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Determinants of Milk Marketing Channel Selection by Urban and Peri-Urban Commercial Dairy Producers in Ethiopia

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አህፅሮት

ይህ ጥናት ገበያ ተኮር የወተት ላሞች ርባታ ላይ የተሰማሩ የወተት አምራቾች የጥሬ ወተት ግብይት መንገዶችን ለማጥናት እና የአምራቾችን የመሸጫ (የግብይት) አማራጮች (ቻናል) አመራረጥን የሚወስኑ ጉዳዮችን ለመለየት የተካሄደ ነዉ። ጥናቱን ለመተግበር በዋና ዋና ከተሞች እና በከተሞች ዙሪያ በተለያየ የሥራ ስፋት የወተት ላሞች ርባታ ላይ ከተሰማሩ 475 አካላት ጥሬ መረጃ ተሰብስቧል። ትንተናዉም የተለያዩ ገላጭ ዘዴዎችንና በዘ ያሉ አማራጮችን መሠረት ያደረጉ ሞዴሎች (መልቲ ቫሪዬት ፕሮቢት ሞዴል) በመጠቀም ተከናውኗል። የጥናቱ ዉጤት እንደሚያሳየዉ ምንም እንኳን በወተት ርባታዉ ላይ የተሰማሩት አካላት የተለያዩ የወተት መሸጫ አማራጮች ቢኖሯቸዉም የወተት ሽያጩ በዋናነት የሚካሄደዉ በኢ-መደበኛ የግብይት አማራጭ ነዉ። የመልቲ ቫሪዬት ፕሮቢት ትንተና ዉጤቱ እንደሚያሳየዉ የወተት አምራቾቹ የትምህርት ደረጃ እና በላሞች ርባታ ላይ ያካበቱት የሥራ ልምድ፣ የሥራዉ ስፋት፣ የወተት መሸጫ ቦታ ርቀት፣ በወተት ላሞች ርባታ የኅብረት ሥራ ማኅበር አባልነት፣ በእያንዳንዱ የወተት መሸጫ አማራጭ የሚቀርበዉ የወተት ዋጋ እና የወተት ላሞች ርባታዉ የሚከናወንባቸዉ ቦታዎች የወተት አምራቹ የሚሸጥበትን ቻናል የሚወስኑ ጉዳዮች ናቸዉ። ስለዚህ አሁን ያለዉን ኢ-መደበኛ የወተት ግብይት ወደ መደበኛዉ ለመቀየር የሚቀየስ የግብይት ሥልት ግብይቱን ማዘመን ላይ የተኮረ መሆን እንዳለበት ጥናቱ አመልክቷል። ይህን ስልት ተግባራዊ ለማድረግ ከሚረዱ ተግባራት መካከል መደበኛና ኢ-መደበኛ ስልጠናዎችን ለወተት አምራቾች በመስጠት መደበኛ ግብይቱን እንዲቀላቀሉ ማድረግ፣ የወተት ማቀነባበሪያ ፋብሪካዎችን በማጠናከር እና በሁሉም ትላልቅ ከተሞች ላይ እንዲመሠረቱ ሁኔታዎችን በማመቻቸት ለወተት አምራቾቹ ጥሩ የገበያ አማራጭ እንዲሆኑ ማድረግ፣ የወተት አምራች የኅብረት ሥራ ማህበራትን አቅም በመገንባት ከወተት አምራቾቹ ወተት የመሰብሰብ ሚናቸዉን እንዲወጡ ማድረግ፣ የወተት ማቀነባበሪያ ፋብሪካዎች በከተማ ዳር እንደሚያደርጉት ሁሉ በትላልቅ ከተሞች ዉስጥም የወተት መሰብሰቢያ ጣቢያዎችን በማቋቋም በኢ-መደበኛ መንገድ የሚሸጠዉን ጥሬ ወተት ወደ መደበኛ ግብይት የመቀየሩን ሂደት ከማሳለጣቸዉም በላይ የማቀነባበሪያ ፋብሪካቸዉን ሙሉ አቅም በመጠቀም የወተት ዘርፉን ትርፋማነት መጨመር ይቻላል።

Abstract

This study investigated the determinants of raw milk marketing channel choice of dairy producers using cross-sectional data collected from 475 commercial dairy farms in selected towns of Ethiopia. Descriptive statistics and a multivariate probit (MVP) model were used to analyze the data. The result showed that milk marketing channel of the surveyed farms was dominated by an informal marketing system. The results of the MVP indicated that education, farm experience, farm size, market distance, membership in local dairy cooperatives, price, and farm locations had a

significant impact on the choices of milk market channel. We suggest that efforts to improve the performance of the commercial farms' milk marketing need to be geared towards modernizing the raw milk marketing. That could include arranging formal and informal training for dairy producers, strengthening the milk processing industries in all major cities so that they can be a feasible marketing option for dairy producers; strengthening existing dairy cooperatives to facilitate milk collection; and organizing milk collection centers in cities by processing companies.

Keywords: Multivariate probit model, market channel, commercial dairy farms

Introduction

Dairy farming is one of the important segments of the urban and peri-urban agriculture that deals with the production, processing and marketing of milk and milk products in the urban centres (Rey *et al*., 1993; Gillah *et al*., 2012). Studies revealed that urban and peri-urban dairy farming has a significant contribution for the economies of East African countries through increased income, employment generation, food and nutrition security, organic waste recycling and uplifting social status (Gillah *et al*., 2012; Kang'ethe *et al*., 2010; Yitaye *et al*., 2011). The contribution of the urban and per-urban dairy farming is also high in supplying fresh milk to urban consumers (Demissie *et al*., 2014).

In Ethiopia, dairy production system is broadly classified into three as rural, urban and peri-urban dairy production systems based on location of operation (Tsehay, 2001). The urban and peri-urban dairy production system is characterized by market-oriented production system with commercial nature of dairy farming activities. In this system, high grade dairy cows are mainly used to produce and sell raw milk through different milk marketing channels. Although the urban and peri-urban dairy production system usually enjoy an advantage of better market access for milk and milk products, they also face milk marketing problems in practice. One of the marketing problems is price instability especially during the Orthodox Christian fasting seasons (Sintayehu *et al*., 2008). Milk and other dairy product demand decrease during the fasting season which results in drop of prices. Urban dairy producers are obliged to process unsold milk whereas part of the milk is spoiled during this time. Milk marketing system in Ethiopia is mainly characterized by informal marketing system in which the majority of the raw milk produced is directly sold to consumers or middlemen that sell raw milk to consumers without passing through processing plants and in the absence of legal processes such as government tax and trade related regulations (Belete *et al*., 2010; Sintayehu *et al*., 2008; Zegeye, 2003).

Marketing channel choice through which urban and peri-urban dairy producers sell their raw milk is a key decision area because, choosing a profitable channel requires a wise decision as it has a direct implication on the farm revenue and

profitability (Dassou *et al*., 2019; Fałkowski, 2012; Fałkowski *et al*., 2013; Kumar *et al*., 2019; Sharma, 2015). In addition, evidence shows that consumers in developing countries, including Ethiopia, are under emerging food system transformation with rapidly changing preferences and shopping habit (Tschirley *et al*., 2014). Therefore, the informal milk marketing channel, that involves direct selling to consumers, may not continue to be a major option for selling milk and hence milk producers need to consider these facts and search for several alternative channels to sell milk.

Ethiopia offers an ideal case to study the choice of raw milk marketing channel along with the drivers behind these choices for a number of reasons. First, there is a missing marketing link between the formal milk processing companies, which are potential buyer of raw milk, and dairy producers in Ethiopia. Studies have shown that formal milk processing companies in Ethiopia are operating at less than half of their full capacity (AACCSA, 2016; Mulugeta *et al*., 2019). On the other hand, dairy producers that operate in and around major cities in Ethiopia face milk marketing problems, especially during fasting periods resulting in low milk prices and high milk wastage (Adam *et al*., 2019; Solomon *et al*., 2016). Second, Ethiopia has the fifth largest cattle population in the world (FAO, 2020) yet a net importer of dairy products (Zelalem *et al*., 2017), a paradox that makes understanding domestic marketing important. Third, the growing urbanization that creates high demand for milk needs to be understood for the urban and peri-urban dairy producers' milk marketing channel choice decision in Ethiopia.

Previous studies in East African countries and India showed that the decision by dairy farmers on their choice of milk marketing channel is influenced by major factors that could be categorized as producers characteristics such as age, education level, farm experience, and labor availability; farm characteristics such as farm size, number and types of cows, the volume of milk produced, location of the farm; and institutional factors including extension, credit and market information services, and market channel-related factors including price and mode of payment, and their distance from the producers' village (Berem *et al*., 2015; Berhanu *et al*., 2013; Huang *et al*., 2012; Innocent *et al*., 2018; Ishaq *et al*., 2017; Mengistu *et al*., 2016; Mohammed *et al*., 2020; Moturi *et al*., 2015; Mutura *et al*., 2015; Sharma, 2015; Singh, 2018; Staal *et al*., 2006; Tadele and Tewodros, 2013; Vykhaneswari and Devi, 2019; Zegeyesh *et al*., 2017).

Among the producers' characteristics, age of the farm operator was found to influence milk producers' market channel choice decision (Berem *et al*., 2015; Huang *et al*., 2012; Ishaq *et al*., 2017; Sharma, 2015; Singh, 2018). Similarly, past studies found that education level of the farm operator was a key factor for milk market channel choice (Berem *et al*., 2015; Ishaq *et al*., 2017; Mengistu *et al*., 2016; Moturi *et al*., 2015; Mutura *et al*., 2015; Sharma, 2015; Singh, 2018; Tadele

and Tewodros, 2013; Zegeyesh *et al.,* 2017). Studies indicated that farm experience was one of the producers' characteristics that affect the choice of milk market channel (Berem *et al*., 2015; Berhanu *et al*., 2013; Mohammed *et al*., 2020).

Studies revealed that farm characteristics such as number of cows owned and herd size had significant impact on milk market channel choice decision (Berhanu *et al*., 2013; Huang *et al*., 2012; Ishaq *et al*., 2017; Mohammed *et al*., 2020; Moturi *et al*., 2015; Mutura *et al.,* 2015; Sharma, 2015; Tadele and Tewodros, 2013; Zegeyesh *et al*., 2017). Similarly, breed type was found to significantly influence milk market channel choice (Mengistu *et al*., 2016). Milk buyers' related factors such as purchase frequency and quantity purchased were found to significantly influence milk market channel choice (Berem *et al*., 2015). Findings also attested that mode of payment was a significant factor of milk market channel choice (Berhanu *et al*., 2013; Innocent *et al*., 2018; Ishaq *et al*., 2017; Singh, 2018; Staal *et al*., 2006). Previous studies also revealed that milk quality requirement significantly affect the choice of milk market channel (Huang *et al*., 2012; Innocent *et al*., 2018; Ishaq *et al*., 2017; Singh, 2018). Studies also indicated that milk selling price had a significant influence on milk market channel choice decision (Berem *et al*., 2015; Berhanu *et al*., 2013; Ishaq *et al*., 2017; Moturi *et al*., 2015; Sharma, 2015; Singh, 2018; Tadele and Tewodros, 2013; Vykhaneswari and Devi, 2019).

Past studies also revealed that distance from point of milk production to milk market had significant impact on the decision to choose milk market channel (Berhanu *et al*., 2013; Huang *et a*l., 2012; Ishaq *et al*., 2017; Moturi *et al*., 2015; Sharma, 2015; Singh, 2018; Staal *et al*., 2006; Vykhaneswari and Devi, 2019; Zegeyesh *et al*., 2017). Institutional factors such as access to credit (Innocent *et al*., 2018), market information (Innocent *et al*., 2018; Mutura *et al.*, 2015; Zegeyesh *et al*., 2017), extension services (Berhanu *et al*., 2013; Ishaq *et al*., 2017; Staal *et al*., 2006; Zegeyesh *et al*., 2017), and membership of dairy cooperatives (Berhanu *et al*., 2013; Moturi *et al*., 2015; Sharma, 2015; Mohammed *et al*., 2020) were key factors affecting milk market channel choice of milk producers.

The focus of the past studies on milk marketing channel selection was smallholder dairy producers with less attention given to urban and peri-urban commercial dairy producers operating at different scales. However, choice of milk market channel also matters for urban and peri-urban commercial dairy producers. Another limitation of the past studies was the methodological approach. The analytical model widely utilized for the econometric analysis was the multinomial logit (MNL) model, which fails to address interdependent decisions to sell milk to more than one channel. The exceptions were the work by Mohammed *et al*. (2020)

and Zegeyesh *et al*. (2017) who utilized the multivariate probit (MVP) model. However, both covered only smallholder dairy producers with limited area coverage.

The current study differs from previous studies and contributes to the existing literature in two ways. First, this study covers small, medium, and large dairy farms that are commercially oriented. Second, the analytical model used in this study also better represent the real-world situation of the market channel choice decision. The decision to choose more than one market channel can be interdependent in the real world. The MNL model cannot model this interdependence. Therefore, the MVP model that can handle this interdependence was used in this study. Accordingly, this paper tries to understand the choice of milk marketing channel and the drivers governing these choices by different commercial farms in the MVP framework.

Background on milk marketing practices of selected urban and peri-urban areas

In Ethiopia, there are eight milk-sheds, namely Addis Ababa, Adama-Asella-Ada/Debre Zeit, Hawassa-Dilla-Shashamane, Bahir Dar-Gondar, Ambo-Woliso, Mekele, Dire Dawa, and Jimma milk-sheds taking the first to the eighth rank, respectively, in terms of the level of dairy development (Brandsma *et al*., 2012). This study covered four milk-sheds. Addis Ababa milk shed, Hawassa from the Hawassa-Dilla milkshed, Gondar from the Bahir Dar-Gondar milk-shed, and Mekele milk-shed were covered in this study. A brief background of the marketing practices of dairy farms operating in the study sites is presented in this section.

Addis Ababa and surrounding (Holeta, Sululta, Sendafa, Debre Zeit and Sebeta) towns was included as the Addis Ababa milk-shed. Dairy producers in Addis Ababa sell raw milk mainly to consumers using different delivery systems such as door-to-door distribution in areas where there are crowded houses and common living apartments and condominium houses (AACCSA, 2016). In contrast, urban and peri-urban dairy farms operating at surrounding of Addis Ababa have formal milk marketing options such as processing plants which collect milk through milk collection points along the main roads. In the peri-urban Holeta, 19%, 21%, 16% and 44% of the dairy producers sold 5%, 16%, 18% and 60% of their raw milk to consumers, cooperatives, Hotels, and traders/processors, respectively (Tadele and Tewodros, 2013). In Debre Zeit, the common milk marketing options for urban dairy farms are processing companies and cooperatives (Kassahun *et al*., 2014). Due to the availability of milk processing plants such as Sebeta Agro-industry, dairy farms that are operating in Sebeta have better access to formal milk marking. Similarly, dairy farms operating in Sululta, in the well-organized Selale dairy-belt,

have the option to sell their milk to processing plants, collectors and dairy cooperatives.

Regarding the dairy farms in Hawassa, a study conducted by Haile *et al*. (2012) indicated that 78% of the dairy producers sold all the produced milk whereas 10% used milk both for sale and for home consumption in Hawassa. Their finding further revealed that the dominant milk market channel was direct sale to consumers, which accounted for 79% of the total milk sold in Hawassa city. Similarly, milk marketing in Gondar was also dominated by direct sale to consumers and usually on a contract basis (Malede *et al*., 2015). Seasonal fluctuation was reported as the first milk market constraint followed by lack of market access in Gondar (Mengestie *et al*., 2016). Their result also indicated that direct sell of milk to consumers is the dominant milk market channel in Gondar. Another study by Shewangizaw *et al*. (2016) also indicated that 78% of urban dairy farmers sold their milk to consumers in Gondar town.

Mekele milk-shed is a relatively the less developed dairy area taking the sixth rank out of the eight major milk-sheds in the country (Brandsma *et al*., 2012). The profile of dairy farms operating in Mekele city was clustered into five by D'Haene and D'Haese (2019): processing female farms (21%), surviving farms (24%), young male entrepreneurs (13%), established output-efficient farms (31%), and established output-input-efficient farms (12%) using 304 samples. Their finding on milk marketing practices revealed that processing female farms, surviving farms and educated male entrepreneurs mainly sold fresh milk to cafes, restaurants or hotel market channel whereas the established output-efficient farms and established output-input-efficient farms mainly sold their fresh milk to neighbor consumers. The second market option for the first three categories and the last two categories was the reverse. The third market outlet category (trader) is rare for most of the farm categories except the established output-input-efficient farms. Their finding further indicated that all of the dairy farm categories had more than one milk buyers (channels). Especially, 33% and 22% of the established output-efficient and established output-input-efficient farms had more than one fresh milk marketing option, respectively. Regarding formal milk marketing system in Mekele, Brandsma *et al*. (2012) indicated that there was no established milk collection center in and around Mekele city.

Materials and Methods

Description of the study areas

The study was conducted in three regional cities namely Hawassa (SNNP), Mekele (Tigray), and Gondar (Amhara) as well as in the capital Addis Ababa and the surrounding towns of Oromia special zones, namely Holeta, Sululta, Sendafa, Debre Zeit (also known as Bishoftu) and Sebeta all situated within 40 km radius

of the capital. Holeta is located West of Addis Ababa while Sululta, Sendafa, Debre Zeit, and Sebeta are found North-West, North, East, and South of Addis Ababa, respectively. On the other hand, Hawassa, Mekele, and Gondar are located in the South, North, and Northwest part of Ethiopia at a distance of 273, 783, and 738 km from Addis Ababa, respectively (Figure 1). The study areas are characterized by commercial-oriented intensive and semi-intensive dairy production systems that keep indigenous Zebu-Holstein Frisian crossbreeds and higher-grade milking cows.

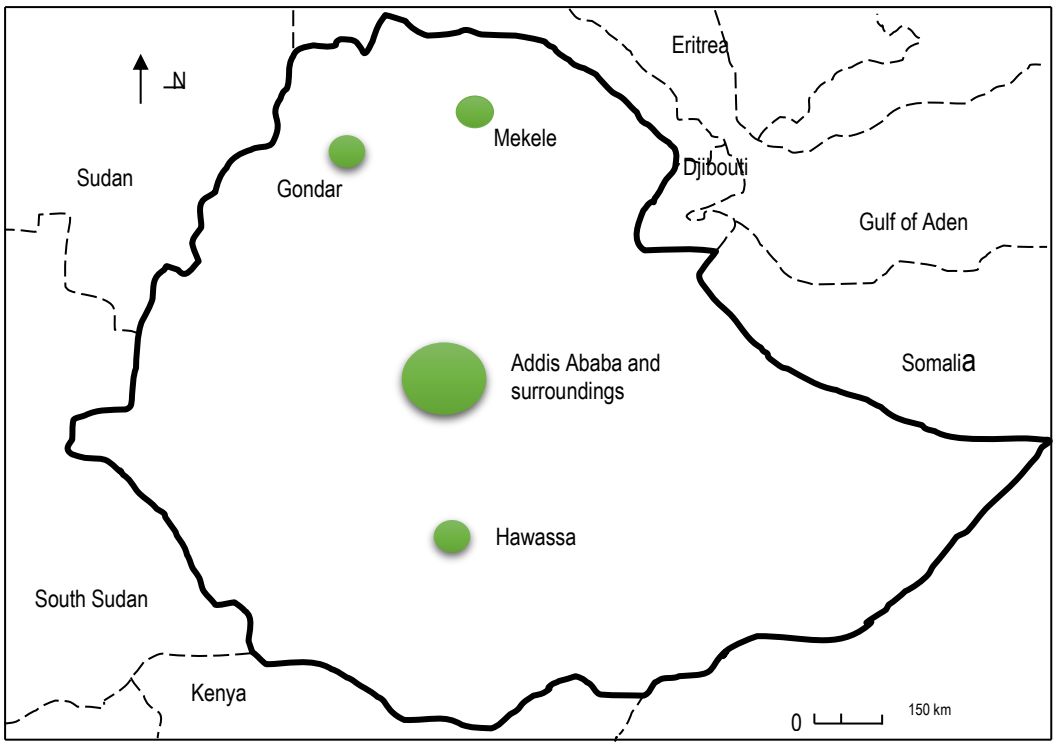

Figure 1. Location of the study sites

The Sample farms

The data used for this study was collected from the sample dairy farms through the joint epidemiological study of bovine tuberculosis (bovine TB) between Ethiopian Institute of Agricultural Research (EIAR) and National Animal Health Diagnostic and Investigation Center (NAHDIC) implemented by the Ethiopia Control of Bovine Tuberculosis Strategies (ETHICOBOTS) project in 2016. The sample dairy farms were from Addis Ababa and surrounding towns, Hawassa, Gondar and Mekele milk-sheds. Dairy farms in and around Addis Ababa are characterized by the most developed dairy areas in the country (Brandsma *et al*., 2012). The urban and peri-urban dairy farms of Addis Ababa have more access to improved inputs and market access for their milk (Zelalem *et al*., 2011). On the other hand, dairy

farms in the regional cities (Hawassa, Gondar and Mekele) are characterized by emerging intensive and semi-intensive dairy production system. The target population used for drawing the sample is the commercial dairy producers having at least five cattle. The sample was categorized into three sizes as small (5-19 cattle), medium (20-49 cattle) and large (50 or more cattle). The categorization was done based on expert judgement. Small and medium farms were randomly selected whereas large farms were all included as they were few in numbers.

A total of 479 dairy farms were recruited. However, four farms' surveys were found not to have completed the marketing section and hence were eliminated from the analysis. Two of these were in Addis Ababa and two were in Sendafa. Therefore, the final sample size used for the analysis was 475 (Table 1).

Table 1. Distribution of sample dairy farms by study areas, 2016

Study area	Dairy farms with ≥5 cattle*	Sample size	%
Addis Ababa	880	162	34.1
Sebeta	92	29	6.1
Holeta	133	34	7.2
Sululta	63	21	4.4
Sendafa	93	23	4.8
Debre Zeit	62	29	6.1
Sub-total	**1323**	**298**	**62.7**
Gondar	177	66	13.9
Mekele	112	60	12.6
Hawassa	81	51	10.7
Sub-total	**370**	**177**	**37.2**
Total	**1693**	**475**	**100**

* The NAHDIC group prepared the complete list of farms in urban and peri-urban areas by the help of urban agriculture and animal veterinary service providers before the actual survey.

The survey was conducted using a structured questionnaire developed using digital data capturing tool, i.e., CAPI (Computer Assisted Personal Interview). The survey instrument covered farm owner characteristics, farm characteristics, institutional factors, market options, and their characteristics.

Data analysis

The data collected from the samples was analysed using both descriptive statistics and an econometric model. Common descriptive statistics such as mean, standard deviations, and frequencies were used to describe the data while a multivariate probit (MVP) model was applied to identify major factors affecting the choice of milk marketing channel by dairy producers.

Conceptual framework

The theoretical basis for choosing an appropriate econometric model to analyze factors affecting milk marketing channel choice decisions of the dairy farms is derived from the random utility theory (McFadden, 1974). The underpinning assumption of this theory is that a decision-maker is rational who has perfect information to make decisions of choosing an alternative that offers the highest utility from a choice set. However, considering dairy producers as a rational decision maker with perfect information is unrealistic because they have cognitive limitations, limited time and do not have full information to make rational decision. This leads to the bounded rationality theory, which means they cannot make utility maximizing decision but a nearly optimal decision that is sufficient to compare alternatives (Simon, 1955). To put this theory in analytical form, an individual dairy producer, *i*, who sells raw milk, choose a particular market channel, *j*, if and only if the expected utility (profit), U_{ij} derived from the channel choice made, is greater than the expected utility says, U_{ik} that can be obtained from another alternative market channel, *k*, in the choice set. In the bounded rationality assumption, the utility, U_{ij} obtained not at profit maximizing point but sufficient to choose the best alternative. However, the utility is not directly observed while only the action of the decision-maker is observed through the choice he made. Based on Greene (2012), the linear random utility model for the two choices can be specified as:

$$U_{ij} = \beta_j' X_j + \varepsilon_j \text{ and } U_{ik} = \beta_k' X_k + \varepsilon_k \qquad \forall j \neq k \tag{1}$$

Where β_j and β_k are vectors of parameters to be estimated, ε_j and ε_k are the error terms assumed to be independently and identically distributed, and X_j and X_k are vectors of explanatory variables that affect the perceived utility obtained by choosing market channel *j* and *k*, respectively.

The perceived utility for the i^{th} dairy farmer obtained from choice of market channel *j* is greater than the utility from another option *k* is represented as:

$$U_{ij}(\beta_j' X_j + \varepsilon_j) > U_{ik}(\beta_k' X_k + \varepsilon_k), \qquad \forall j \neq k \tag{2}$$

Assume that Y is the decision to choose market channel j so that Y takes the value of 1 if j is chosen and 0 otherwise, the probability that a dairy farmer chooses the j^{th} market channel conditional on X can be expressed as:

$$\begin{aligned}(Y = 1|X) &= P\left(U_{ij} > U_{ik}\right) \\ &= P(\beta_j' X_i + \varepsilon_j - \beta_k' X_i - \varepsilon_k > 0|X) \\ &= \mathrm{P}(\beta_{\mathrm{j}}' \mathrm{X}_{\mathrm{i}} - \beta_{\mathrm{k}}' \mathrm{X}_{\mathrm{i}} + \varepsilon_{\mathrm{j}} - \varepsilon_{\mathrm{k}} > 0|\mathrm{X}) \\ &= P(\beta^* X_i + \varepsilon^* > 0|X) = F(\beta^* X_i)\end{aligned} \tag{3}$$

where P is a probability function, U_{ij}, U_{ik} and X_{ik} are as defined above, $\varepsilon^* = \varepsilon_j - \varepsilon_k$ is a random error term, $\beta^* = \beta_j' - \beta_k'$ is a vector of unknown parameters to be estimated and can be interpreted as the net influence of the vector of explanatory variables affecting market channel choice, and $F(\beta^* X_i)$ is the cumulative distribution function of ε^* evaluated at $\beta^* X_i$. The distribution of F depends on the distribution of ε^*.

Following this theoretical framework, conceptualizing the study in terms of factors that would have an impact on milk producers' decision to choose milk marketing channel choice in the study sites is important. The decision to sell raw milk to one or more of the available market channels is influenced by dependent variables listed in the left part of Figure 2. Milk sellers can sell to more than one market channel listed in the right part of the Figure.

The analytical framework of this study was guided by the fact that multiple milk selling channels are available in the study sites and the behaviour of sellers to sell milk to multiple market channels. Based on the survey data, the raw milk market channel was grouped into four namely: 1) direct selling to consumers, 2) traders/cooperatives, 3) processors, and 4) hotels/cafes/restaurant. This leads to the use of polychotomous (multiple-category) response or dependent variables to model the market channel choice behaviour (Gujarati and Porter, 2009). Econometric models to estimate such unordered multinomial response can be multinomial logit (MNL), multinomial probit (MNP), multivariate logit (MVL), and multivariate probit (MVP) models, among others. The MNL model has been widely applied to analyse the determinants of smallholder dairy producers' milk market channel (Berem *et al*., 2015; Berhanu *et al*., 2013; Innocent *et al*., 2018; Ishaq *et al*., 2017; Kumar *et al*., 2018; Mengistu *et al*., 2016; Moturi *et al*., 2015; Sharma, 2015; Vykhaneswari and Devi, 2019).

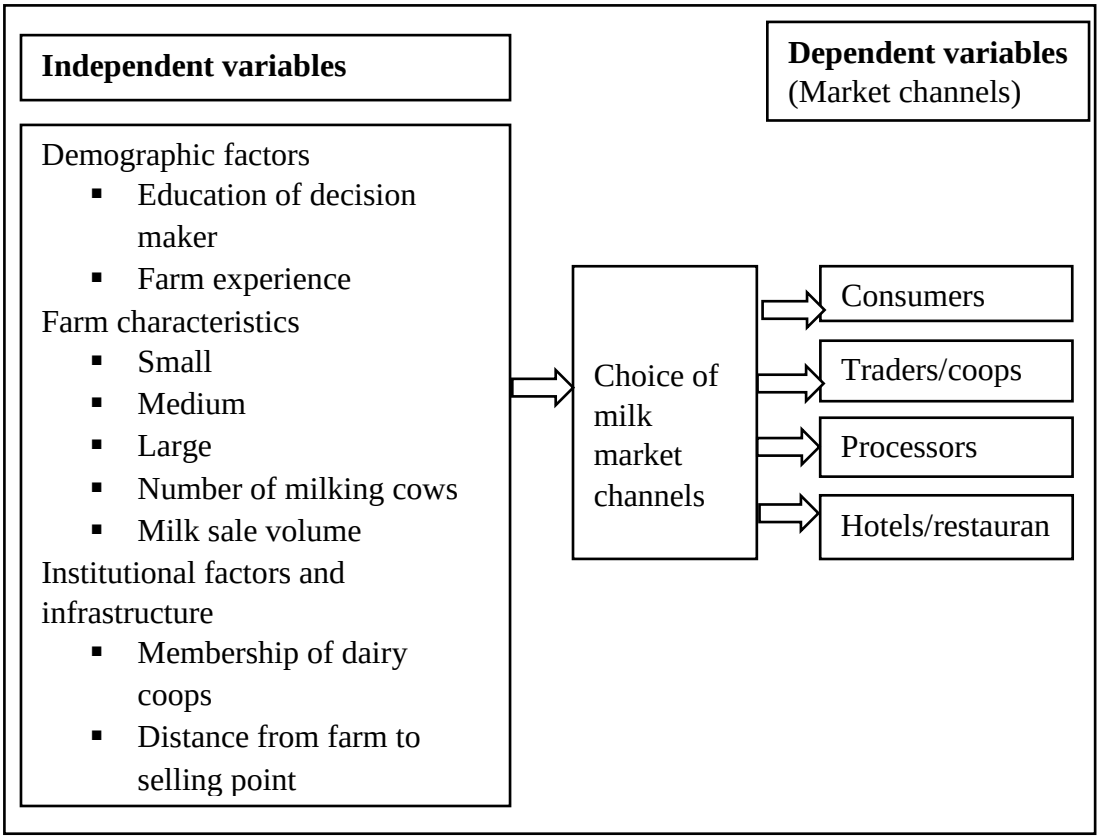

Figure 2. Conceptual framework of factors affecting farmers' choice of milk market channel

However, MNL and MNP models have one common limitation that they are the 'pick-one' type models that assume individuals make just one choice at a time from the total choice set available to maximize utility (Dube, 2004; Walsh, 1995). This assumption is not realistic as an individual usually chooses more than one choice that are interdependent of one another (Chandukala *et al*., 2007; Kim *et al*., 2007; Mehta, 2007; Mehta and Ma, 2012; Aurier and Mejia, 2014). To overcome the limitations of the MNL and MNP models, MVL and MVP models that have a 'pick any' model type are used as alternative models (Aurier and Mejia, 2014). Although both the MVL and MVP models generate comparable results, the MVP model is widely used than the MVL model in literature because the 'mvprobit' that easily available for most of the software. In this study, dairy farmers can sell raw milk to more than one market channels, which means alternatives are not mutually exclusive. The decision to sell raw milk to one market channel can also be correlated with the decision to sell it to other market channels (the error terms can be correlated), which means the unobserved factors affecting the choice of market channel can be correlated. Hence, the MVP is more appropriate and was used to investigate factors affecting dairy farmers' market channel choice decision.

Econometric model: Multivariate Probit (MVP) model

Following Greene (2012), a system of simultaneous probit models was constructed for consumers, traders/cooperatives, processors, and hotels/cafes/restaurant market channels as follows:

$$Y_m^* = \mathrm{X}_m'\beta_m + \epsilon_m, Y_m = 1 \; if \; Y_m^* > 0, 0 \; otherwise, m = 1, \dots M$$
$$E[\epsilon_m|\mathrm{X}_1, \dots, \mathrm{X}_M] = 0$$
$$\mathrm{Var}[\epsilon_m|\mathrm{X}_1, \dots, \mathrm{X}_M] = 1$$
$$\mathrm{Cov}[\epsilon_j, \epsilon_m|\mathrm{X}_1, \dots, \mathrm{X}_M] = \rho_{jm}\ , (\epsilon_1, \dots \dots \dots \epsilon_M) \sim \mathrm{N}_M[0, \mathrm{R}] \qquad (4)$$

Where Y_m^* and Y_m are the latent dependent variables and actual observations relating to the latent dependent variables, respectively, X_m' is a matrix of covariates, β_m is the matrix of unknown parameters to be estimated, ϵ_m are residual error terms distributed as multivariate normal, each with mean 0 and variance-covariance matrix R with the value of 1 on the leading diagonal and correlation $\rho_{jm} = \rho_{mj}$ as the off-diagonal elements that represent the unobserved correlation between the stochastic component of the j^{th} and m^{th} options.

The joint probabilities of the observed events $[y_{i1}, y_{i2}, \dots y_{iM}|\mathrm{X}_{i1}, \mathrm{X}_{i2}, \dots \mathrm{X}_{iM}]$, i=1, ..., n, that forms the basis for the likelihood function are the M-variate normal probabilities (Green, 2012) is given as:

$$L_i = \Phi_M(q_{i1}\mathrm{X}_{i1}'\beta_1, \dots \dots, q_{iM}\mathrm{X}_{iM}'\beta_M, \mathbf{R}^*), \qquad (5)$$

Where,

$$q_{iM} = 2y_{iM} - 1 \;\; R_{jM}^* = q_{ij}q_{iM}\rho_{jm}$$

Where ρ_{jm} is the correlation between ϵ_j and ϵ_m. The distributions are independent if and only if ρ_{jm} = 0. If that is the case, one can use a single probit model for each equation instead of MVP.

To estimate the above system of equations, the simulated maximum likelihood (SML) methods of the Geweke–Hajivassiliou–Keane (GHK) simulator was used due to the numerical complexity of estimating integrals under the multivariate normal (Gates, 2006). Moreover, the user-written Stata command named 'mvprobit' developed by (Cappellari and Jenkins, 2003) was used to run the estimation procedure.

Definition and measurement of explanatory variables

Based on the relevant economic theories and previous findings, relevant explanatory variables were included in the econometric model. Brief description, measurement and expected signs are given in Table 2.

Table 2. Description of variables included in the econometric model

Variables	Description and measurement	Expected sign
Education	Education of operator owner or hired manager (years)	+
Farm experience	Experience of dairy farming (years)	+
Small farm	dummy: takes 1 if owned 5-19 cattle and 0 otherwise	+/-
Medium farm	dummy: takes 1 if owned 20-49 cattle and 0 otherwise	+/-
Large farm*	dummy: takes 1 if owned 50 or more cattle and 0 otherwise	
Milking cows	Number of milking cows owned	+
Milk sale volume	Volume of milk sold (litres/day/farm)	+/-
Market distance	Distance between farm location and milk selling point (Kms)	-
Membership	Dummy: takes 1 if member of dairy coops and 0 otherwise	+
Net milk price	Milk price less milk marketing cost (Birr/Liter)	+
Addis Ababa	Dummy: takes 1 if the farm is in Addis Ababa and 0 if not	+/-
Gondar	Dummy: takes 1 if the farm is in Gondar and 0 if not	+/-
Mekele	Dummy: takes 1 if the farm is in Mekele and 0 if not	+/-
Oromia SZ-Addis Ababa	Dummy: takes 1 if the farm is in Oromia special zone surrounding Addis Ababa and 0 if not	+/-
Hawassa*	Dummy: takes 1 if the farm is located in Hawassa and 0 if not	

*Refers to base category that is arbitrarily chosen to solve the dummy variable trap.

Results and Discussion

Sample dairy farm characteristics

The dairy operators (managers) had on average a grade of '9 years of schooling' and had considerable experience in dairy farming business (on average 14years). However, there were significant mean differences of both education and dairy farm experience among the study sites with the highest and lowest education level seen in Debre Zeit and Sendafa farms, respectively,while the highest and lowest dairy farm experience were observed in Gondar and Sululta, respectively. The result also revealed that there was a significant mean difference of education and farm experience variables among farm sizes. More educated and experienced farm managers operated larger farm size while less educated and less experienced ones operated smaller farm size showing increasing trend with farm sizes (Tables 3 and 4).

The average dairy farm size was holding about 9 milking cows and sold nearly 78 liters of milk per day. Nevertheless, there were significant mean differences of both the number of milking cows and milk output sold per day among the study sites and farm sizes. Both the highest number of milking cows and the highest milk output sold per day was found among Debre Zeit dairy farms, whereas the lowest number of milking cows and milk output sold per day was recorded in Holeta and Mekele dairy farms, respectively (Table 3). By disaggregating the number of milking cows and milk output sold per day by farm size, the result showed that small, medium and large dairy farms owned five, 12 and 34 milking cows on average and sold 42, 111 and 320 litres of milk on average per day, respectively, with significant mean differences among the farm sizes (Table 4).

One of the advantages of operating urban and peri-urban commercial dairy farms is the better market access to sell raw milk. The result indicated that the farms are situated relatively close to the milk markets; the average distance was three kilometers. However, there was a significant difference of mean distance from milk selling point to dairy farms between the dairy farm sites and between farm sizes. Dairy farms operated in large cities such as Addis Ababa, Hawassa, Mekele and Gondar were situated at close milk marketing distance of two to three kilometres on average, whereas those operating in towns such as Debre Zeit, Sululta, Sendafa and Holeta were situated at far distance to milk market with five to seven kilometres on average (Table 3). Furthermore, the result indicated the milk selling market distance increases with farm sizes, with significant mean differences between farm sizes (Table 4).

Table 3. Characteristics of sample dairy farms by farm location (mean (standard deviations) of continuous variables)

Site (location)	N	Education of manager	Dairy experience	Number of milking cows	Milk output sold per day	Distance to milk sell point
Addis Ababa	162	9 (5)	15 (15)	8 (7)	68 (68)	2 (4)
Sebeta	29	11 (5)	13 (11)	12 (11)	93 (84)	4 (8)
Holeta	34	9 (5)	11 (8)	7 (7)	70 (93)	7 (14)
Sululta	21	8 (5)	9 (6)	12 (13)	121 (156)	5 (10)
Sendafa	23	7 (6)	17 (11)	9 (10)	77 (111)	6 (12)
Debre Zeit	29	13 (4)	12 (9)	14 (14)	183 (245)	5 (11)
Gondar	66	9 (5)	20 (13)	8 (8)	59 (64)	2 (2)
Mekele	60	10 (5)	11 (8)	8 (10)	49 (50)	3 (3)
Hawassa	51	11 (2)	15 (12)	9 (9)	83 (75)	3 (3)
Total	475	9 (5)	14 (11)	9 (9)	78 (101)	3 (7)
F (8, 466)		5.2***	4.5***	2.7***	6.1***	3.9***

*** means statistically significant at 1%.
Source: Survey, 2016

Table 4. Characteristics of sample dairy farms by farm size (mean (standard deviations) of continuous variables)

Site	Small (N=334)	Medium (N=106)	Large (N=35)	Total (N=475)	F-values
Education of manager	9 (5)	11 (5)	13 (4)	9 (5)	18.4***
Farming experience	14 (11)	16 (10)	19 (12)	14 (11)	5.8***
Number of milking cows	5 (3)	12 (6)	34 (12)	9 (9)	624***
Milk output sold per day	42 (28)	111 (69)	320 (207)	78 (101)	278***
Milk market distance form farm	2 (4)	4 (7)	12 (15)	3 (7)	37.8***

*** means statistically significant at 1%.
Source: Survey data, 2016

The majority (70%) of the sample dairy farms were categorized under small farm followed by medium farm (22%) whereas large farms were only seven per cents. Nonetheless, there was a significant difference in the proportion of farm sizes among the study sites. The highest proportion of large dairy farms was found in Debre Zeit followed by Sendafa and Sebeta while the lowest proportion was obtained in Addis Ababa and Mekele covering only three per cent. In contrast, the highest proportion of small farms was found in Mekele followed by Gondar and

Addis Ababa while the lowest proportion of small farms was found in Debre Zeit. The result further indicated that 22% of the sampled dairy farmers were members of dairy cooperatives. There was a significant difference in the proportion of membership of dairy farms among the study sites with the highest (52%) and the lowest (0%) were found in Gondar and Sendafa dairy farms, respectively (Table 5). However, there was no significant difference in the proportion of membership of dairy cooperatives between dairy farm sizes (not reported).

Table 5. Herd size and membership of dairy cooperatives by farm location, 2016

Site	N	Herd size of dairy cattle (%)			Membership of dairy coops (%)	
		Small	Medium	Large	Yes	No
Addis Ababa	162	76	21	3	17	83
Sebeta	29	55	31	14	7	93
Holeta	34	71	24	6	29	71
Sululta	21	57	29	14	24	76
Sendafa	23	65	17	17	0	100
Debre Zeit	29	45	31	24	10	90
Gondar	66	80	14	6	52	48
Mekele	60	83	13	3	13	87
Hawassa	51	55	37	8	27	73
Total	475	70	22	7	22	78
		Pearson $\chi 2(16) = 44$, Pr = 0.000			Pearson $\chi 2(8) = 54$, Pr = 0.000	

Source: Survey, 2016

Milk production and utilization

The average daily milk production per farm was 88 liters, of which most (85%) was supplied to the market, and the remaining was used for home consumption (6.4%) and for feeding farm calves (8.2%). However, there were significant differences farm sizes (small, medium, and large farms) in terms of milk utilization. Small farms tend to supply less (85%) milk to the market and consume more milk (7%) at home than the two categories. The opposite is true for the large farms in which 91% and 1% of the total milk produced was supplied to the market and used for home consumption, respectively. There was no significant difference in the percentage of milk feed to their calves between farm sizes (Table 6).

There were also significant differences in the mean daily milk production and mean and percentage of home consumption, calf consumption and milk sold perday among the study locations. Debre Zeit, Sululta and Sendafa were the top three milk producing sites whereas the lowest daily milk producing farms were obtained in Mekele site. The percentage of home consumption was the highest in Gondar and the lowest in Debre Zeit whereas the percentage of milk feed to calves was the highest in Addis Ababa and the lowest in Gondar. Sululta, Debre Zeit and Hawassa were ranked as the top three sites in terms of the percentage of milk sold per day whereas Gondar was ranked last (Table 7).

The proportion of milk supplied to the market by the overall sample in the present study is comparable to 86.8% recorded by Melese and Mustefa (2019) in a study conducted in Sululta and Holeta (Welmera) and higher than an earlier study by Sintayehu *et al*. (2008) who reported 79.2% for Hawassa, Shashamane, Dilla and Yirgalem urban dairy producers. Ahmed *et al*. (2003), in and around Addis Ababa, reported that 73% of the total milk produced was sold, which is also lower than the current study. The corresponding figure for various studies in different locations was 76% in Holeta urban and peri-urban dairy production (Tadele and Tewodros, 2017), 68% in Bahir Dar-Gondar milk-shed (Yitaye *et al*., 2009).

Table 6. Milk production and utilization (liters/day) at 475 dairy farms, by farm category

Farm category	N	Production	Home consumption		Calf consumption		Sold	
		Mean (SD)	Mean (SD)	%	Mean (SD)	%	Mean (SD)	% %
Small	334	48 (30)	2.9 (5.3)	6.9	3.8 (4.2)	8.4	42 (28)	84.7
Medium	106	127 (72)	7.8 (19.7)	6.3	8.7 (9.1)	7.7	111(69)	86.0
large	35	350 (222)	2.6 (4.7)	1.2	26.9 (32.2)	7.5	320 (207)	91.3
Total	475	88 (109)	4.0 (10.6)	6.4	6.6 (12.0)	8.2	78 (101)	85.4
F (2,472)		289***	9.2***	***	81.5***	0.49	278.4***	***

*** means statistically significant at 1%.
Source: Survey, 2016

Table 7. Milk production and utilization (liters/day) at 475 dairy farms, by location

Site (location)	N	Production	Home consumption		Calf consumption		Sold	
		Mean (SD)	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%
Addis Ababa	162	78 (73)	2.5 (6.8)	4.3)	7.2 (8.4)	10.8	68 (68)	85
Sebeta	29	106 (91)	5.8 (8.7)	7.3	6.7 (14)	6.4	93 (84)	86
Holeta	34	78 (101)	1.3 (0.9)	3.8	6.4 (9.8)	8.1	70 (93)	88
Sululta	21	128 (163)	1.4 (1.5)	3.6	5.6 (7.8)	4.1	121 (156)	92
Sendafa	23	82 (115)	1.2 (10)	4.9	3.7 (5.8)	7.9	77 (111)	87
Debre Zeit	29	202 (268)	1.2 (0.9)	1.7	17 (34)	7.6	183 (245)	91
Gondar	66	76 (74)	13 (21)	19.0	3.2 (9.3)	3.5	59 (64)	77
Mekele	60	57 (55)	3 (12)	5.3	5.3 (6.0)	9.9	49 (50)	85
Hawassa	51	91 (78)	2.7 (5)	3.7	5.4 (5.4)	7.1	83 (75)	89
Total	475	88 (109)	4.0 (11)	6.4	6.5 (12)	8.2	78 (101)	85
F-value (8, 466)		5.75***	8.5***	21***	4.0***	6.9***	6.1***	7***

*** means statistically significant at 1%.
Source: Survey, 2016

Milk marketing channels

As listed in Table 8, eight milk marketing channel options were recorded across the study sites. The majority of the dairy farmers (71%) sold their milk directly to consumers followed by those who sold to hotels (including restaurants, and cafes) (28%), and to collectors (24%). Only 3% of the dairy farms sold to cooperatives during the year preceding the study. However, there were significant variations in the percentage of farms supplying milk to different channels among the study locations. The majority of dairy farms operating in large cities including Addis

Ababa, Gondar, Mekele and Hawassa supplied milk directly to consumers. The second milk market channel for these large cities was hotels. In contrast, for dairy farms operating in most of the Oromia special zones surrounding Addis Ababa towns (Holeta, Sululta, Sendafa and Debre Zeit) supplied milk to collectors than other locations. In terms of the percentage of dairy farms supplying milk to processors, Debre Zeit was the highest followed by Sebeta. The reason for this is likely that dairy processing industries are operating at a larger scale in both of these cities as compared to in other parts of Ethiopia. In Holeta, the proportion of dairy farms supplied milk to dairy cooperatives was the highest followed by Debre Zeit and Hawassa sites as compared to all other study sites. Surprisingly, dairy farms in five sites (Sebeta, Sululta, Sendafa, Gondar and Mekele) did not supply milk to dairy cooperatives. The previous finding reported by Yitaye *et al*. (2009) in Gondar and Bahir Dar has also shown that the highest (67%) proportion of urban dairy producers was found to sell their milk to consumers followed by sale to retailers (29%, including hotels, shops, tea or coffee houses in their context) which was higher than our result in the case of consumers and lower in the case of hotels. Here we can conclude that only a small proportion of the dairy farmers (9%) sold their milk to the formal milk processing sectors.

Table 8. Proportion of milk supplied to each milk market channel by study location, 2016

		Dairy farms supplying milk to [channel] (%)							
Study site	**N**	**Cons[1]**	**Coll[2]**	**WStrad[3]**	**Ret[4]**	**Coops[5]**	**SSProc[6]**	**MLSProc[7]**	**Hot[8]**
Addis Ababa	162	88	22	4	6	4	9	2	24
Sebeta	29	69	41	4	0	0	10	21	14
Holeta	34	32	29	24	9	15	9	9	18
Sululta	21	10	71	5	14	0	5	10	10
Sendafa	23	17	74	0	13	0	4	9	13
Debre Zeit	29	52	4	0	7	7	24	48	21
Gondar	66	88	0	0	5	0	6	0	47
Mekele	60	75	32	2	0	0	0	0	43
Hawassa	51	78	6	8	31	6	6	4	35
Total	475	71	24	5	8	3	8	9	28
Pearson chi2 (8)		133***	102***	36***	49***	23***	18**	101***	33***

Numbers 1-8 refers to consumers, collectors, traders/wholesalers, traders/retailers, cooperatives, small-scale processors, medium and large-scale processors and hotels, respectively.
*** and ** means statistically significant at 1% and 5%, respectively.
Source: Survey, 2016

A similar pattern is observed in terms of the volume and the proportion of the volume of milk sold to the buyers listed (Tables 9 and 10). The proportion of the volume of milk sold to consumers and hotels reported in this study was lower than what was reported earlier by earlier studies conducted on smallholder dairy farms in Soddo *Zuriya* district of the SNNP region of Ethiopia, which were 56% and 35%, respectively (Zegeyesh *et al*., 2017). Cooperatives received the smallest share (2%) of milk sold by dairy farms (Table 9). The result of this study indicated that cooperatives were not playing important role in raw milk marketing.

However, this was not the case in all study sites as more than 10% of Holeta and nearly 7% of Debre Zeit sites dairy farmers sold their raw milk to cooperatives. Nevertheless, none of Sebeta, Sululta, Sendafa, Gondar, and Mekele sites dairy farmers sold to cooperatives whereas about 3% and 2% of Addis Ababa and Hawassa site dairy farmers, respectively sold to cooperatives. This might be because farmers had relatively better market access in these urban areas and the role of cooperatives might be reduced under such conditions. The implication is that there have to be some measures that would increase the role of cooperatives as efficient cooperatives can be beneficial to dairy producers. Yitaye *et al*. (2009) in their study in Bahir Dar and Gondar also confirmed that only 4% of urban dairy producers used cooperatives/producers' groups as their milk selling channel while considerably higher proportion (45%) of the peri-urban dairy producers sold milk to cooperatives.

Table 9. Average volume of milk supplied to each market channel by study sites, 2016

		Dairy farms supplying milk (L/day) to [channel] (Mean (Standard Deviation))							
Study site	**N**	**Cons[1].**	**Col[2].**	**WStrad[3].**	**Ret[4].**	**Coops[5].**	**SSProc[6].**	**MLSProc[7].**	**Hot[8].**
Addis Ababa	162	39 (48)	8 (26)	2 (11)	1 (8)	2 (12)	3 (16)	2 (11)	11 (30)
Sebeta	29	34 (51)	34 (73)	2 (13)	0 (0)	0 (0)	3 (10)	17 (47)	2 (7)
Holeta	34	13 (31)	6 (12)	15 (38)	6 (23)	1 (4)	9 (41)	7 (26)	11 (33)
Sululta	21	0.3 (1.0)	37 (45)	2 (7)	11(46)	0 (0)	15 (69)	31 (120)	24 (76)
Sendafa	23	10 (34)	20 (30)	0 (0)	2 (10)	0 (0)	7 (32)	16 (67)	22 (67)
Debre Zeit	29	80 (219)	2 (12)	0 (0)	20 (91)	9 (39)	14 (36)	33 (52)	26 (71)
Gondar	66	30 (51)	0 (0)	0 (0)	4 (21)	0 (0)	3 (12)	0 (0)	22 (39)
Mekele	60	20 (31)	14 (32)	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	13 (31)
Hawassa	51	46 (76)	1 (6)	6 (29)	12 (23)	2 (15)	3 (16)	2 (11)	10 (18)
Total	475	33 (73)	10 (30)	3 (16)	5 (28)	2 (13)	5 (25)	6 (36)	14 (39)
F(8,466)		3.37***	7.42***	3.6***	2.33**	1.53	1.58	4.89***	1.53

Numbers 1-8 refers to consumers, collectors, traders/wholesalers, traders/retailers, cooperatives, small scale processors, medium and large-scale processors and hotels, respectively.
*** and ** means statistically significant at 1% and 5%, respectively.
Source: Survey, 2016

Table 10. Proportion of milk volume supplied to each market channel by study sites, 2016

		Percentage of milk volume supplied to [channel] (mean (Std. Dev.))							
Study site	**N**	**Cons[1].**	**Col[2].**	**WStrad[3].**	**Ret[4].**	**Coops[5].**	**SSProc[6].**	**MLSProc[7].**	**Hot[8].**
Addis Ababa	162	65 (41)	12 (29)	2 (14)	2 (12)	3 (18)	4 (16)	1 (10)	9 (21)
Sebeta	29	39 (40)	34 (43)	1 (6)	0 (0)	0 (0)	4 (15)	17 (38)	4 (16)
Holeta	34	12 (28)	29 (45)	22 (41)	6 (20)	12 (31)	4 (13)	7 (23)	10 (27)
Sululta	21	1 (2)	69 (46)	4 (17)	5 (14)	0 (0)	3 (13)	10 (10)	10 (30)
Sendafa	23	8 (23)	68 (44)	0 (0)	5 (14)	0 (0)	2 (8)	9 (29)	8 (25)
Debre Zeit	29	26 (38)	2 (9)	0 (0)	5 (18)	7 (25)	10 (23)	44 (48)	7 (18)
Gondar	66	60 (40)	0 (0)	0 (0)	4 (18)	0 (0)	4 (16)	0 (0)	32 (37)
Mekele	60	48 (42)	25 (39)	0 (3)	0 (0)	0 (0)	0 (0)	0 (0)	27 (39)
Hawassa	51	52 (43)	4 (19)	7 (25)	17 (31)	2 (13)	3 (12)	3 (15)	13 (24)
Total	475	47 (43)	18 (36)	3 (17)	4 (17)	3 (15)	4 (14)	6 (22)	15 (29)
F(8,466)		17.2***	22.0***	7.0***	5.0***	2.6***	1.3	17.2***	6.8***

*** means statistically significant at 1%.
Source: Survey, 2016

The proportion of dairy farms supplying milk to available market channel disaggregated by farm category is presented in Table 11. The result revealed that the majority of farms were found to supply milk to consumers irrespective of the farm category. Quarter of small and medium farms and significantly lower (6%) of the large farms supplied milk to collectors. However, significantly higher proportion of the large farms supplied milk to wholesale traders as compared to the other two farm categories whereas significantly lower proportion of the small farm supplied milk to small-scale processors as compared to the other two farm categories. The result also indicated that more than half of the large farms, 35% of the medium and 23% of the small farms supplied milk to hotels with a significant difference among the farm category. The result also indicated that none of the large farms supplied milk to cooperatives. This is likely because dairy cooperatives are less likely a feasible marketing option for large farms. Jitmun *et al*. (2020) also indicated that as the size of dairy farm increases, the likelihood of participating in dairy cooperatives decreases in Thailand.

Table 11. Proportion of dairy farms supplied milk to each market channel by farm size, 2016

	Farm category				
Channels	**Small (N=334)**	**Medium (N=106)**	**Large (N=35)**	**Total (N=475)**	**Chi2**
Consumers	69.5	76.4	68.6	71	1.99
Collectors	25.2	25.5	5.7	24	6.8**
Traders/ wholesalers	3.9	3.8	14.3	4.6	8.0**
Retailers	7.2	11.3	8.6	8.2	1.83
Cooperatives	3.9	2.8	0.00	3.4	1.6
Small-scale processors	5.4	13.2	14.3	7.8	9.1**
Medium and large-scale processors	6.0	7.6	14.3	7.0	3.45
Hotels	23.4	35.0	54.3	28.2	18***

*** and ** means statistically significant at 1% and 5%, respectively.
Source: Survey, 2016

The volume and percentage of the volume of milk supplied to each market channel disaggregated by farm category are presented in Tables 12 and 13, respectively. The result showed that higher volume of milk was supplied to consumers by all farm categories. The result indicated that the volume of milk supplied to all but cooperative market channel was the highest for the large farm followed by medium farm categories. Large farms tend to supply more milk volume than the other two categories (Table 12). However, there was a significant difference among the farms in terms of milk volume supplied to all the available market channels. A similar pattern is observed in terms of the percentage of the volume of milk supplied to each market channel. However, there was significant difference in the mean percentage of the volume of milk supplied to collectors, small scale processors and hotels among the farm categories and no significant mean difference in all other market channels (Table 13).

Table 12. Average volume (L/day) of milk sold to each market channel by farm size

Channels	Farm category				F (2, 472)
	Small (N=334)	Medium (N=106)	Large (N=35)	Total (N=475)	
Consumers	18.0 (20.8)	49.8 (56.3)	128 (216)	33.3 (72.5)	48 ***
Collectors	7.4 (16.4)	18.4 (44.2)	11.9 (61.6)	10.2 (30.2)	5.48***
Traders/ wholesalers	1.5 (7.8)	3.8 (22.2)	12.2 (37.5)	2.8 (16.2)	7.45***
Retailers	2.6 (13.8)	5.3 (17.7)	21.5 (88)	4.6 (28)	7.41***
Cooperatives	1.0 (6.0)	4.0 (25.0)	0.0 (0)	1.6 (13)	2.48 *
Small-scale processors	1.6 (8.5)	5.9 (18.6)	29.6 (77.1)	4.6 (24.6)	22. 47***
Medium/large-scale processors	3.1 (14.1)	6.1 (24.5)	39.5 (115)	(6.4 (36.2)	17.17***
Hotels	6.4 (17.2)	17.8 (37.6)	77.3 (97.2)	14.2 (39.2)	66.73***
Total	42 (28)	111 (69)	320 (20.7)	78 (100)	278.37***

*** and * means statistically significant at 1% and 10%, respectively.
Note: Numbers in the parenthesis are Standard Deviation.
Source: Survey, 2016

Table 13. Percentage of milk volume supplied to each market channel by farm size, 2016

Channels	Farm category				F (2, 472)
	Small (N=334)	Medium (N=106)	Large (N=35)	Total (N=475)	
Consumers	48 (44)	48 (42)	39 (39)	47 (43)	0.78
Collectors	20 (38)	17 (35)	4 (19)	18 (36)	3.10**
Traders/ wholesalers	3 (17)	4 (19)	5 (13)	3 (17)	0.15
Retailers	4 (17)	5 (16)	4 (15)	4 (17)	0.17
Cooperatives	3 (17)	2 (14)	0 (0)	3 (15)	0.63
Small-scale processors	3 (13)	5 (15)	8 (22)	4 (14)	2.81*
Medium/large scale processors	5 (21)	6 (21)	13 (33)	6 (22)	1.73
Hotels	14 (29)	14 (24)	27 (34)	15 (29)	3.71**

** and * means statistically significant at 5% and 10%, respectively.
Source: Survey, 2016

The milk market channels identified in this study were categorized into four depending on their similarity of action and scale of operation. First, consumer market channel is left as it is. The second market channel type is traders marketing channel. Collectors who collect and sell milk, large traders or wholesaler traders who buy milk in larger volume and sell in large volumes to retailers or directly to consumers, retailers who buy in small volume and sell milk to consumers, and primary cooperatives which also buy and sell milk to consumers all do similar function of buying and selling milk. Moreover, they are almost similar in terms of the price they pay to milk producers. Hence, they are categorized as one as traders market channel. Third, small and large-scale processors are also similar in terms of functions, price setting and other related marketing properties. Hence, they are categorized as processors. Finally, hotel is left as it is which include hotels, restaurants and cafeterias. The proportion of the volume of milk sold to each marketing channel is summarized in Table 14. Of the total sample, 47% of the total milk supplied to market was sold to consumers followed by traders (29%). The rest 15% and 9% was sold to hotels and processors, respectively.

However, there were significant differences among the study areas in terms of the proportion of the volume of milk supplied to each market channel. Dairy farms in Addis Ababa, Gondar, Hawassa and Mekele supplied 65%, 60%, 52% and 48% of

the total milk sold to consumers. In contrast, dairy farms operating in peri-urbans in Sululta, Sendafa, and Holeta, all of which are situated in the surroundings of Addis Ababa, supplied 77%, 74% and 68% of the total milk sold to traders (that includes collectors, traders and cooperatives). However, as this market channel usually pay lower net milk price, it may not be a stable long-term milk market channel. The peculiar feature was observed in dairy farms operating in Debre Zeit where 54% of the total milk supplied to market was sold to processors. Sebeta dairy farms also supplied 22% of the total milk sold to processors. These features are likely explained by the fact that large milk processors are available in both Debre Zeit and Sebeta. The result from Mekele further indicated that about 27% of the total milk supplied to market was supplied to hotels. Likewise, the sample dairy farms in Gondar supplied 32% of the total milk sold to hotels.

Table 14. Proportion of sample dairy farmers who sold milk to major marketing channels

Site	N	The proportion of milk volume supplied to [channel] (%)			
		Consumers	Traders[1]	Processors	Hotels[2]
Addis Ababa	162	64.9	20.2	5.4	9.4
Sebeta	29	39.5	34.7	22.0	3.9
Holeta	34	11.7	68.2	10.0	10.1
Sululta	21	0.7	77.4	12.4	9.5
Sendafa	23	7.9	73.4	10.4	8.3
Debre Zeit	29	25.7	13.1	53.7	7.4
Gondar	66	60.3	3.8	3.8	32.1
Mekele	60	47.5	25.2	0.0	27.3
Hawassa	51	51.7	30.2	5.5	12.7
Total	475	47.3	28.6	9.3	14.7
F-value		17.17***	20.14**	6.81***	16.77***

*** and ** means significant at 1% and 5%, respectively

[1]refers to wholesalers, retailers, collectors and cooperatives, [2]hotels, cafeterias, and restaurants.

Source: Survey, 2016

Raw milk net price offered by different milk marketing channels

Milk selling net price paid by each market channel is presented in Table 15. There was significant variation in milk net prices paid to dairy farms by different market channel across the study sites. The net price data covered a 12-month period from January to December 2015, averaged to remove the seasonal price dynamics effect. The net price was obtained by subtracting marketing (mainly transportation) cost from the price received from buyers. The result showed that, overall, the highest net price was paid by consumers and hotels that include restaurants and cafeterias, with a mean net price of 16.8 and 16.0 Birr/liter, respectively, while the lowest overall net price was paid by traders at a mean of 14.3 Birr/liter, followed by processors at 14.4 Birr/liter (Table 15). The low net price paid by the latter two might be associated with the additional costs such as transportation costs to collect the milk mostly at or near to farm gates while the producers usually deliver their raw milk to consumers and hotels/restaurants/cafes at their home or working places. However, milk producers usually deliver milk to

their neighbour consumers and hotels by walking and no direct financial cost incurred to deliver. Therefore, selling milk to traders or processors is unlikely to appeal to producers unless the other two high paying channels (consumers and hotels) are absent or unable to purchase all the milk produced by the dairy farms. The net prices paid to dairy farms by different market channels varied significantly from site to site with the highest net price received from consumers, traders, and processor in Addis Ababa and the lowest at Sululta from processors, traders and consumers and at Holeta from trader market channel. On the other hand, for the Hotel/restaurant/cafe market channel, the highest and the lowest net prices were observed at Sendafa and Gondar sites, respectively.

The result further indicated that the mean net price (Birr/Liter) paid by consumers (16.8) was statistically higher than the mean net price (16.0) paid by hotels, traders (14.3) and processors (14.4) at 5%, 1% and 1%, respectively. Likewise, the mean net price paid by hotels was statistically higher than the mean net price paid by traders and processors at 1%, each. However, there was no statistically mean difference between the net price paid by traders and processors.

Table 15. Net price (Birr/L) of raw milk offered by different market channels by study sites

	Consumers		Traders		Processors		Hotels	
Sites	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Addis Ababa	142	19.0 (2.3)	54	16.5 (2.1)	19	16.2 (2.6)	38	18.6 (2.2)
Sebeta	20	16.5 (2.2)	13	14.3 (2.1)	9	13.5 (2.8)	4	19.4 (1.7)
Holeta	11	14.1 (3.6)	25	11.4 (1.7)	6	13.4 (3.5)	6	13.5 (3.7)
Sululta	2	13.9 (1.2)	17	12.2 (0.9)	3	11.8 (1.1)	2	16.0 (3.7)
Sendafa	4	17.5 (3.9)	17	12.6 (1.3)	3	16.0 (6.1)	3	20.3 (2.5)
Debre Zeit	15	16.6 (3.4)	5	13.7 (2.9)	19	13.4 (2.1)	6	16.6 (2.4)
Gondar	58	14.0 (1.7)	3	12.3 (0.9)	4	11.3 (1.0)	31	13.4 (1.2)
Mekele	45	14.0 (1.1)	20	13.5 (0.6)	0	-	26	13.5 (0.8)
Hawassa	40	15.4 (2.6)	25	14.8 (1.5)	5	13.7 (1.2)	18	15.3 (1.3)
Total	337	16.6 (3.2)	179	14.1 (2.5)	68	14.1 (2.9)	134	15.7 (3.0)
F-value		41.96***		26.1***		3.4***		29.44***

SD refers to standard deviation

*** means statistically significant at 1%.

Source: Survey, 2016

Factors affecting the choice of milk marketing channel among the dairy producers

Factors affecting the decision by dairy producers when choosing among different marketing alternative (channels) were assessed using the MVP econometric model and the result is presented in Table 16. The overall fitness of the MVP model was assessed using appropriate model tests. First, using the Wald Chi-square statistic, the explanatory variables included in the model were tested for their significance and the result showed that the variables jointly explained the model at 1% level of significance (Wald chi2 (52) = 330.78, p = 0.000). Second, the goodness-of-fit of the model was tested using likelihood ratio test that the null hypothesis of

independence between the milk market channels choice decision was rejected (Chi2 (6) = 51.61, p-value = 0.000). This implies that estimating a separate binary probit model for each of the four equations (market channels) is inappropriate and leads to biased estimates. Overall, these specification tests justify the appropriateness of the MVP model to analyse the raw milk market channel choice decisions of the dairy produces.

The model result showed the presence of differences in milk market channel choice behavior among the dairy producers and interdependence of market channel choice decisions as indicated in the likelihood ratio statistics of the estimated correlation matrix. The correlation coefficient values (ρ_{ij}) indicate the correlation between a pair of dependent variables (market channels). The coefficient between traders and consumers market channels (ρ_{21}), processors and traders market channels (ρ_{32}), hotels and consumers (ρ_{41}), and hotels and traders market channels (ρ_{42}) were all negatively interdependent– an indication of substitutionary position. In contrast, the correlation coefficient between hotels and processors (ρ_{43}) was positive- an indication of competition position. This implies that milk producers that deliver their raw milk to consumers, processors, and hotels are less likely to choose traders as their raw milk marketing channel. The reverse is also true. Those who go for traders may not go for the consumers, hotels or processors. This is because consumers usually pay a higher price as no middlemen who are seeking to make a profit from the sale directly to consumers. Another reason is that when there is an opportunity to sell to processors and hotels/restaurants/cafes, who purchase in a larger volume, there is little incentive to sell to traders who resell either to consumers or the processors at a profit which is unlikely to be transferred to the producers. Although traders also purchase in large volume and pay similar net price to processors, sellers can reasonably prefer processors due to long-time relationship as processors usually do the business once they install the processing plant. The estimation result of the simulated maximum likelihood (SML) showed that the predicted probability of choosing consumers as the milk market channel had the highest probability (71%) followed by traders (38%) and hotels (28%) while the predicted probability of choosing processors channel was the lowest (14%). The likelihood of milk producers to jointly choose all the four milk market channels was 0.32% and the joint probability of failure to choose all the four channels was 4.5%. That is, the probability of dairy farms to supply milk to all the four market channels and supplying to none of the four market channels was less than one per cent and nearly five per cent, respectively.

The MVP model results showed that most of the explanatory variables included in the econometric model had a significant effect on choosing at least one market channel. The education level of the farm operator (manager) was found to increase the probability of choosing processors and hotels. The implication is that highly

educated dairy farm operators tended to deliver their raw milk to processors and hotels instead of traders who then resell at profit. The possible reason why educated farm operators prefer to sell to processors might be due to long-term business relationship with processors since they usually operate for long period of time once processing facilities are installed. This result is consistent with a study undertaken in Malaysia where dairy farmers with higher education levels had a higher probability of choosing intermediary markets, which they labeled as restaurants, hotels, or processing firms (Suhaimi *et al*., 2017).

Dairy farm experience was found to increase the likelihood of choosing the consumer market channel. This result implies that experience plays a significant role in the formation of a preference for direct marketing as more experienced farm operators build a long-term market relationship with consumers.

The result also revealed that dairy farms that operated with small farm sizes were negatively associated with the probability of choosing hotels market channel as compared to the large dairy farms (base category) whereas the volume of milk sale was positively associated with it. The possible reason for the negative relationship between farm size and hotel channel, and positive relationship between milk sale volume and hotel channel might be because small farms supply lower milk volume, lower than the minimum threshold hotels might need.

The impact of distance of dairy farm from milk selling center (measured in kilometers) indicated that the further away a dairy farm is situated from milk selling center, the higher the probability of choosing hotel market channel. Small bars and cafes are more distributed in the vicinity of cities and can be a possible option to sell raw milk. This is especially plausible when farms are situated in a location where processors and traders cannot reach them to collect milk and where consumers who buy at lower volume may not be a feasible marketing option.

Membership to dairy cooperatives was found to decrease the probability of choosing to sell milk directly to consumers (1% level) but increase the probability of choosing to sell to hotels (5% level of significance). Since consumers need less quantity of milk than hotels, the larger volume of milk purchased by hotels can attract milk suppliers to choose hotels than consumers.

Another important variable that had a significant impact on milk marketing channel choice was the average annual net price offered at different channels. The net price of raw milk was positively associated with the likelihood of choosing consumers and hotels whereas it was negatively related to the probability of choosing traders and processors. This is because both consumers and hotels pay relatively higher prices than traders and processors. This result agrees with the finding by Singh (2018) who observed a positive impact of price on choosing

consumers and partly agrees with the finding by Berem *et al*. (2015) who reported a negative relationship between price and trader (hawker in their term) and price and milk bars (hotels in our case).

The location of dairy farms was also found to affect the likelihood of different market channel choices. Addis Ababa dairy producers had a higher probability of choosing the processor market channel to sell their raw milk as compared to the base category (Hawassa dairy producers). On the other hand, as compared to the base category, Gondar dairy producers had a higher probability of choosing both consumer and hotel and a lower probability of choosing trader market channels to sell their raw milk. Mekele dairy producers also share the same behavior with dairy farms in Gondar as they had a higher probability of choosing hotels but less likelihood of choosing the trader market channel compared to the base category. The reason why Gondar dairy producers had a higher probability of choosing direct sales to consumers might be that they have a higher degree of contact with urban milk consumers who pay higher prices compared to other market alternatives. Another reason for these results is that it may be difficult for processors and traders to collect milk from producers in these areas, as the sites on which they operate are not always visible due to urban regulations that hinder the production of dairy in the city related to waste management. However, this may be not a problem for Addis Ababa and surrounding cities, where there is a long history of modern dairy farming. Hotels are also the next market option for Gondar and Mekele dairy producers implying that dairy producers in these two sites have close contact with hotels that also pay a higher net price.

The model results also showed that dairy producers found in the area surrounding Addis Ababa (Holeta, Sululta, Sendafa, Debre Zeit, and Sebeta) had different behaviors when choosing market channels to sell raw milk as compared to those in other study sites. Their probability of choosing to sell their raw milk to consumers and to hotels is lower, while their probability of choosing to sell their milk to processors is higher as compared to Hawassa farms. These areas are known as the 'Addis Ababa milk-shed' (Brandsma *et al*., 2012) because they supply milk to large processors such as Lame dairy (*Mama*) and Sebeta agro-industry, who sell much of their processed milk and milk products in the city of Addis Ababa. These processors have set up milk collection centers in these towns and collect milk at the roadside every morning. The implication of these findings from the 'Addis Ababa milk-shed' area suggests that dairy producers prefer to engage with a predictable, reliable, and seemingly sustainable market, even when the processors who are the gateway to that market offer a lower net price than some other channels. This might be plausible as a considerable portion of milk and milk product consumers practices frequent fasting during which they abstain from the food of animal origin that leads to lower demand for the dairy product as well as livestock products in general. In these seasons, it is feasible to process milk into

long shelf-life products such as butter, cheese, and ultra-heat treated (UHT) milk that can be consumed after the fasting season.

Table 16. Multivariate probit results (Coefficients and Std. Err.) of market channel choices

	Raw milk marketing channels			
	Consumers	Traders	Processors	Hotels
Variables	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Operator's education	0.004 (0.02)	-0.022 (0.014)	0.044** (0.018)	0.041*** (0.015)
Farm experience	0.012* (0.007)	-0.009 (0.007)	-0.009 (0.008)	0.002 (0.006)
Small farm	-0.01 (0.54)	0.35 (0.49)	-0.12 (0.59)	-0.87* (0.48)
Medium farm	0.27 (0.47)	0.43 (0.42)	0.017 (0.5)	-0.46 (0.40)
Milking cows	-0.006 (0.017)	-0.003(0.016)	-0.01 (0.02)	-0.02 (0.016)
Milk sale volume	0.001 (0.001)	0.001 (0.001)	0.0015 (0.001)	0.002* (0.001)
Market distance	-0.004 (0.012)	0.015 (0.011)	0.016 (0.01)	0.04*** (0.01)
Coops membership	-0.45** (0.19)	0.034 (0.17)	0.14 (0.20)	0.37** (0.16)
Net milk price	0.29*** (0.04)	-0.18*** (0.03)	-0.12*** (0.04)	0.05* (0.03)
Addis Ababa	-0.29 (0.28)	-0.11 (0.23)	0.77** (0.32)	-0.25 (0.24)
Gondar	0.96*** (0.32)	-1.93*** (0.33)	-0.087 (0.36)	0.53** (0.26)
Mekele	0.122(0.28)	-0.67*** (0.26)	-4.1 (107.8)	0.6** (0.26)
Oromia zone surrounding Addis Ababa	-0.78*** (0.25)	-0.014 (0.22)	0.66** (0.29)	-0.85*** (0.25)
Constant	-3.5***(0.88)	2.6*** (0.75)	-0.19 (0.88)	-1.18 (0.72)
Predicted probability	0.71	0.38	0.14	0.28
ρ_{21}		-0.33*** (0.08)		
ρ_{31}		0.07 (0.11)		
ρ_{41}		-0.16* (0.095)		
ρ_{32}		-0.45*** (0.08)		
ρ_{42}		-0.21** (0.083)		
ρ_{43}		0.18* (0.096)		
Wald chi2(52)		330.78***		
Log-likelihood		-813.62***		
Joint probability (success) = 0.0032, Joint probability (failure) = 0.045				

Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 51.63*** Prob > chi2 = 0.0000.
***, **, and * means statistically significant at 1%, 5%, and 10%, respectively.
Source: Survey, 2016

Conclusions and Implications

This paper investigates the determinant factors of raw milk marketing channel choice decision of commercial dairy farms in Ethiopia. Four main raw milk marketing channels (consumers, traders, processors, and hotels) were identified, of which the dominant market channel was the informal marketing channel that involves a direct sale to consumers. In contrast, only 9% of the dairy producers supplied milk to formal milk marketing (processing plants). Nevertheless, the peculiar characteristics were observed at Debre Zeit and Sebeta in which more than 50% and 20% of the farms, respectively, preferred to choose formal marketing (processors) as their primary marketing channel.

The results from the multivariate probit model estimates suggest that dairy farm operators with more farm experiences, non-member of dairy cooperatives, eager to receive the higher net price offered by consumers, and operate in the northern

cities such as Gondar were found to prefer a direct sale to consumers. On the other hand, dairy farm operators with higher education level, more farm experience, tolerate to receive lower net prices offered by trades for some reasons, and operate in the northern cities such as Gondar and Mekele were less likely to choose traders as their raw milk market channel. Furthermore, dairy farm operators with higher levels of education, tolerate lower net prices paid by processors for some reasons, and those who operate in Addis Ababa city had a higher probability of choosing processors as their raw milk market channel. Dairy farm operators with a higher level of education and, large dairy farms, who can go the longer distance to the milk selling point, member of dairy cooperatives, who want to enjoy higher net price offered by hotels, and operate in northern cities such as Gondar and Mekele city had a higher probability of choosing hotels/restaurants/cafes as their raw milk market channel while dairy farms operate in Oromia special zones surrounding Addis Ababa were found to less likely doing so.

The study provides the following policy implications. First, to modernize (formalize) the milk marketing system and strengthening the milk processing industries in all major cities will be crucial so that they can be feasible marketing options for dairy producers and supply processed dairy products with long shelf life and that are safe for consumers. This could be achieved by attracting investors towards dairy processing industries by easing regulations and arranging appropriate incentives. Second, strengthening dairy cooperatives, so that they can play an increased role in milk collection and processing, and supplying processed dairy products to consumers, would help to modernize the milk marketing system. Creating favourable environment for dairy cooperatives, following up on their performance, and designing appropriate supporting mechanisms would be one of the strategies to strengthen dairy cooperatives. Third, the primary raw milk selling option of dairy farms operating in large cities was nearby consumers and hotels/restaurants/cafes. This could be due to the absence of milk collecting centers in these cities. Hence, it may work if dairy processing companies organize milk collecting points in cities to contribute more towards modernizing the dairy marketing system. Fourth, this study was based on a sample of dairy farms recruited from nine cities and towns and it investigated raw milk marketing only from the producers' perspective. Therefore, further studies with larger geographical area coverage and milk marketing system from producers, traders, processors, and consumers' perspective would give a more complete picture of the milk marketing system in Ethiopia.

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