privatization of land and the shift in livestock ownership from state to individual farms. This led to a steep decline in agricultural production during the early transition years, since then the sector has experienced some recovery (Lerman & Zedik, 2009).

Smanalieva et al. (2022) mentioned that Kyrgyzstan has a rich tradition of producing and consuming dairy products, which play a significant role in the Kyrgyz cuisine and culture. They also concluded that the dairy market in the country is dynamic and diverse, with a wide range of products and brands. The industry is largely dominated by small-scale farmers or households, who produce milk for both their consumption and market (FAO, 2020). Although the Kyrgyz Republic lacks a precise definition of a smallholder farm or family farm in its legislation, there are several approaches to analyze the agricultural activity of small production units from different perspectives (FAO, 2020). One approach is to classify enterprises based on the number of workers or annual turnover, as defined by Kyrgyz Government Decree No. 78 (*Decree of the Corporation of the Kyrgyz Republic*, 2002) for the sectors of agriculture, hunting, forestry, and fishery. However, this classification system does not specifically cover agricultural activity implemented by formally registered farmers and rural households. The National Statistical Committee of Kyrgyz Republic identified the "households" sector as one of the institutional units in the economy in 1997 (FAO, 2020). This sector encompasses all resident households, which act as consumers, but some of them also engage in productive activities as unincorporated enterprises that produce goods and services for sale and personal use. Private rural household activity on a home plot of land, individual entrepreneurial activity without hired labor, and individual peasant farms are examples of such activities. Therefore, households that are located

in rural areas involved in private activity in agriculture with their own land and livestock are considered smallholders and family farms in Kyrgyzstan. That is why, households, smallholders and family farmers are interchangeable in this research.

The implementation of land reform in Kyrgyzstan during the late 1990s was instrumental in shifting from planned socialist agriculture to smallholder agriculture (Fitzherbert, 2006). This was made possible by the distribution of over 80% of the arable land in the country among rural households during the recognition of private land ownership between 1996 and 1999 (Fitzherbert, 2006). Under this system, every registered family in a rural area received an agricultural land plot, or privatization share, based on the number of household members (FAO, 2020). The family head was given a land certificate in their name, and larger families were allocated more land than smaller families, based on the number of household members (FAO, 2020). The average size of the land plot was determined by three factors: the size of the family, the amount of land available for distribution, and the population density of rural areas at the time of the agrarian reform in the late 1990s (Akramov & Omuraliev, 2009). The land reform led to a significant increase in the number of small-scale farms, which were based on single households, from 20,000 in 1994 to 250,000 in 2001 (Akramov & Omuraliev, 2009). This led to a decrease in the average size of farms from 15 hectares in 1994-1996 to 3 hectares in 2002. Relative to the country's population, there is a large number of smallholders engaged in agricultural production. The number of households was 1.5 million in 2015 (FAO, 2020).

1.2.Research Problem

There are plenty of studies which helps to understand the economic importance of direct market sales for producers (Burke, 2009b; Kim et al., 2016; Olwande et al., 2015; Pingali, 1997).

Even though there is a sufficient amount of research on this field it does not include any parts of Central Asia.

Many smallholder and family farmers in central Asian countries, including Kyrgyzstan, still struggle to maintain economic viability (FAO, 2016). Rural residents remain the poorest and most vulnerable part of the population, with limited access to markets, financing, and technology (Akramov & Omuraliev, 2009). These challenges are compounded by the limited infrastructure, environmental degradation, and natural disasters that often affect the region. As a result, there is a need for continued support to rural communities to help them build resilient and sustainable livelihoods (FAO 2020). Kyrgyzstan government has implemented several policies to support the dairy sector, including subsidies for farmers and the development of processing facilities (FAO, 2016). The national policy on the development of agriculture focuses on improving the quality and efficiency of agricultural production, managing natural resources better, developing markets and trade in agricultural products, and improving rural financial systems (Akramov & Omuraliev, 2009). Strategic policy documents also highlight the need to enhance agricultural production and improve the living standards of the rural population. Despite the government's efforts, the dairy sector in Kyrgyzstan faces several challenges, including inadequate infrastructure, low productivity, and limited access to markets (FAO, 2020) although the country has the potential to increase its dairy market and improve the livelihoods of its producers, given its favorable climate and abundant natural resources.

The gap in the literature is noteworthy given the importance of agriculture to the economies of Central Asian nations including Kyrgyzstan and the potential benefits that could accrue to smallholder farmers if they were able to participate more frequently in market sales. By exploring the factors that facilitate or hinder direct market sales in this region, researchers and

policymakers could identify better strategies to support smallholder farmers and promote economic growth.

1.3.Research Questions and objectives

The dairy industry plays a vital role in the agricultural sector of many developing countries, including Kyrgyzstan. However, little is known about the factors that drive milk producers to enter the milk market as a seller and how these factors affect the quantities of sold milk among market participants. The main research questions that this study aims to investigate are:

- What are the key factors driving milk producers to enter the milk market as a seller in Kyrgyzstan?
- How do these factors affect the quantities of sold milk among market participants?

The significance of this study lies in its potential to inform policy decisions aimed at promoting the economic growth of the dairy industry in Kyrgyzstan. By identifying the key factors that drive milk producers to join in the milk market and understanding how these factors affect the quantities of sold milk, this study can provide insights into the design of development strategies that enhance the participation of smallholder farmers in the market for economically important value chains. Moreover, the study findings could contribute to the broader understanding of the factors that influence milk producers' participation in the market, thus advancing the existing knowledge and informing future research in the field.

1.4.Scope of the Study

This study is one of the earliest investigations conducted in the central Asian area, and there is a shortage of prior research conducted by scientists to comprehend the cultural behavior of the people in terms of their involvement in milk market sales. To gain a better understanding,

we endeavored to use a large amount of data. We analyzed 38 variables by utilizing four years of survey data collected from 1905 households across all seven regions of Kyrgyzstan. Multiple organizations, including the German Institute for Economic Research, gathered the data in Central Asia and Europe. The findings of this study will provide insight into the determinants of milk market participation by producers in Kyrgyzstan, as well as the effect of these factors on the amount of milk sold. Nonetheless, the conclusions and recommendations of the study are limited to Kyrgyzstan and neighboring countries with comparable policies since milk production and marketing techniques differ from one country to another in Central Asia. Nonetheless, this research will pave the way for future investigations in this region.

2. Literature Review

2.1.Background

In order to construct an effective study model, it is necessary to engage in a comprehensive literature review. This review was conducted with a focus on academic papers related to market participation, utilizing databases such as Web of Science, Scopus, Google Scholar, and relevant policy briefs. The analysis of these papers underwent a rigorous screening process, beginning with keyword searches and progressing to the careful review of titles and abstracts. The literature review focused on several key topics, including the importance of households' participation in markets, the factors that influence market participation, strategies for improving market participation, and the econometric approach to modeling market participation.

While the study's focus is on Kyrgyzstan, the literature review did not include country-specific information, as there were very few studies on market participation in the region and

none specifically related to households' market participation. Instead, the review aimed to build a general model for the study, utilizing research conducted in a global context.

To gain a better understanding of farmers' intentions towards market participation in Kyrgyzstan, the study examines participation intentions for agricultural markets. The importance of farmer participation in markets is discussed in this chapter, followed by an exploration of the factors that influence market participation and the strategies that can be employed to improve small-holder farmer participation. The study aims to synthesize the findings of previous research to identify the essential factors that influence market participation. Finally, the literature review concludes with the development of the study framework.

2.2.The significance of smallholder farmer participation in markets

The shift from agriculture characterized by low productivity and subsistence-oriented practices to one that is highly productive and commercially focused has been a central topic in agricultural economics and development studies for more than fifty years (Barrett, 2008). Commercialization strengthens the connections between input and output sides of agricultural markets and farmers' engagement, as highlighted by Jaleta et al. (2009). In the perspective of Pingali (1997), the concept of agricultural commercialization goes beyond simply marketing agricultural products. Rather, it involves households making decisions about product choices and input use based on the principle of maximizing profit. This approach to agricultural commercialization seeks to increase the income of farmers and reduce their reliance on subsistence agriculture by providing incentives for them to adopt modern farming technologies and practices (Reyes et al., 2012). By embracing this profit-maximizing approach, farmers can achieve greater economic stability, security, and sustainability. Moreover, market participation can create jobs in rural areas like sorting, storing and transporting activities at the same time, it

increases farm's output, enabling the farmer to make more income (Sigei et al., 2014). Therefore, market participation has been identified as a significant factor that motivates farmers to transition from subsistence farming to commercial farming (Makhura, 2002). According to Sigei et al. (2014), the engagement of farmers in market activities has been associated with a range of rural development initiatives such as rural road construction, electrification, and industrialization. These development activities have contributed to the improvement of rural livelihoods and economic growth in regions where economy is based on mostly agriculture. Furthermore, households who participate in markets are more likely to be food secure due to the income generated from the sale of their agricultural produce (Makhura, 2002). The process of economic liberalization has presented smallholder farmers with various prospects to expand their production portfolio and access nearby markets with their products (Asfaw et al., 2010). According to (Makhura, 2002), policy measures are similar for participating in the livestock market, as it is also a high-value commodity, much like horticulture.

In the context of agricultural development, market participation is often viewed as a means to improve income and livelihoods for farmers (Barrett, 2008; Burke et al., 2015; Sigei et al., 2014). However, it should be noted that mere participation in markets does not automatically guarantee these benefits (Asfaw et al., 2010) so the volume of the participation is also essential. In short, promoting the commercialization of subsistence farming is a critical and significant approach to guarantee household food security and economic development of the nation, as suggested by Kim et al. (2016).

2.3.Factors impacting on probability of market participation

The likelihood of selling agricultural product is known as the probability of market participation. Previous research by Burke et al. (2015), Kim et al. (2016), Mkuna & Wale

(2022), Olwande et al. (2015), Reyes et al. (2012) Sigei et al. (2014) showed that market participation of smallholder farmers is influenced by a range of factors, including socioeconomic factors, institutional factors, market factors, and external factors such as political stability, natural disasters, and calamities. These factors may have positive or negative impacts, which could enhance or diminish the welfare of the actors involved.

Socioeconomic factors such as gender, age, education, household size, and land size play a significant role in determining market participation (Reyes et al., 2012). The gender of the household head plays a crucial role in determining whether or not to participate in the market. According to Zamasiya et al. (2014), male household heads had a lower probability of participating in the market, while Reyes et al. (2012) found that they were more likely to participate compared to females, possibly due to their stronger negotiation skills as suggested by Cunningham III et al. (2008). The household head's age can have both positive and negative effects on market participation. Older farmers may have an advantage due to accumulated capital, and long-term relationships with clients, resulting in a positive impact on market participation (Sall et al., 2000). However, the impact of age can also be negative as younger farmers may have a longer planning horizon and be more willing to take risks (Zegeye et al., 2001).

Having education can enhance a farmer's capacity to acquire and interpret market information and effectively utilize it, leading to reduced marketing costs and fostering better relationships between buyers and sellers. Makhura (2002) and Randela et al. (2008) found that farmers with higher education levels tend to possess stronger production and management skills, which in turn increases their probability of engaging in market participation. On the other hand, Musah et al. (2014) discovered a negative correlation between education and the likelihood of

market participation. They attributed this to the possibility that highly educated farmers may have full-time jobs and only farm part-time for their own consumption.

Household size (number of members of family) has been found to positively influence on market participation, as evidenced by studies conducted by Gani & Adeoti (2011) and Reyes et al. (2012). Larger households are able to benefit from their family labor and produce more output surplus. However, Siziba et al. (2011) discovered a negative relationship between household size and market participation probability, as larger households may not be able to produce a surplus beyond their consumption needs.

Ohen et al. (2013) and Siziba et al. (2011) have reported that the total land size has a positive and significant impact on the likelihood of market participation. The reason behind this is that a larger land size allows farmers to produce a greater marketable surplus (Key et al., 2000). Farmers with larger farm outputs are also more likely to participate in the market since they have a greater potential for producing a greater amount of marketable surplus (Gani & Adeoti, 2011; Musah et al., 2014; Ohen et al., 2013).

The likelihood of market participation is typically negatively and significantly impacted by the distance to the market, as longer distances result in increased transport costs (Siziba et al., 2011).

In developing countries, inadequate infrastructure can hinder market participation among smallholder farmers because many of them reside in remote areas where infrastructure is poor, resulting in high transaction costs that make it difficult for them to participate in the market. This is supported by the findings of Makhura, (2002).

The possession of transport and communication assets can influence a farmer's decision to participate in the market. Sigei et al. (2014) found that the possession of communication tools

such as mobile phones, radios, and televisions can enhance market participation by providing marketing information to farmers. The possession of transport assets such as bicycles, motorcycles, and trucks can also facilitate market participation by decreasing the cost of transporting produce from the farm to the market. This assertion is supported by Key et al. (2000).

Studies have shown that distance from the farm to the point of sale and access to market information are significant barriers to market participation (Montshwe, 2006; Omiti et al., 2009). However, the price factor has a positive influence on market participation. According to Alene et al. (2008) output prices serve as incentives for sellers to increase their supply in the market.

2.4.Determinants that influence the intensity of market participation

Intensity of market participation refers to the extent or degree to which a household holder engages in selling their produce in the market, indicating the amount or quantity of their products that are being offered for sale. The decision of how much to sell (intensity of participation) and the decision to participate in the market are considered separate and sequential decisions, and they may be influenced by different factors. Sometimes, the same factor may affect the two decisions differently (Mzyece, 2016). This section focuses on reviewing literature that examines the factors influencing the intensity of market participation decisions. Kena et al. (2022) found that the participation level was negatively affected by the age of the household head while Emukule et al. (2018) reported a positive correlation between the age of the household head and the level of dairy sales. Those who have received education might have an advantage in comprehending the potential benefits of selling their products in. Kena et al. (2022) found that the education level of the household head had a positive and significant impact on the sales of dairy products. Ehui et al. (2003) found a positive relationship between higher levels of

education, a larger number of cows, and increased sales of dairy products in households. The more land the households own the more dairy products they sell (Emukule et al., 2018; Kena et al., 2022). Studies have shown that the distance to the market decreases the proportion of output sold because of the additional travel time and cost (Siziba et al., 2011). Sigei et al. (2014) stated that enhanced market access leads to the production of more marketable surplus, resulting in increased income from agriculture and higher revenues, which can be saved and invested in productivity-enhancing technologies. Matungul et al. (2002) argued that investing in public goods such as telecommunication, efficient legal systems, farmer support services (e.g., extension services, marketing information, and research), and road infrastructure can help reduce transaction costs, leading to increased farm and non-farm income. Nevertheless, Zamasiya et al. (2014) discovered that there is a positive and significant correlation between distance and the extent of market participation. This implies that more produce was sold at more distant markets, which were found to offer better prices compared to those closer to the farmer. Receiving extension services has been found to positively influence market participation, as it provides individuals with access to valuable information, skills, and knowledge. Studies conducted by Reyes et al. (2012) and Siziba et al. (2011) have supported this finding. According to Shepherd (1997) obtaining information incurs transaction costs that farmers must deal with. Owning a radio or having access to information sources can help farmers obtain valuable market information, allowing them to sell more in the market (Alene et al., 2008; Musah et al., 2014; Omiti et al., 2009; Siziba et al., 2011). Household size has typically been associated with a higher intensity of market participation, according to studies by Alene et al. (2008) and Musah et al. (2014). The rationale behind this is that larger households have a greater labor supply for production, and thus they tend to produce more food than they consume. However, Omiti et al.

(2009) found a negative correlation between household size and the quantity of products sold, suggesting that larger households sell less due to their higher consumption needs. Omiti et al. (2009) discovered that a male head of a household had a positive and significant effect on the quantity of output sold, indicating that male farmers were more successful in marketing their products. Cunningham III et al. (2008) argue that this could be due to the fact that men generally have better skills in negotiating, bargaining, and enforcing contracts. On the other hand, Musah et al. (2014) and Sigei et al. (2014) found that females sold more than males. There was a negative correlation between the age of the household head and the quantity of output sold (Musah et al., 2014). This was explained by the fact that older farmers tend to be more risk-averse and less likely to adopt new technologies, which limits their ability to produce for the market. Their experience may help overcome some fixed costs, but this is outweighed by their other characteristics. Omiti et al. (2009) found that non-farm income has a negative effect on the quantity of output sold when used for off-farm investments. However, non-farm income has a positive effect on the amount sold when used to finance farm production (Siziba et al., 2011). Moreover, studies have demonstrated a positive correlation between farm output and the quantity of output sold in the market (Reardon et al., 2009; Reyes et al., 2012). Farmers with higher levels of farm output tend to have more surplus produce available for sale, allowing them to sell a greater quantity in the market. Barrett (2010) suggested that the choice of production technology by a household has a direct impact on its market participation. This is because the technology choice affects the household's productivity, which in turn affects its decision to participate in the market. The literature reveals that farmers are incentivized to sell when prices are high, leading to increased sales of their output (Musah et al., 2014). Lastly, to improve market participation, contract farming can be a useful strategy. Contract farming allows farmers and processors to

share risks, decision-making power, and benefits in a mutually beneficial way, according to Eaton & Shepherd (2001). Contract farming has been identified as a crucial element in promoting smallholder agriculture commercialization in many developing countries, as it provides farmers with a guaranteed market, higher prices, necessary inputs, and knowledge of new agricultural technologies (Mishra et al., 2018).

2.5. Econometric approaches to modeling market participation

As discussed in earlier sections of this paper, this study aims to analyze the determinants of marketing decisions made by households that engage in milk production in seven regions of Kyrgyzstan. The household's decision to participate in markets has been widely viewed by economists as a two-step process. In the first stage, producing households must decide whether to participate in market activities, in the second stage, given the decision to participate, households decide on the quantity of the good to sell (Bellemare & Barrett, 2006). In the previous literature, three alternative economic models have been mentioned to estimate the factors of market participation to get unbiased, consistent and efficient parameters (Bellemare & Barrett, 2006; Burke, 2009a; Mzyece, 2016; Sigei et al., 2014).

James Tobin proposed the Tobit model in 1958 as a statistical model that relates an independent variable to a non-negative dependent variable (Tobin, 1958). The Tobit model assumes that decisions regarding market participation and sales volume are made at the same time, so factors influencing both decisions are the same. Therefore, this assumption has a limitation that it assumes the same set of parameters and variables determine both the probability of market participation and the level of transaction (Makhura, 2002).

Another alternative to modeling market participation is the Heckman two-stage model developed by Heckman (1979), and has been used in many previous studies (Sigei et al., 2014).

This model is a two-stage model. In the first stage, it uses a probit regression with all variable data to estimate the probability of market participation; in the second stage, the inverse Mills ratio is included and is used to estimate the quantity participation in market sales (Sigei et al., 2014). The model assumes that the sample selection is influenced by a selection process, which determines the inclusion of individuals in the sample. This process can be influenced by observable factors, such as age, gender, and ethnicity, as well as unobservable factors, such as motivation and ability. It is imperative to note that the model postulates that the selection mechanism is uncorrelated with the outcome of interest (i.e., sales volume) given the observed and unobserved factors. In the event of this assumption being violated, the estimates produced by the model may exhibit bias.

Cragg (1971) proposed the double hurdle model, which is a more flexible alternative to other models as it allows for the possibility of different factors influencing the decision to sell a product and the decision of how much to sell. The double hurdle model estimates the likelihood of participation in the market in the first stage and the quantity traded given participation in the second stage. The first hurdle is estimated using a probit model, while the second hurdle uses a truncated normal regression model (Reyes et al., 2012). The truncated normal regression model is fitted using the maximum likelihood estimator, which provides estimates of the partial effects of a variable for each observation. These partial effects can be used to estimate the average partial effect of the variable of interest by averaging across all observations.

The Heckman model and the double hurdle model are two commonly used econometric models that address selection bias. However, they differ in their underlying assumptions. As discussed, the Heckman model assumes that there is a selection process that determines which individuals are included in the sample, and that this selection process is uncorrelated with the

outcome of interest given observable and unobservable factors. The model estimates the probability of selection in the first stage and adjusts for selection bias in the second stage using the inverse Mills ratio. In contrast, the double hurdle model assumes that there are two separate decisions involved in the process being analyzed: the decision to participate in the market and the decision of how much to sell. The model estimates the probability of participation in the first hurdle and the quantity traded given participation in the second hurdle. The double hurdle model does not explicitly address selection bias but assumes that the two decisions are independent. Therefore, the Heckman model focuses on correcting for selection bias in a single decision process, while the double hurdle model assumes two independent decision processes without explicitly accounting for selection bias.

In this thesis, we will utilize both Heckman selection and the double hurdle models to provide a comprehensive empirical analysis. By employing two models, we aim to address the potential limitations and assumptions of each approach and to provide a robust interpretation of the findings.

3. Methodology

3.1.Conceptual framework

The conceptual framework of study is based on Barrett (2008), which assumes that households aim to maximize their utility and that their participation in the market is non-separable, which means that the decision to participate in a market and the decision on how much to sell within that market are interrelated and should be modeled jointly rather than separately. This framework has been widely adapted in previous studies, such as Mzyece (2016) and Burke et al.(2015). On the other hand, Fafchamps & Hill (2005) used a framework that

identifies the factors that impact on the sales volume. However, a major drawback of this approach is that it does not take into account factors that encourage households to participate. The framework used by Barrett (2008) is more suitable for our research as it accounts for both the farmer's decision to participate or not in the market and the level of participation. According to (Bellemare & Barrett, 2006), participation decision is not the same for all households due to the fact that transaction costs are different from one to another and the marketing behavior is not the same in all areas. As mentioned above, Barrett (2008) assumes that a farming household has a goal to maximize their utility either as a net buyer, net seller, or self-sufficient entity. This decision is based on a parametric market price for each crop and crop-specific transaction costs per unit sold, which can vary depending on the household and the crop's location. The model considers two types of transaction costs, one is household-specific and other one is crop and location-specific. That makes market participation differ by crop, household, and location (Bellemare & Barrett, 2006).

Suppose an agricultural commodity x_1 and a commodity for trade is x_2, the decision of the household to join the market as a buyer of the agricultural commodity is M_b, and the choice of the household as a seller of the product is M_s. If the household decides to join the market to buy a product, $M_b = 1$, otherwise $M_b = 0$. Similarly, when the producer sells the product the product in the market, $M_s = 1$, otherwise $M_s = 0$. The price for the agricultural commodity x_1 is P_1 and for the commodity x_2 is P_2. A household chooses the quantity to buy or sell of x_1 and x_2 based on their income constraint. The output function of agricultural commodity x_1 is $Q(A, G)$, where A is household assets used during the production of x_1 and G is road system of the neighborhood or access to information, and credit services. And there is off-farm income that is known as Y.

The household's decision can be expressed by the following optimization problem:

$$\max_{M_b, M_s, x_1, x_2} U(x_1, x_2)$$

subject to

$$P_2 x_2 + M_b P_1 x_1 = M_s P_1 Q(A, G) + Y \quad (1)$$

$$(1 - M_b) x_1 \leq Q(A, G) \quad (2)$$

Assume $P*$ is the market price of product x_1 may include or exclude transaction cost known as $\tau(A, G, Y, Z, NS)$. The transaction cost is the function of A – household assets used during the production of x_1, G – road system of the neighborhood or access to information, credit services, Y – household-special characteristics, Z – off-farm income of the household, NS – the amount traded product. Then the price P_1 can be expressed as,

$$P_1 = P^* + \tau(A, G, Y, Z, NS) \quad \text{if } M_b = 1 \quad (3)$$

$$P_1 = P^* - \tau(A, G, Y, Z, NS) \quad \text{if } M_s = 1 \quad (4)$$

$$P_1 = P_a \quad \text{if } M_b = M_s = 0 \quad (5)$$

where P_a is an autarkic shadow price that equates the supply and demand of the household.

According to the structural model above, we can express each choice variable in terms of observable factors of $A, G, Y, Z, P_1,$ and P^*. The model structure assumes that households' decisions on production and consumption are not separable and so that the prices of goods are endogenous due to transaction costs.

3.2.Empirical Model

As discussed, we assume that milk producers' market participation is non-separable. Therefore, we use two different models that have two stages for marketing decision analysis. We first employ the double hurdle model (Cragg, 1971) based on the non-separability of market participation. In this model, the first hurdle gives estimates about the decision of participation in the market using the probit model, then the second hurdle estimates parameters of the quantity sold using truncated normal regression (Reyes et al., 2012).

The first stage can be expressed as,

$$\varphi = X\beta + e \quad (6)$$

where φ is a vector of latent variable shows the choice of the household to sell the product or not, X is a vector of explanatory variables that affects the participation decision, β is a vector of coefficients explaining participation decision effect, e is a vector of identically independently distributed (i.i.d) error term.

The second stage is expressed as,

$$y = Z\gamma + u \quad (7)$$

where y is the sales volume, Z is a vector of explanatory variables that affects the sales volume, γ is a vector of coefficients and u is i.i.d error term.

Note that y is the observed dependent variable describes the amount of milk sold that is censored at zero:

$$y = \begin{cases} y_i if\ y_i > 0 \\ 0\ if\ y_i \leq 0 \end{cases} \quad (8)$$

We also used Heckman two-stage model. The procedure is similar to double hurdle model. To be more precise, Heckman two stage model also uses the probit model in the first stage to estimate the factors affecting the market participation decision. However, in the second stage, ordinary least squared (OLS) regression is used with the inverse Mills ratio,

$$y = Z\gamma + \delta IMR + u \quad (9)$$

where, y is the vector of sales volume of milk sold by a household, Z is a vector of explanatory variables, γ is a vector of coefficients explaining participation level, IMR is the vector of inverse Mills ratio, $IMR = \boldsymbol{\phi}(Z\gamma) \Big/ \boldsymbol{\Phi}(Z\gamma)$, where $\boldsymbol{\phi}$ and $\boldsymbol{\Phi}$ are the standard normal probability density

function (PDF) and cumulative density distribution (CDF), respectively, and u is the i.i.d error term.

3.3.Data collection

The analysis of this research is based on Life in Kyrgyzstan dataset. The Life in Kyrgyzstan Study (LiK Study) is an open access survey of households and individuals in Kyrgyzstan. The LiK Study was initiated by Professor Tilman Brück and funded by the German Volkswagen Foundation from 2010 to 2012. The project involved various institutions in Central Asia and Europe, and the German Institute for Economic Research is the leading member. Wave 4, which took place from 2013 to 2015, was financed by Department for International Development, UK and Institute of Labor Economics as part of the Growth and Labour Market-Low Income Country Programme, with the Stockholm International Peace Research Institute as the main partner and the University of Central Asia (UCA) as the primary Kyrgyz partner. Several research institutions from Asia, Europe, and North America were also involved. The Leibniz Institute of Vegetable and Ornamental Crops (IGZ) hosted Waves 5 and 6 from 2015 to 2020, which were funded by Food and Agriculture Organization of the United Nations, International Food Policy Research Institute, and IGZ and UCA internally. Sotseconik, a reputable company that provides services in Kyrgyzstan and other Central Asian countries, collected data for the first five waves of the LiK survey, while the survey company SIAR Consult collected data for the sixth wave (The 'Life in Kyrgyzstan' Study, n.d.).

The survey follows 3,000 households and 8,000 individuals in all regions of Kyrgyzstan, including two major cities, Bishkek and Osh. The data collected is nationally representative and covers various topics such as household demographics, assets, expenditure, migration, employment, agricultural markets, shocks, social networks, and subjective well-being, among

others. The survey has been conducted six times, with the first one in 2010, and the latest one in November 2019-February 2020. All members of the households in 2010 are tracked for each wave, and new household members are added and tracked as well. Some topics are covered in each wave, while others are only covered in selected waves. The data from the Life in Kyrgyzstan Study is accessible to anyone interested in non-profit research, policy analysis, and teaching. The project website (https://lifeinkyrgyzstan.org/) provides the survey questionnaires and interviewer manuals for downloading.

Milk production and milk sales data were available in the survey from 2012. Therefore, for our research, we utilized survey data collected in four years, specifically 2012, 2013, 2016, and 2019. As mentioned above, the LIK study surveys around 3,000 households in each wave. At first, we selected a sample of 2,023 observations on 1113 households in the sample data that were milk producers in at least one of the four waves of the survey. After carefully screening of selected data, 1905 observations on 1062 households were suitable for our analysis. 118 observations (51 households) were dropped from the first selected data because there were some missing values in some key explanatory variables.

The explanatory variables in the data generating process are divided into four categories of household characteristics, private assets, public assets, and marketing-related variables. These variables were chosen based on theoretical expectations of their impact on marketing decisions. In total, one dependent and 34 independent variables were utilized to run models (Table 1).

Most variables are self-explanatory; however, we give a more detailed explanation of some variables. There are many ethnic groups in Kyrgyzstan. Kyrgyz ethnic group is dominant in the country with 64.9% of the total population while Uzbeks are 13.8% and Russians are 12.5 % and the remainder is other nations (Faranda & Nolle, 2011).

Table 1. Variable information used in the research

	Variable name in the dataset	Label	Number of models used
Dependent variable			
1	Amount of sold milk	Milk sold, liters	1,2
Independent variables			
Household characteristics			
1	Gender	= 1 if household head is male	1,2
2	Age	Age of household head	1,2
3	Kyrgyz	= 1 if household head is Kyrgyz	1,2
4	Uzbek	= 1 if household head is Uzbek	1,2
5	Russian	= 1 if household head is Russian	1,2
6	Other nation	= 1 if household head is other nationality	1,2
7	Marital status	= 1 if household head is married	1,2
8	Secondary education	= 1 if household head has secondary education	1,2
9	Risk taking level of household head	Risk level of household member (0~10)	1,2
10	Size of the household	Size of the household, number of people	1,2
11	Share of male labor	Share of male labor (0~1)	1,2
12	Dependency ratio	Share of members over 65 or younger than 15 in household (0~1)	1,2
13	Share of members with higher education	Share of members with higher education (0~1)	1,2
14	Ratio of off-farm income	Ratio of off-farm income (0~1)	1,2
Private assets			
15	Total assets value	Total value of all assets, 1000 KGS	1,2
16	Bicycle ownership	= 1 if household owns bicycle	1,2
17	Motorcycle ownership	= 1 if household owns motorcycle or scooter	1,2
18	Car ownership	= 1 if household owns car, pick-up, or van	1,2
19	Tractor ownership	= 1 if household owns tractor, truck, or agricultural machines	1,2
20	Cell phone ownership	= 1 if household owns mobile phone	1,2
21	Land size	household total land size in ha	1,2
Public assets			
22	Distance to agro market	Distance from home to agricultural market, km	1,2
23	Issyk kul	= 1 if household is located in Issyk Kul	1,2
24	Djalal Abad	= 1 if household is located in Djalal Abad	1,2

Table 1 (Cont.)

	Variable name in the dataset	Label	Number of models used
25	Naryn	= 1 if household is located in Naryn	1,2
26	Batken	= 1 if household is located in Batken	1,2
27	Osh	= 1 if household is located in Osh	1,2
28	Talas	= 1 if household is located in Talas	1,2
29	Chui	= 1 if household is located in Chui	1,2
30	Urban	= 1 if household is located in urban area	1,2
Marketing-related variables			
31	Milk price	Price per liter of milk, KGS	1,2
32	Internet access	= 1 if household has internet connection	1,2
33	Environmental affect	= 1 if household has been affected by environmental and climate shocks	1,2
34	Family shock	= 1 if household has been affected by family shocks	1,2

Moreover, there are some differences in the boundaries of ethnic identities. In the data, we have a variable about the ethnic group of the household. Therefore, we would like to see if it affects the decision of the household in terms of market participation. We created 4 dummy variables (kyrgyz, uzbek, russian, other nation) about the ethnic belonging of the household head. Risk taking level of household head describes the risk-taking behavior of the household head, and it is measured 1-10 Likert scale (from risk-averse to risk-seeking). Male labor ratio (male_labor_ratio) was calculated by dividing the male labor to the total number of labor in the household. Dependence ratio (dep_ratio) was estimated by dividing the number of people who were younger than 15 and older than 65 to the total number of people in the family. High education share (high_ed_sh) is ratio of people with high education to the total number of people in the family. Off farm income ratio (off_farm_inc_ratio) was calculated by dividing the off-farm income to the total income of household. Distance to agricultural market (dist_agrmark) is the distance between where the household is located and the agricultural market. We created 7

dummy variables (Issyk_kul, Djalal_Abad, Naryn, etc.) depending on households' location (Figure 1). For instance, in the household is located in Issyk kul region of Kyrgyzstan, the variable of dumIssyk_kul variable is 1. As density of population and the environment are different in each region, people may have different decisions in terms of market participation. Milk price variable (p_milk_l) describes the price of the milk per liter in the local market in the area where the household is located and it is not necessarily the price the household would receive if it sold milk. That is why the price differs from household to household depending on their location.

Figure 1. Map of Kyrgyzstan derived from United Nations Geospatial (2011).

There may be some effect of environment on the participation too, that is why we have included environmental shock (envir_shock) variable if a household has witnessed any damage from nature, such as windstorm, drought, or water shortage in the given year, while family shock

(family_shock) variable tells us if the family has lost any member or has a serious illness in the given year.

4. Results and Findings

4.1.Descriptive Statistics

In this chapter, descriptive results of household, institutional, and market characteristics with respect to market participation are presented. The statistical software Stata and RStudio were used to obtain these results. Different types of tests were run depending on the type of variable to obtain descriptive statistics. For categorical variables, a chi-square test was used, while for continuous variables, a t-test was used.

4.1.1. Household characteristics

As mentioned before, depending on the variable type, we used t test and chi-square test. Household characteristics consist of both continuous and categorical variables. In table 2, we have the results of t-test and all variables in the test were continuous. The average age of individuals who participated in the market was approximately 54 years, whereas the average age of those who did not participate was over 55 years.

Table 2. Household characteristics difference between participants and nonparticipants.

	Mean			P-value
Name of Variables	Non-market participant	Market participant	Overall	
Age of household head	55.437	54.004	54.729	0.017**
Risk taking level of household head (0~10)	4.707	4.631	4.669	0.570
Size of the household	6.299	5.842	6.073	0.000***
Share of male labor (0~1)	0.509	0.491	0.500	0.013**
Dependency ratio (0~1)	0.335	0.320	0.328	0.120
Share of members with higher education (0~1)	0.074	0.065	0.069	0.160
Ratio of off-farm income (0~1)	0.327	0.300	0.314	0.090*

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Number of observations equals 1,905.

The average age of milk producers in general was less than 55 years old. When conducting a two-tailed test, it was discovered that the age variable was statistically significant at a 5% level, suggesting that the average age of market participants was lower compared to non-market participants. The measure of risk propensity for the household heads who were not participating in the market was approximately 4.7, whereas, for the market participants, it was about 4.6. The average measure of risk propensity was approximately 4.7 overall. The outcome of the two-tailed tests indicated that the measure of risk propensity was not statistically significant, suggesting that the eagerness to take risks between the market participants and non-market participants was almost equal. The study found that non-market participants had a mean household size of 6.3 members, while market participants had a mean household size of 5.8 members. The overall mean household size was 6 members. A two-tailed test revealed that the difference in household size between market and non-market participants was statistically significant at the 1% level, indicating that they were not equal.

Table 3. Gender of the household heads

Gender		Non-market participant	Market participant
Female	Frequency	181.000	180.000
	Row percentage	50.140	49.860
	Column percentage	18.800	19.110
Male	Frequency	782.000	762.000
	Row percentage	50.650	49.350
	Column percentage	81.200	80.890
Total		963.000	942.000
Row percentage		50.550	49.450
Column percentage		100.000	100.000
Pearson chi2 = 0.0303 P-value = 0.862			

The mean share of male labor was higher for non-market participant households at a significant level of 5%. Dependency ratio of households showed a similar mean regardless of market decisions. The share of members with higher education was also similar among both market participant and non-market participant households. The ratio of off-farm income among market

and non-market participants was statistically significant at 10 % significance level, meaning that on average households who joined market sales had less off farm income comparing to non-market participants.

Table 3 displays that the proportion of male household heads in the market participant group was 80.89%, while that of female household heads was 19.11%. In contrast, the proportion of male heads in the non-market participant group was 81.2%, while that of females was 18.8%. According to the chi-square test, gender did not have a significant effect, implying that the number of male-headed households that participated in the dairy market was comparable to those who did not participate.

Table 4: Ethnicity.

Ethnicity		Non-market participant	Market participant	Total
Kyrgyz	Frequency	817.000	782.000	1599.000
	Row percentage	51.090	48.910	100.000
	Column percentage	84.840	83.010	83.940
Uzbek	Frequency	112.000	20.000	132.000
	Row percentage	84.850	15.150	100.000
	Column percentage	11.630	2.120	6.930
Russian	Frequency	3.000	22.000	25.000
	Row percentage	12.000	88.000	100.000
	Column percentage	0.310	2.340	1.310
Other nation	Frequency	31.000	118.000	149.000
	Row percentage	20.810	79.190	100.000
	Column percentage	3.220	12.530	7.820
Total		963.000	942.000	1905.000
Row percentage		50.550	49.450	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 129.9103 P-value = 0.000				

Table 4 shows descriptive analysis about ethnicity groups in the dataset. In our sample, around 84% households were Kyrgyz, almost 7% of households were Uzbek while Russians accounted for only over 1% and remaining 8% was other nations. According to the chi-square

test, Ethnicity have a significant effect, implying that Uzbek households were not willing to join market sales while Russians and other nation households were more likely to sell their milk in the market in Kyrgyzstan.

Table 5 presents that among the household heads, 21.21% were unmarried, while 78.79% were married. Similarly, among non-market household participants, 21% of the household heads were unmarried, while 79% were married. The chi-square test indicated that marital status was not statistically significant. This suggests that the proportion of unmarried household heads is approximately the same for both market participants and non-market participants.

Table 5. Marital status of household head

Marital status of household head		Non-market participant	Market participant	Total
Single	Frequency	199.000	205.000	404.000
	Row percentage	49.260	50.740	100.000
	Column percentage	20.660	21.760	21.210
Married	Frequency	764.000	737.000	1501.000
	Row percentage	50.900	49.100	100.000
	Column percentage	79.340	78.240	78.790
Total		963.000	942.000	1905.000
Row percentage		50.550	49.450	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 0.3433 P-value = 0.558				

Table 6. Secondary education status of the head of household

Secondary education status of the head of household		Non-market participant	Market participant	Total
With education	Frequency	227.000	200.000	427.000
	Row percentage	53.160	46.840	100.000
	Column percentage	23.570	21.230	22.410
No education	Frequency	736.000	742.000	1478.000
	Row percentage	49.800	50.200	100.000
	Column percentage	76.430	78.770	77.590
Total		963.000	942.000	1905.000
Row percentage		50.550	49.450	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 1.5003 P-value = 0.221				

The findings in Table 6 indicate that more than 21% of household heads who was involved market had completed secondary education, while the remaining 79% had not did not finish secondary school. Conversely, 76% of household heads who is non-market participants had completed secondary education, while 24% had not completed secondary school. The chi-square test revealed that the educational attainment of the household head was not statistically significant, which suggests that the proportion of household heads without secondary education was similar for among market participants and non-market participants.

4.1.2. Private assets

We can see from that Table 7 that the average value of total assets of households was 1,548,030 KGS, among non-market participants this was around 1,578,750 while for market participants it was almost 1,507,430. Two-tailed test results showed that total household assets value was not statistically significant, suggesting that the variable mean was similar for regardless of marketing decisions. Land owned by a household was 1.88 ha on average in the dataset. While households who were not involved dairy market sales had around 1.7 ha, land owned was over 2 ha for market participants. However, analysis showed that land size is not statistically significant. It is worth to mention that the land owned variable describes the total area that is owned by a household, including, plots, gardens, and building areas.[1]

Table 7. Total value of assets difference between participants and nonparticipants.

	Mean			P-value
Name of Variables	Non-market participant	Market participant	Overall	
Total assets in (KGS, 1000)	1587.749	1507.427	1548.030	0.299
Land size (ha)	1.722	2.049	1.884	0.235

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Number of observations equals 1,905.

[1] In the dataset, there is a lack of information regarding whether households rent any land for agricultural purposes. This may be a potential limitation of the data because there could be households that engage in nomadic practices, utilizing public or government lands through leasing arrangements.

The findings presented in Table 8 indicate that among the market participants, 14.97% owned a bicycle, while 14.54% did not own one. In contrast, 49.32% of non-market participants owned a bicycle, while 50.68% did not. The chi-square analysis showed that there was no statistically significant difference in bicycle ownership between the two groups. This suggests that the distribution of bicycle ownership was similar among market participants and non-market participants.

Table 9 displays that merely 0.96% of market participants possessed a motorcycle, while 99.04% did not. Similarly, only 0.52% of non-market participants owned a motorcycle, while 99.48% did not possess one. According to the chi-square test, there was no statistically significant distinction in motorcycle ownership between the two groups. Therefore, this implies that the distribution of motorcycle ownership was comparable among market participants and non-market participants.

Table 8. Bicycle ownership

Bicycle ownership		Non-market participant	Market participant	Total
No	Frequency	823.000	801.000	1624.000
	Row percentage	50.680	49.320	100.000
	Column percentage	85.460	85.030	85.250
Yes	Frequency	140.000	141.000	281.000
	Row percentage	49.820	50.180	100.000
	Column percentage	14.540	14.970	14.750
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 0.0701 P-value = 0.791				

Table 10 displays that 42.25% of households in the market participant group owned a car, while 57.75% did not. For non-market participants, the corresponding figures were 46.11% and 53.89%. The chi-square analysis indicates that vehicle ownership was statistically significant at

the 10% level, implying that non-market participants owned cars more frequently than market participants.

Table 9. Motorcycle ownership

Motorcycle ownership		Non-market participant	Market participant	Total
No	Frequency	958.000	933.000	1891.000
	Row percentage	50.660	49.340	100.000
	Column percentage	99.480	99.040	99.270
Yes	Frequency	5.000	9.000	14.000
	Row percentage	35.710	64.290	100.000
	Column percentage	0.520	0.960	0.730
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 1.2420 P-value = 0.265				

Table 10. Car ownership

Car ownership		Non-market participant	Market participant	Total
No	Frequency	519.000	544.000	1063.000
	Row percentage	48.820	51.180	100.000
	Column percentage	53.890	57.750	55.800
Yes	Frequency	444.000	398.000	842.000
	Row percentage	52.730	47.270	100.000
	Column percentage	46.110	42.250	44.200
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 2.8699 P-value = 0.090				

Table 11 displays that among market participants, 11.36% owned a tractor while 88.64% did not. In comparison, only 8.83% of non-market participants owned a tractor while 91.17% did not. The chi-square result indicates that the difference in tractor ownership between the two groups is statistically significant at 10%, suggesting that tractor ownership rate was higher among marker participant households than non-market participants.

Table 11. Tractor ownership

Tractor ownership		Non-market participant	Market participant	Total
No	Frequency	878.000	835.000	1713.000
	Row percentage	51.260	48.470	100.000
	Column percentage	91.170	88.640	55.800
Yes	Frequency	85.000	107.000	192.000
	Row percentage	44.270	55.730	100.000
	Column percentage	8.830	11.360	44.200
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 3.3691 P-value = 0.066				

Table 12 the results demonstrate that over 95% of market participants possessed a mobile phone, while only less than 5% did not. Similarly, almost 94 % of non-market participants owned a cell phone, while solely 6% did not possess one. According to the chi-square test, there was no statistically significant distinction in mobile phone ownership between the two groups. Therefore, this implies that the distribution of cell phone ownership was comparable among market participants and non-market participants.

Table 12. Mobile phone ownership

Cell phone ownership		Non-market participant	Market participant	Total
No	Frequency	58.000	43.000	101.000
	Row percentage	57.430	42.570	100.000
	Column percentage	6.020	4.560	5.300
Yes	Frequency	905.000	899.000	1804.000
	Row percentage	50.170	49.830	100.000
	Column percentage	93.980	95.440	94.700
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 2.0164 P-value = 0.156				

4.1.3. Public assets

Table13 shows that Distance to agro market in two group of households were statistically significant at the 10% level, indicating that market participant households were located closer to agro market than non-market participants.

Table 13. Public assets

	Mean			P-value
Name of Variables	Non-market participant	Market participant	Overall	
Distance to agro market	11.033	10.663	10.850	0.535*

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Number of observations equals 1,905.

Table 14 shows descriptive analysis about 7 regions in the dataset. In our samples, almost 60% the observations' household location was in the three regions of Issyk kul, Djalal Abad, and Osh, accounting for 20.31%, 17.74% and 20.58%. The remaining approximate 40% of observations had houses in Naryn, Batken, Talas, and Chui, being 4.15%, 13.39%, 10.66% and 13.18% in turn. According to the chi-square test, location of household in the region had a significant effect, implying that households located in Chui, Talas and Issyk kul were more willing to participate market while people in Osh, Batkan, Naryn and Djalal Abad had vise verse behavior in terms of market participation.

Table 14 gave details about regions while table 15 shows descriptive analysis about urban location. Almost 95% of households were located in non-urban area in the dataset. As p value is significant at 1% significant interval in the chi-square test, we can say that urban location of household had a significant effect on behavior of house hold in terms of market decisions. That means, households located in urban area were more eager to sell their milk in markets.

Table14. Region difference between participants and nonparticipants.

Region		Non-market participant	Market participant	Total
Issyk kul	Frequency	162.000	225.000	387.000
	Row percentage	41.860	58.140	100.000
	Column percentage	16.820	23.890	20.310
Djalal Abad	Frequency	221.000	117.000	338.000
	Row percentage	65.380	34.620	100.000
	Column percentage	22.950	12.420	17.740
Naryn	Frequency	74.000	5.000	79.000
	Row percentage	93.670	6.330	100.000
	Column percentage	7.680	0.530	4.150
Batken	Frequency	177.000	78.000	225.000
	Row percentage	69.410	30.590	100.000
	Column percentage	18.380	8.280	13.390
Osh	Frequency	291.000	101.000	392.000
	Row percentage	74.230	25.770	100.000
	Column percentage	30.220	10.720	20.580
Talas	Frequency	11.000	192.000	203.000
	Row percentage	5.420	94.580	100.000
	Column percentage	1.140	20.380	10.660
Chui	Frequency	27.000	224.000	251.000
	Row percentage	10.760	89.240	100.000
	Column percentage	2.800	23.780	13.180
Total		963.000	942.000	1905.000
Row percentage		50.550	49.450	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 548.8857 P-value = 0.000				

Table 15. Urban location

Urban location		Non-market participant	Market participant	Total
No	Frequency	928.000	877.000	1805.000
	Row percentage	51.410	48.590	100.000
	Column percentage	96.370	93.100	94.750
Yes	Frequency	35.000	65.000	100.000
	Row percentage	35.000	65.000	100.000
	Column percentage	3.630	6.900	5.250
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 10.2107 P-value = 0.001				

4.1.4. Marketing-related variables

It is evident from the Table 16 that average milk price in the area where non market participant households were located was 22 KGS per liter while it was reported as almost 18 KGS in the neighborhood of market participant households. Average milk price was approximately 20 KGS for a liter of milk for all the data. As the p-value is significant at 1% level, we can say that there was significant difference in the mean of milk price for the areas of market participant and non-market participant households.

Table 16. Milk price difference between participants and nonparticipants.

Name of Variables	Mean			
	Non-market participant	Market participant	Overall	P-value
Milk price (Per litres)	21.914	17.697	19.829	0.000***

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Number of observations equals 1,905.

Table 17 shows that almost 95% of households in our sample did not have internet access. According to the chi-square test, there was statistically significant distinction at 5% level in internet access frequency between the two groups. That means, the distribution of internet access was different between market participants and non-market participants.

Table 17. Internet access

Internet access		Non-market participant	Market participant	Total
No	Frequency	933.000	891.000	1824.000
	Row percentage	51.150	48.850	100.000
	Column percentage	96.880	94.590	94.750
Yes	Frequency	30.000	51.000	81.000
	Row percentage	37.040	62.960	100.000
	Column percentage	3.120	5.410	4.250
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 6.1808 P-value = 0.013				

Table 18 reveals statistics about environmental damage to the household. Almost 65% of households in the sample data had environmental shock. The result of the chi-square shows that the occurrence of environmental damage was statistically significant indicating that market participant households faced more environmental damage than non-market participants.

Table 18. Environmental affect

Environmental affect		Non-market participant	Market participant	Total
No	Frequency	375.000	294.000	669.000
	Row percentage	56.050	43.950	100.000
	Column percentage	38.940	31.210	35.120
Yes	Frequency	588.000	648.000	1236.000
	Row percentage	47.570	52.430	100.000
	Column percentage	61.060	68.790	64.880
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 12.4898 P-value = 0.000				

Table 19 presents information on the family shock experienced by the households. Approximately 20% of households in the sample reported experiencing a family shock. The chi-square test results indicate that the incidence of family shock was not statistically significant, indicating that the occurrence of family shock was evenly distributed between the market participant and non-market participant groups.

Table 19. Family shock.

Family shock		Non-market participant	Market participant	Total
No	Frequency	766.000	765.000	1531.000
	Row percentage	50.030	49.970	100.000
	Column percentage	79.540	81.210	80.370
Yes	Frequency	197.000	177.000	347.000
	Row percentage	52.670	47.330	100.000
	Column percentage	20.460	18.790	19.630
Total		963.000	942.000	1905.000
Row percentage		50.550	49.550	100.000
Column percentage		100.000	100.000	100.000
Pearson chi2 = 0.8388 P-value = 0.360				

4.2.Econometric results

As mentioned in earlier sections, we use two models to determine factors of market decision by households in Kyrgyzstan. Heckman two-step model is a powerful tool for addressing selection bias while double hurdle model is known for improved estimation efficiency. The inverse Mills ratio coefficient of the Heckman two-step model was significant (inverse Mills ratio = -1525.787, P value = 0.045), suggesting the possibility of sample selection issues in our dataset. Therefore, our main interpretation is based on the results of the Heckman two-step model. In the next sections, we compare the output of two models: the Heckman two-step and the double hurdle.

4.2.1. Estimation of factors influencing market participation decision.

Even though we utilize two different models, we use the same variables in both models. Table 20 shows the estimated market participation probability of independent variables. In terms of household characteristics, Uzbek and Russian (ethnic group of household) are highly significant.

The probability of milk sales participation is reduced by 59% for Uzbek households and increases by 85% Russian household compared to Kyrgyz households. Dependency ratio and ratio of male labor are also significant factors for the likelihood of participating in market sales. Having relatively more male labor or dependents in the household decreases the probability of market participation. Total value of assets has positive impact on milk market participation by households in Kyrgyzstan. A car ownership by a household decreases market participation by almost 21%, which is not intuitively straightforward. The observed negative association may potentially be attributed to a cultural trait prevalent in Central Asian countries. Specifically, it is notable that the region tends to feature lower taxi fares relative to other nations. Moreover, it is possible that households that possess private vehicles predominantly utilize them for

Table 20. Estimation of factors influencing market participation decision.

	Variable name in the dataset	Double hurdle	Heckman
Household characteristics			
1	Gender	0.239	0.239
2	Age	-0.005	-0.005
3	Uzbek	-0.593***	-0.593***
4	Russian	0.851**	0.851**
5	Other nation	-0.021	-0.021
6	Marital status	-0.208	-0.208
7	Secondary education	-0.013	-0.013
8	Risk taking level of household head	-0.012	-0.012
9	Size of the household	-0.003	-0.003
10	Ratio of male labor	-0.397*	-0.397*
11	Dependency ratio	-0.388**	-0.388**
12	Ratio of members with higher education	-0.278	-0.278
13	Ratio of off-farm income	-0.026	-0.026
Private assets			
14	Total assets value	0.0001**	0.0001**
15	Bicycle ownership	-0.115	-0.115
16	Motorcycle ownership	-0.138	-0.138
17	Car ownership	-0.209**	-0.209**
18	Tractor ownership	0.080	0.080
19	Cell phone ownership	0.086	0.086
20	Land size	-0.007	-0.007
Public assets			
21	Distance to agro market	-0.007**	-0.007**
22	Djalal Abad	-0.109	-0.109
23	Naryn	-1.635***	-1.635***
25	Osh	-0.458***	-0.458***
26	Talas	1.468***	1.468***
27	Chui	1.282***	1.282***
28	Urban	0.179	0.179
Marketing-related variables			
29	Milk price	-0.993***	-0.993***
30	Internet access	-0.052	-0.052
31	Environmental affect	0.081	0.081
32	Family shock	-0.302***	-0.302***

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Number of observations equals 1,905.

non-agricultural activities, thereby generating revenue from their cars. Distance from the household to agricultural market has a negative effect on the likelihood of market participation, suggesting that the additional 1 kilometer distance decreases the market participation probability by 0.7%. Most regional locations are statistically significant. As we did not include Issyk kul region in the model, the coefficients are showing difference with Issyk kul region. For instance, household located in Batken region is almost 30% less likely to sell milk compared to the households in Issyk kul region.

In terms of market related variables, log of milk price is statistically significant with negative impact on the market participation. As mentioned in previous sections, milk price is the price of the milk per liter in the local market in the area where the household is located. In the dataset, we did not have the price that the household would receive if they sold milk. Family shock negatively and significantly influences on the milk market participation, decreasing the participation probability by 30%. As we can see from table 20 that the results from double hurdle model and Heckman two step model are identical. The reason for that is both models uses probit regression in the first stage.

4.2.2. Estimation of factors influencing on the extend of market participation.

The output from the second stage in the double hurdle model was similar in the Heckman two-step model to a certain extent. Household head's age and risk-taking willingness are significant and positive factors on the volume of sales according to both double hurdle model and Heckman two-step model. A one year increase in the household head's age results in an increase of household milk sales of 10.7 liters according to Heckman two step model and 8.4 liters according to double hurdle model. This can be explained that the more household gets older, the more they will be experienced in sales and get benefit from higher volume sales.

Double hurdle model estimates that an additional one level of risk-taking willingness by head of household increases milk sales by 25 liters in a year while this increase is almost 86 liters according to Heckman two step model. Additional one percentage point increase in dependent ratio of household can increase the annual milk sales by 6.37 liters according to Heckman two step model. Higher education ratio and off-farm income ratio are statistically significant in Heckman model showing that a one percentage point increase in the ratio of higher education in the household increases milk sales by about 11.64 liters yearly, however a one percentage point increase in off-farm income to total household income encourages households to decrease sales 4.17 liters.

Increase of total value of assets enable higher volume of milk sales by households. If the total value of household assets goes up one Kyrgyz sum, it may lead to 0.08 or 0.17 liters more milk sales.

Heckman model results indicate that car owner households sell approximately 311 liters more milk in a year while motorcycle ownership increases sales by 2153 liters but these factors are not significant in double hurdle model with a negative impact.

Additional one-hectare land leads 68 liters more milk sales according to Heckman model; on the other hand, it was also not significant with negative impact in double hurdle model result.

Both models suggested that the longer distance to the agricultural market has negative impact on market decision but it has positive impact on the extent of participation. Once the decision on participation has been made, the participant household wants to increase the volume so that they can decrease the transportation cost per liter of milk. All regions except Batken are statistically significant in the Double hurdle model and suggests that if the household in Osh, Naryn and Djalal Abad, the household sells less milk than the household in Issyk Kul.

Table 21. Estimates of factors influencing milk sales volume.

	Variable name in the dataset	Double hurdle	Heckman
Household characteristics			
1	Gender	134.616	-21.694
2	Age	8.404***	10.673*
3	Uzbek	-193.499	644.396
4	Russian	356.305	-623.656
5	Other nation	112.952	-91.012
6	Marital status	-10.980	115.268
7	Secondary education	114.557	69.164
8	Risk taking level of household head	25.075*	85.751***
9	Size of the household	-3.334	-13.214
10	Ratio of male labor	499.372**	698.326
11	Dependency ratio	4.381	637.294*
12	Ratio of members with higher education	-64.360	1164.902**
13	Ratio of off-farm income	-160.700	-417.572*
Private assets			
14	Total assets value	0.082***	0.166***
15	Bicycle ownership	68.793	172.166
16	Motorcycle ownership	-131.935	2152.851**
17	Car ownership	-45.374	310.851*
18	Tractor ownership	168.564	326.924
19	Cell phone ownership	136.325	-334.640
20	Land size	-7.444	68.534**
Public assets			
21	Distance to agro market	7.734***	26.714***
22	Djalal Abad	-760.163***	-1006.982***
23	Naryn	-861.536***	1184.307
24	Batken	-162.577	507.273
25	Osh	-893.932***	-393.984
26	Talas	759.783***	-434.264
27	Chui	1437.098***	782.997*
28	Urban	-379.270***	-757.957**
Marketing-related variables			
29	Milk price	-642.101***	414.770
30	Internet access	38.353	76.900
31	Environmental affect	-71.114	-53.378
32	Family shock	-116.230	377.989*
The inverse Mills ratio = -1525.787, P value = 0.045			

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1%, respectively.

However, milk market participation level of households in Talas and Chui is higher than Issyk Kul. Table 22 shows the average milk production and average milk sales volume by region. It is evident that more production or higher density level does not mean higher milk sales rate by a region. For instance, Issyk Kul is the most populated region but Chui has more sales volume than Issyk Kul. There may be other factors of the region that influence on sales.

Table 22. Household milk production and sales by region.

Region	Average milk production by a household (in liters)	Average milk sales by a household (in liters)	Percentage sold	Density (km^2/# of population)
Issyk Kul	1320	1022	77%	80
Djalal Abad	748	193	26%	40
Naryn	1175	116	10%	7
Batken	1030	393	38%	33
Osh	534	93	17%	49
Talas	2053	1906	93%	20
Chui	2168	2085	96%	50

Density information is derived from http://www.stat.kg/ru

Heckman model suggests that urban location of household is not significant factor on market participation decision but after decision has been made, it has negative impact on the volume of milk sales, suggesting that if the household is located in urban area, their sales volume is 758 liters less than a household in non-urban area. This is because in urban area, the household cannot expand their production output.

The results from the double hurdle model show that one percent increase of milk price decreases about 642 liters of yearly milk sales by a household, while this factor is not significant with positive impact on sales volume in Heckman two step model.

Family shock has negative effect on the market participation, on the other hand, it increases the sales volume by 378 after the participation decision has been made. For example, a family shock of a member of household dies, they may decrease the milk consumption volume in some extent and sell more.

We also tried to run our models with share of milk production sold (share of milk production sold =sales volume/production level) as the dependent variable and the same 34 explanatory variables. This is useful to see how the coefficients will be different from the previous model. In Table Annex 23, we have the results of the first stage, which are the same as the results in Table 20, while Table Annex 24 shows the second stage results. The coefficients in Table Annex 24 from the second stage show the percentage changes and there are some differences compared to the previous results when sales volume is dependent variable (Table 21). Heckman two step model shows that the inverse Mills ratio equals 0.029102 and P value equals 0.699, that means, if we run the model where sales share as a dependent variable, there is not enough evidence for sample selection issues in our dataset. Therefore, here the assumption is based on the result of double hurdle model. The results show that Uzbek households sales shares is 11% less than Kyrgyz household. Additionally, if the household head has secondary education, their sales share is 4% higher than the household whose head does not have secondary education. In this model the milk price also has a negative effect according double hurdle result suggesting that if the price increases, household decreases share of sales by 28%.

5. Conclusion and recommendation Recommendations

5.1.Conclusions

The dairy industry plays a crucial role in the agricultural sector of numerous developing countries. Despite its importance, there is limited knowledge regarding the factors that motivate milk producers to participate in the milk market as sellers, as well as how these factors influence the quantities of milk sold by market participants. The primary objective of this study was to explore the key factors that drive milk producers to enter the milk market as sellers in Kyrgyzstan and the factors that impact the quantities of milk sold among market participants.

We utilized the Life in Kyrgyzstan dataset. The survey is nationally representative and covers a range of topics, including household demographics, assets, expenditure, migration, employment, agricultural markets, shocks, social networks, and subjective well-being, among others. We had 1905 observations and 34 variables in the dataset.

Regional location and ethnic origin have not been discussed as factors in the previous literature. However, we incorporated such variables and estimated their impact via two different models (double hurdle and Heckman two step). While some key factors were significant in both models, others were only significant in one model.

The results of this study hold significance in establishing effective interventions that can empower rural smallholder farmers in Kyrgyzstan and neighboring countries to engage in the market actively. By identifying the key factors that affect market participation, policymakers can prioritize and implement targeted interventions that are likely to yield the most significant impact.

Findings suggest that in terms of household characteristics, some ethnic groups, and ratio of male labor and dependency ratio in the household have negative impact on market participation; once the decision has been made, age, risk-taking willingness of household head and higher dependency ratio can increase the volume of the yearly milk sales. However, off-farm income has a negative effect on sales volume.

Concerning to private assets, findings from both models suggests that total value of assets has positive effect on market participation and the volume of the participation. Car ownership has negative impact on marketing decision but once the decision has been made motorcycle and car ownerships enable household to increase their capacity of milk sales. The land size has positive impact on the volume of sales.

Public assets, such as most of region locations, have an impact on the marketing decision. Also, the distance to agricultural market has a negative impact on marketing decision. On the other hand, an additional one kilometer distance from household to market increases milk sales by household. A household in Chui sells more milk than a household in Issyk Kull but a household in Djalal Abad region sells less milk than a household in Issyk Kull. An urban location of household has negative impact on sales volume relative to a rural location.

Analyses show that encountering a family shock creates a barrier to entering the milk market, however once the decision has been made, the household is likely to increase the sales even if they have a family shock.

Based on the results of the study, we may conclude that regions with a negative impact on sales need more attention by the government or policymakers. The value of total assets was found as a significant factor, therefore, encouraging household to own more technology that can be used in dairy production can increase the number of dairy market participants and the sales volume. In addition, better market infrastructure should also be considered by policymakers as distance to markets was statistically significant with a negative effect on market participation. Government should also take equal opportunities for all regardless of their origin ethnic group due to the fact that the ethnic group of household was statistically significant, meaning that there may be some barriers for households who are other than Kyrgyz.

5.2.Further research

In the research, we analyzed 34 independent variables to find out if they have an impact on market participation or volume of milk sales. All variables were chosen based on previous literature and data availability. However, we were not able to capture all relevant variables, such as credit availability for the household or the quality of roads or electricity access for the

household. As milk is a perishable product, storing milk requires technology based on electricity and perhaps credit to have sufficient funds to purchase the technology. Therefore, future research could include variables on household access to electricity or if credit is easily accessible to purchase new assets.

6. Annexes

Table Annex 23. Estimation of factors influencing market participation decision (share of sales as dependent variable).

	Variable name in the dataset	Double hurdle	Heckman
Household characteristics			
1	Gender	0.239	0.239
2	Age	-0.005	-0.005
3	Uzbek	-0.593***	-0.593***
4	Russian	0.851**	0.851**
5	Other nation	-0.021	-0.021
6	Marital status	-0.208	-0.208
7	Secondary education	-0.013	-0.013
8	Risk taking level of household head	-0.012	-0.012
9	Size of the household	-0.003	-0.003
10	Ratio of male labor	-0.397*	-0.397*
11	Dependency ratio	-0.388**	-0.388**
12	Ratio of members with higher education	-0.278	-0.278
13	Ratio of off-farm income	-0.026	-0.026
Private assets			
14	Total assets value	0.0001**	0.000**
15	Bicycle ownership	-0.115	-0.115
16	Motorcycle ownership	-0.138	-0.138
17	Car ownership	-0.209**	-0.209**
18	Tractor ownership	0.080	0.080
19	Cell phone ownership	0.086	0.086
20	Land size	-0.007	-0.007
Public assets			
21	Distance to agro market	-0.007**	-0.007**
22	Djalal Abad	-0.109	-0.109
23	Naryn	-1.635***	-1.635***
24	Batken	-0.295*	-0.295*
25	Osh	-0.458***	-0.458***
26	Talas	1.468***	1.468***
27	Chui	1.282***	1.282***
28	Urban	0.179	0.179
Marketing-related variables			
29	Milk price	-0.993***	-0.993***

Table Annex 23 (Cont.)

	Variable name in the dataset	Double hurdle	Heckman
30	Internet access	-0.052	-0.052
31	Environmental affect	0.081	

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Number of observations equals 1,905.

Table Annex 24. Estimates of factors influencing milk sales volume as a share of total milk production.

	Variable name in the dataset	Double hurdle	Heckman
Household characteristics			
1	Gender	0.026	0.026
2	Age	0.000	0.001
3	Uzbek	-0.111**	0.017
4	Russian	0.151	0.061
5	Other nation	0.048	0.040
6	Marital status	0.008	0.057*
7	Secondary education	0.045*	0.070***
8	Risk taking level of household head	0.000	0.006**
9	Size of the household	0.003	0.000***
10	Ratio of male labor	0.067	0.120
11	Dependency ratio	-0.050	0.019
12	Ratio of members with higher education	-0.077	0.034
13	Ratio of off-farm income	-0.002	-0.033
Private assets			
14	Total assets value	0.000**	0.000
15	Bicycle ownership	-0.038	0.033*
16	Motorcycle ownership	-0.123	0.023
17	Car ownership	-0.043**	0.012
18	Tractor ownership	0.013	0.017
19	Cell phone ownership	-0.026	0.004
20	Land size	-0.002	0.002
Public assets			
21	Distance to agro market	-0.001	0.001
22	Djalal Abad	-0.125***	0.181***
23	Naryn	-0.362***	0.412***
24	Batken	-0.157***	0.163***
25	Osh	-0.199***	0.179***
26	Talas	0.206***	0.041

Table Annex 24 (Cont.)

	Variable name in the dataset	Double hurdle	Heckman
27	Chui	0.228***	0.016
28	Urban	0.005	0.017
Marketing-related variables			
29	Milk price	-0.281***	0.097**
30	Internet access	-0.020	0.010
31	Environmental affect	0.035	0.033**
32	Family shock	-0.076***	0.017
The inverse Mills ratio = 0.029102, P value = 0.699			

*, **, *** indicates the corresponding coefficients are significant at the 10%, 5%, and 1%, respectively.

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