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BEYOND FOCUS: EXPLORING VARIABILITY OF SERVICE PROVISION OF AGRICULTURAL COOPERATIVES

Abstract

The wide array of services provided by agricultural cooperatives for their members is often not considered in academic studies. Addressing this gap in the literature, our paper explores the wide array of services provided by agricultural cooperatives and how these extend beyond those they were initially intended to provide. We study the extent and characteristics of service portfolios from 511 agricultural cooperatives in the Tigray region of Ethiopia. Results from two-limit Tobit models confirm that government and NGO-initiated cooperatives have a wide service portfolio compared to member-initiated cooperatives. In many of the studied cooperatives, the services they provide and their portfolios are more diverse than expected. Cooperatives seem to go beyond their focal areas of intervention. Also, those cooperatives that are more outward-oriented and where the chair has contact with other cooperatives or businesses, have a wider service portfolio. These results may help to explain the mixed findings on the impact of cooperative membership.

Keywords: Agricultural cooperatives, cooperative services, variability, tobit model, Ethiopia

1 Introduction

The literature on impact analysis of agricultural cooperatives is vast, with studies showing how cooperatives increase farmers' incomes and food security (Chagwiza et al. 2016, Ma and Abdulai 2016, Mojo et al. 2017), technical support and input provision (Wossen et al. 2017, Ma et al. 2018, Ma and Abdulai 2019, Zhang et al. 2019), savings and credit (Ma and Abdulai 2017, Nan et al. 2019), product quality control behaviour (Cai et al. 2016, Ji et al. 2019) and marketing services (Hao et al. 2018, Liu et al. 2019). Cooperatives contribute to rural development through capacity building (Bernard et al. 2008b, Abdulai and Abdulai 2017), provision of financial services (Ma and Abdulai 2017) and job creation (Ferguson 2012). The literature mainly reports positive outcomes for members' livelihoods. However, some studies find limited or no impact (Hailu et al. 2015, Shumeta and D'Haese 2016). Emerging literature points to different impacts across cooperatives (Verhofstadt and Maertens 2014, Hailu et al. 2015, Shumeta and D'Haese 2016). Some of this variability in impact, however, remains unexplained. This may be due to the way in which the cooperatives are organized or function, but as we argue in this paper, cooperatives differ in the range of services they deliver. The diversity of services offered by cooperatives, which is arguably an important determinant of their impact, is yet to be explored.

Many impact studies compare outcomes for members and non-members of cooperatives (Bernard et al. 2008b, Fischer and Qaim 2012). Papers present a single or a limited number of case studies in terms of the type of cooperative, product or research area (cf. references above), while fewer papers have included wider sets of cooperatives in impact studies (see Grashuis and Su [2019] for an overview of these papers). Moreover, the cooperative is taken as a given institutional structure (Bernard et al. 2008b, Chagwiza et al. 2016), almost a 'black box', whereas, in reality, cooperatives may address multiple problems faced by members. Papers may mention the services cooperatives provide, but their portfolio is seldom analyzed (Marcis et al. 2018). The portfolio of services is the starting point for this paper. This study aims to quantify the diversity of services offered by cooperatives and to identify explanatory variables for this diversity, in particular the initiating mechanism of the cooperative. Henceforth, our research aims to answer two questions, (1) to what

extent do cooperatives differentiate the services they provide; and (2) are government or NGO-initiated cooperatives more likely to have a wide portfolio of services? Data were collected from 511 agricultural cooperatives in the Tigray region of northern Ethiopia. The services provided by the cooperatives are covered, as well as their characteristics. Based on the listed services provided, an index of diversity is constructed. Its attributes are analyzed using tobit models.

The first research question relates to the concern voiced earlier in this introduction; namely that very few papers consider the array of services cooperatives offer. The second research question addresses the importance of the way in which cooperatives are initiated. A significant share of the cooperatives around the world were initiated by an external partner, be it the government or NGOs. For example, Olson (1965) describes how the United States Farm Bureau played a crucial role in the formation of cooperatives in the Illinois and Indiana states in the early 1900s. The Farm Bureau was established by the government to support farmers through the provision of technical assistance, training and education. Similarly, in many developing countries, agricultural cooperatives result from government or NGO initiatives (Huppi and Feder 1990). In Ethiopia, Bernard et al. (2008b) estimated that 74% of all cooperatives were established by the government or donors. These top-down initiated cooperatives have received preferential treatment for seed, capital, material support, technical and administrative assistance (Bernard et al. 2008b, Francesconi and Heerink 2011). Of all the agricultural cooperatives in Ethiopia, the multipurpose cooperatives are more likely to be part of a government program, as they have been used to support several rural development policies (Huppi and Feder 1990) and serve relatively more heterogeneous investment interests (Franken and Cook 2013). They have multiple tasks, such as supplying inputs (e.g. fertilizers, seeds, farm tools and implements), financial services, marketing members' products, leasing and rental of machinery and repairs, as well as the provision of basic consumer goods (Bernard et al. 2010, Franken and Cook 2015). Different from multipurpose cooperatives, single purpose cooperatives engage in a specific activity, such as livestock fattening, beekeeping or irrigation systems. Our results confirm that cooperatives established with government and NGO intervention provide a wide range of services. In particular, multipurpose cooperatives have a relatively larger portfolio compared to single purpose cooperatives. Yet, the portfolio of some single purpose cooperatives is surprisingly large.

Our main contribution to the literature is our evidence of diverse services and portfolios across a wide range of cooperatives. This is, to the best of our knowledge, the first paper to explore the diversity of services. We note that multipurpose cooperatives, which have been important cornerstones for Ethiopian agriculture, offer an extended range of services to their members compared to cooperatives of other types. While this may not come as a surprise, we also find a wide range of services provided by other product-specific cooperatives. Wider service portfolios are also associated with cooperatives initiated by the government and NGOs compared to self-initiated cooperatives, as well as to those that have been in contact with other cooperatives through membership of a higher-tier union or visits to other cooperatives.

2 Material and methods

2.1 Research area and data collection

Cooperatives have a long history in Ethiopia. Traditional forms of collective action such as *iqqub*, (traditional forms of rotating savings and credit associations), working groups such as *jige*, *wonfel*, and *debo* (which help in mobilizing labor resources) as well as *iddir* (traditional associations that provide insurance for members) are widespread in Ethiopia (Abebaw and Haile 2013). Formal cooperatives were established in the 1950s (Kodama 2007). Since then, the number of agricultural cooperatives in Ethiopia has increased rapidly. Member-owned and member-controlled cooperatives are supported by different Ethiopian government policies and programs (Navarra et al. 2017). These interventions play a major role in providing farmers with access to inputs, services, information and markets (ATA 2012). We distinguish multipurpose cooperatives, many of which were established by the government to provide services to farmers (and non-farmers), from other product-specific cooperatives, such as those involved in livestock and natural resource management. Important to note is that multipurpose cooperatives have been the only (official) source of fertilizers.

This research was conducted in Tigray, located in the northern most region of Ethiopia. The region is home to about 5 million people, 73% of whom live in rural areas (CSA 2017). Tigray covers a total area of 54,593 square kilometers. The population density is 0.8 persons/hectare, which is higher than the national average of 1.5 persons/hectare (CSA 2017). The region has four administrative zones, namely, Eastern, Central, South and Southeast (SSE), and West and Northwestern (WNW). These zones are further subdivided into 46 weredas (districts) and 763 tabias/kebeles (sub-districts), of which 702 are rural tabias (CSA 2017). The economy recorded a growth rate of 9.8% in 2017 (Tigray Bureau of Planning and Finance (TBoPF), 2018). The agricultural sector represents about 46% of the regional GDP. Rain-fed crop production, livestock and mixed farming are important sources of livelihood for 83% of its population. Farmers in the study area are smallholders with average land holdings of less than a hectare on which they mainly grow cereals (*teff*, barley, wheat and sorghum), pulses (beans, chickpeas and lentils), and oil crops (sesame and cotton). The region is also known for its exports of natural gums and resins, sesame, hides and skins, and honey (TBoPF 2018).

Cooperatives are considered to be instrumental in catalyzing the commercialization of smallholder production and are given due attention in the Agricultural Development Led Industrialization strategy (Bernard et al. 2010), the Sustainable Development and Poverty Reduction program (MoFED 2002), the Plan for Accelerated and Sustained Development to End Poverty 2006-2016 (MoFED 2006), the Agricultural Cooperative Sector Development Strategy 2012-2016 (ATA 2012), and the Growth and Transformation Plans (MoFED 2010, 2017). Agricultural cooperatives provide vital services to increase access for smallholders to farm inputs, credit, training and technical assistance, market information; they facilitate product aggregation and supply of basic consumer goods (Bernard et al. 2010). The Tigray region has 4,265 registered cooperatives of which 30% are livestock cooperatives (i.e. beekeeping, beef-cattle fattening, sheep and goat fattening, dairy), 24% natural resource cooperatives (i.e. irrigation and forestry cooperatives), 16% multipurpose cooperatives, and 30% service cooperatives that offer savings and credit services (Tigray Cooperative Promotion Agency (TCPA), 2017).

This study uses data that was collected in the Tigray region from April to August 2017. The survey covered multipurpose, beef-cattle, beekeeping, sheep and goats, dairy, irrigation and natural resource cooperatives. The following procedure was used to define the cooperatives sampled. First,

three weredas (districts) from the four zones in the region were randomly selected (Figure 1). Next, we selected 249 tabias (villages) from each wereda. Finally, using a probability proportional to size technique, 511 agricultural cooperatives were identified within those 249 tabias (Table 1). When the sample was taken, we did not consider cooperatives that had permanently relocated to other districts or villages, split or divided, dissolved, or were in the process of dissolution. Non-agricultural service cooperatives that provide savings and credit services were also excluded.

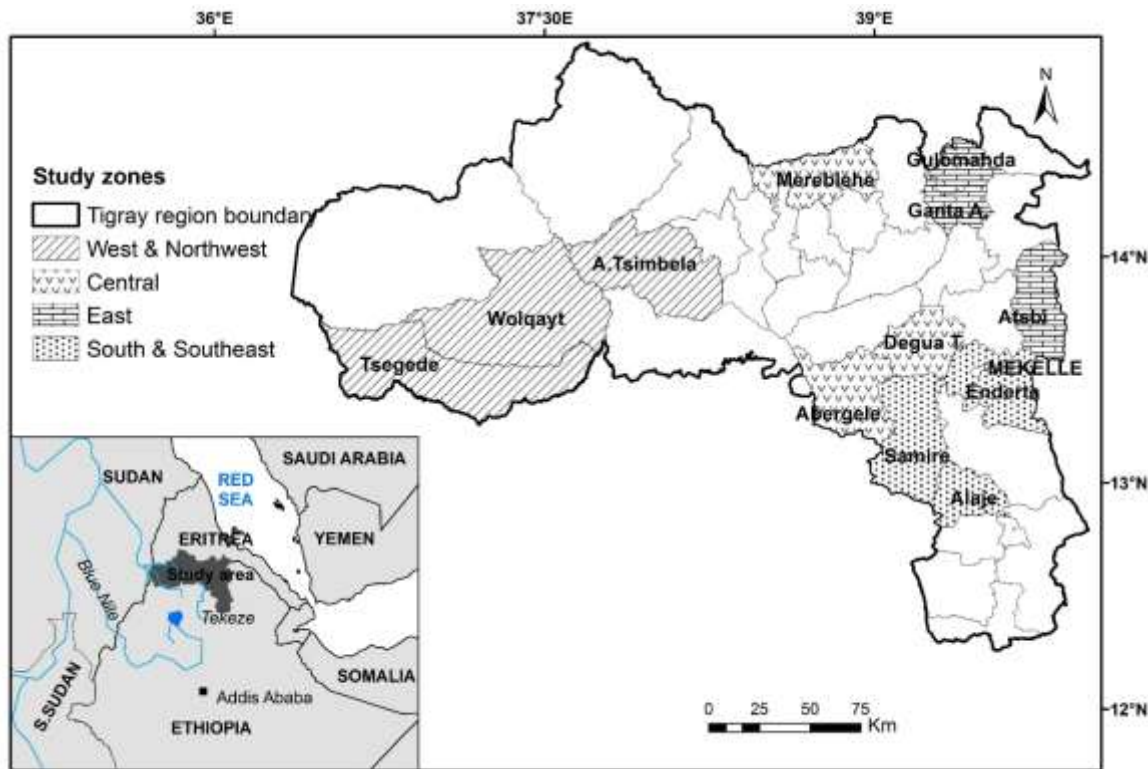


Figure 1 – Study area in the Tigray Region, Ethiopia

A structured questionnaire (which was pre-tested and adapted) was used to capture the cooperative chairs' socio-demographic characteristics as well as the cooperative's service provision, performance, and governance. A group of trained enumerators and supervisors, fluent in Tigrigna, interviewed the chairs of the cooperatives. In the absence of the chair, we interviewed the vice-chair (which occurred in 18% of the sample). The interviews were held in the cooperatives' offices. The data were coded and entered into SPSS (version 23) and STATA (version 14) for analysis.

Table 1– Distribution of sampled agricultural cooperatives across zones and weredas

Zone	Number of weredas selected in each zone	Number of selected tabias in each wereda	Number of coops selected from tabias in each wereda
Eastern	Atsbi Wenberta	33	43
	Ganta Afeshum	16	40
	Gulomekeda	25	51
	Subtotal	74	134
Central	Abergale	22	32
	Degua Tembien	17	64

	Mereb Leke	14	22
	Subtotal	53	118
South and southeastern (SSE)	Alaje	16	41
	Enderta	24	53
	Samre	20	41
	Subtotal	60	135
West and northwestern (WNW)	AsgedeTsimbla	12	25
	Tsegede	25	57
	Wolqayt	25	42
	Subtotal	62	124
Total		249	511

2.2 Operationalizing service portfolios

Literature reviews and socio-economic features of the study area helped to identify the components of five types of services for consideration as follows: (1) *financial services* – including in-kind credit, cash loans, insurance and dividends; (2) *input provision* – including fertilizer, improved seeds, herbicides, pesticides, farm tools, implements, dairy and beekeeping equipment, grass and animal feed services; (3) *information and training services* – including training, technical advice, production and market information provision; (4) *marketing services* - including marketing, payment and collaboration services; and, (5) *social services* – including consumable goods, community services, employment and external relations services (Table 2).

Table 2– Service portfolio of cooperatives, proxy variables, and their definitions

Portfolio	Services	Definition	Related literature
Financial services	Credit	1 if the cooperative finances the purchase of production inputs, and 0 if not	Myers 2004, Brehanu and Fufa 2008, Pollet 2009, Xu et al.2013, Ma and Abdulai 2017
	Loan	1 if the cooperative provides a loan to at least one member, and 0 if not	
	Insurance	1 if the cooperative provides insurance for dairy cows, and 0 if not	
	Dividend	1 if the cooperative provides patronage divided between its members, 0 if not	
Input Provision	Fertilizer	1 if the cooperative provides fertilizer to the members, and 0 if not	Hellin et al. 2009, Ferguson 2012, Holmgren 2012, Abebaw and Haile 2013, Xu et al. 2013, ICA 2015, Tamirat 2015, Souza 2019
	Improved seed	1 if the cooperative provides improved seed to the members and 0 if not	
	Herbicides	1 if the cooperative provides herbicides to the members, and 0 if not	
	Pesticides	1 if the cooperative provides pesticides to the members, and 0 if not	
	Farm tools	1 if the cooperative provides axes, sickles, spades, hammers and 0 if not	
	Farm implements	1 if the cooperative provides motor pumps, treadle pumps, tractors, fuel and 0 if not	
	Dairy equipment	1 if the cooperative provides cream separators, milk tankers, butter makers, yogurt makers, and 0 if not	
	Beekeeping equipment	1 if the cooperative provides modern beehives, honey extractors, smokers, hats, gloves, and 0 if not	

	Grass	1 if the cooperative provides leaves and grass for livestock fodder or housing and 0 if not	
	Animal feed	1 if the cooperative provides animal feed including green forage, molasses, and maize stover, and 0 if not	
Information and training services	Training	1 if the cooperative gives training on the nature and importance of cooperatives to the members, and 0 if not	Myers 2004, Bernard and Spielman 2009, Ferguson 2012, Holmgren 2012, Chagwiza et al. 2016, Mojo et al. 2017
	Technical advice	1 if the cooperative provides specific technical advice to at least one member, and 0 if not	
	Production information	1 if the cooperative provides information about agricultural production, and 0 if not	
	Market information	1 if the cooperative provides accurate and reliable market information, and 0 if not	
Marketing services	Marketing	1 if group marketing is conducted via cooperatives, and 0 if not	Bernard and Spielman 2009, Ma and Abdulai 2017, Mojo, et al. 2017
	Payment	1 if there is timely payment for selling members' products, and 0 if not	
	Collaboration	1 if the cooperative collects farm products from members for sale, and 0 if not	
Social services	Consumable goods	1 if the cooperative provides basic consumable goods including sugar, coffee food and oil, and 0 if not	Bernard et al. 2008a, Pollet 2009, Wanyama et al. 2009, Bernard et al. 2010, Holmgren 2012, Tamirat 2015
	Community services	1 if the cooperative provides community-oriented services to the society such as house maintenance for elderly people, tree planting, soil bund and stone terrace, public infrastructure such as road and school maintenance, and 0 if not	
	Employment	1 if the cooperative creates employment opportunities, and 0 if not	
	External relation	1 if the cooperative has interactions with external organizations (such as agricultural research institutions and universities), and 0 if not	

We developed a simple index by scoring each cooperative in the dataset with a 1 for each service it provides or applies. Next, a portfolio index was calculated by service type for each cooperative reflecting its diversity, as follows:

$$Portfolio_index_j = \frac{\sum S_i}{n_j} \quad (1)$$

where $Portfolio_index_j$ calculated for each portfolio j being financial services, input provision, information and training services, marketing services and social services; S_i scored 1 if service i is provided by the cooperative, 0 otherwise, and n_j is the total number of services considered for each service type. The $Portfolio_index_j$ scored 1 if the cooperative offers all possible services considered for that service type. We also calculated an overall portfolio index based on the diversity of all 25 services considered in the study (Table 2). The overall portfolio index was calculated considering the services across all five types, namely financial services, input provision, information and training services, marketing services and social services. The S_i scored 1 if a service i of any of the five types is provided, divided by 25 which is the total number of services considered in the analysis.

2.3 Tobit model specification

We estimated a Tobit model to study the characteristics influencing service portfolios. Tobit models are commonly used to analyze censored dependent variables (Tobin 1958). Ma et al. (2019) examined the impact of off-farm income on rural household energy expenditure by applying a Tobit model. Saz-Salazar et al. (2020) analyzed the determinants of willingness to pay for air pollution reduction through the estimation of a Tobit model. Previous studies have also used a two-tobit model to analyze cooperative service provision (e.g. Brehanu and Fufa 2008, Mensah et al. 2012). The Portfolio_indexes are the dependent variables of six two-limit Tobit models and their values range between 0 and 1. A two-limit Tobit model is defined as follows (Rosett and Nelson 1975):

$$Y_i^* = X_i' \beta + \varepsilon_i \quad (2)$$

where Y_i^* is a latent variable (not observed for the values less than zero and greater than one) that represents the cooperative service portfolio, calculated for the indices representing each service type (financial services, input provision, information and training services, marketing services and social services) and the overall portfolio index; X_i is a vector of cooperative characteristics that are assumed to influence the services portfolio; β is a vector of unknown parameters; ε_i is a vector of the error terms that are distributed normally with a mean of 0 and variance σ^2 ; and $i = 1, 2, 3, \dots, N$ represents the number of agricultural cooperatives.

If Y_i is the observed variable, representing the proportion of service portfolio indexes, its value is censored from below at $A=0$ and from above at $B=1$. Thus,

$$Y_i = \begin{cases} 0 & \text{if } Y_i^* \leq A \\ Y_i^* & \text{if } A \leq Y_i^* \leq B \\ 1 & \text{if } Y_i^* \geq B \end{cases} \quad (3)$$

The expected value of the latent service portfolio Y_i^* , is given by:

$$E(Y_i^*/X_i) = X_i' \beta \quad (4)$$

The change in this expected value by a unit in cooperative characteristics is given by:

$$\frac{\partial E(Y_i^*/X_i)}{\partial X_i} = \beta \quad (5)$$

As the values of service portfolio indexes Y_i are truncated from below at 0 and from above at 1, its conditional expected value is given by:

$$E(Y_i/X_i, A < Y^* < B) = X_i' \beta + \sigma \frac{\phi(Z_A) - \phi(Z_B)}{\Phi(Z_B) - \Phi(Z_A)} \quad (6)$$

where $Z_a = (A - X_i' \beta)/\sigma$ and $Z_b = (B - X_i' \beta)/\sigma$; $\phi(\cdot)$ and $\Phi(\cdot)$ denote the probability density function and the cumulative distribution function, respectively, of the standard normal distribution. In the absence of the limits, $Z = X_i' \beta/\sigma$. We estimated the censored regression models using the Maximum Likelihood (ML) method.

We controlled for other cooperative characteristics including the cooperative's (1) chair, (2) structure, (3) governance, and (4) external links and formation (Table 3).

Table 3 – Description of the variables included in the analysis

Variables	Variable description	Expected effect	Mean (Std. Dev)
<i>Key independent variables of interest</i>			
Member-initiated	Relates to the formation initiative defined as cooperative is self-initiated by the farmers (1=yes)	-	0.55 (0.50)
Type of cooperative	Multipurpose cooperatives are the base category of the cooperative type dummies	+	
<i>Control variables</i>			
<i>Chair characteristics</i>			
Age of chair	Age of the chair (years)	-	42.4 (11.2)
Chair's exposure visit	Chair undertook an exposure visit to observe the best practices of other cooperatives (1=yes)	+	0.53 (0.50)
<i>Structural characteristics</i>			
Age of cooperative	Years since the establishment of the cooperative	+	8.68 (7.42)
Membership size	Total number of cooperative members	+	380.62 (551.16)
Cooperative size	Logarithm of total assets (1000 ETB) of the cooperative	+	681.74 (4638.32)
Youth involvement in leadership	Total number of younger board members	+	1.54 (1.68)
Office	Cooperative has an office (1=yes)	+	0.52 (0.50)
<i>Governance characteristics</i>			
Membership policy	Cooperative has adopted closed membership (1=yes)	+	0.30 (0.46)
Audited	Cooperative financial accounts have been audited since its inception (1=yes)	-	0.56 (0.50)
Audit committee	Cooperative has an audit committee (1=yes)	-	0.75 (0.43)
Conflict	Cooperative experiences conflict among members (1=yes)	-	0.43 (0.50)
<i>External link and formation</i>			
Business link with other coops	Cooperative has horizontal business links with others (1=yes)	+	0.52 (0.50)
Union membership	Membership of union or second-tier cooperative (1=yes)	+	0.47 (0.50)

Note: ETB (Ethiopian currency) exchange rate reported by commercial bank of Ethiopia on 15 June 2018, 1 USD= 28.20 ETB.

It was hypothesized that younger chairs would be more likely to seek the addition of new services to their portfolio and provide services to their members. Younger board members may be less risk-averse, more likely to accept strategic change, and more likely to challenge rules and authority (Kempers et al. 2019). Younger board members (defined here as up to 29 years old) may have received more education, which allows them to better evaluate strategic alternatives (Chen et al. 2020). They may also be highly motivated out of career concerns, perhaps more than directors

nearing the end of their careers (Sahel et al. 2020). It was assumed that chairs who develop their leadership skills by observing the best-performing cooperatives through exposure visits will be more likely to widen their service portfolio. Some studies suggest that the cooperative age is associated with service provision (Karami and Rezaei-Moghaddam 2005, Adane 2019, Sebhatu et al. 2020). Over time, cooperatives may develop wider service portfolios with experience, or by extension. Similarly, cooperatives that serve more members could be tempted to increase the service diversity as the unit transaction costs would decrease (Van Puyvelde et al. 2015). Also, cooperatives with more assets might be more capable of processing, branding extension, and differentiated marketing (Huang et al. 2013). Having basic office infrastructure may increase diversity, including the availability of infrastructure facilities such as office space and storage areas, workshops, etc. (Sebhatu et al. 2020).

We also controlled for governance characteristics. Our sample includes both closed and open member cooperatives of which we assume the former could provide more diverse service portfolios due to their capacity to reduce free-riders, horizon, and portfolio problems (Cook and Iliopoulos 2000). Ethiopian cooperatives need to be audited on an annual basis by designated government bodies to obtain permission to pay dividends. Yet, organizational problems (such as the shortage of auditors) limit their deployment. Audited cooperatives may be less tempted to provide a wide range of services, as this may deviate from the cooperative's focus and reduce its effectiveness. If in addition, the cooperative has an audit committee, its controlling function could restrict the cooperative's management in taking risks by venturing into new activities. A final governance characteristic is the occurrence of conflict. With conflict arising in the cooperative, service delivery may be negatively impacted.

Finally, business links may influence the cooperatives' service portfolios. Cooperatives may link up with other cooperatives or become members of unions or second-tier cooperatives. Collaboration between cooperatives is expected to increase supply of diverse services. Also, unions provide inputs, marketing services, and technical assistance to their member cooperatives (Bernard et al. 2010) and are considered to be a source of competitive advantage (Wanyama et al. 2009).

3. Results

3.1 Sample characteristics

As explained in the data collection section, 4,265 cooperatives are registered in Tigray (TCPA 2017). This number is based on the TCPA registry database covering all the cooperatives in the region. The registry includes 2,986 agricultural cooperatives (70% of all cooperatives). It is important to note that the registry includes some inactive cooperatives that we have encountered in the field. It is, however, not possible to estimate how many cooperatives were inactive at the time of data collection. We collected data from 511 agricultural cooperatives; this corresponds to 12% of all registered cooperatives and 17% of all agricultural cooperatives. Within the agricultural cooperative type, the data represents 16% of all livestock cooperatives, 13 % of all natural resource cooperatives, and 26 % of all multipurpose cooperatives. Moreover, the cooperatives surveyed represent 65% (n=788) of all active agricultural cooperatives in the selected study weredas. Therefore, it can be inferred that the sample of 511 active agricultural cooperatives is representative of all cooperatives in Tigray.

Table 4 gives an overview of the sample by cooperative type and zone. The sample is balanced across the zones. Most cooperatives in the sample are multipurpose cooperatives (35%), followed by beekeeping (25%) and irrigation cooperatives (22%) compared to other cooperative types. Our data counts relatively more beekeeping and irrigation cooperatives compared to what would be expected based on their share in the TCPA registry.

Table 4 – The characteristics of the cooperatives in the sample (n=511) (in percent)

Zone	Multipurpose	Beef-cattle	Bee-keeping	Sheep and goats	Dairy	Irrigation	Natural resource	Total
Eastern	24	5	33	8	5	21	2	27
Central	34	5	25	8	2	26	1	23
South & southeast	38	4	15	3	7	24	10	26
West & north western	46	4	25	5	2	17	2	24
Total percent	35	5	25	6	4	22	4	100

Most chairs interviewed were male, with an average age of about 42 years (Table 5). On average, chairs had enjoyed primary education and had been members of the cooperative for quite some time. They had attended at least one training session relating to cooperative issues and many had visited another cooperative. Almost all chairs were elected by a majority vote.

Table 5 – The socio-economic characteristics of cooperative chairs (n=511)

	Minimum	Maximum	Mean	Std. Deviation
Age (years)	18.0	76.0	42.4	11.2
Education (years)	0.0	13.0	5.9	2.8
Duration of membership (years)	0.3	29.0	7.5	5.9
Work experience (years)	0.0	41.0	3.6	3.4
		Frequency	Percent	
Gender	Female	22	4.3	
	Male	489	95.7	
Membership of political party	No	26	5.1	
	Yes	484	94.7	
Attending training	No	24	4.7	
	Yes	486	95.1	
Frequency of attending training	0-3	347	67.9	
	4-7	106	20.7	
	8-11	23	4.5	
	12-15	6	1.2	
	15-32	4	0.8	
Private occupation	Agriculture	471	92.2	
	Trade	33	6.5	
	Mason/carpenter	13	2.5	
	Civil servant	3	0.6	
	Daily labor	6	1.2	
Membership in another cooperative	No	85	16.6	
	Yes	424	83.0	

Election of the chairs	Appointed by an outside person or entity	24	4.7
	Appointed by the former chair of the cooperative	1	0.2
	Appointed by vote involving a small group of members	150	2.9
	Appointed by majority vote	468	91.6

3.2 Portfolios of cooperative services

Table 6 lists the services the cooperatives provide. Multipurpose cooperatives are actively engaged in all stages of agricultural production and provide input purchase and marketing services. The most frequent activities are the provision of farm inputs for members, such as fertilizer, improved seeds, agro-chemicals, and farm implements. They also provide basic consumer goods to members such as sugar, wheat flour, cooking oil, etc. and they contribute to public goods (such as the construction of schools, health centers, and local roads). Livestock cooperatives are specialized in cattle fattening, mainly providing credit, training, and marketing services. Sheep and goat fattening cooperatives provide technical advice and credit. In addition, they provide animal feed and employment opportunities. Beekeeping, sheep and goats and dairy cooperatives provide special services related to raising specific types of livestock. Natural resource cooperatives that are mainly involved in collectively organizing irrigation schemes, have the least diverse service portfolio.

Many cooperatives provide loans and credit. Only a few cooperatives are engaged in issuing insurance. Dividends are paid by half of the multipurpose cooperatives but much less by other cooperatives. As expected, many multipurpose cooperatives are involved in the provision of inputs, such as fertilizers, seeds, and farm implements. Other cooperative types are surprisingly much less involved in supplying inputs. These cooperatives are involved in training and information provision, more than multipurpose cooperatives. As a result, multipurpose cooperatives have the most diverse portfolios compared to other types of cooperative (Table 7). The diversity is substantial for services that contribute to financial, marketing, input provision, and social services. The average index for marketing service provision is significantly higher in multipurpose cooperatives compared to other types of cooperative.

Table 6 – Services provided by type of service and cooperative

Type of cooperatives						
Multipur- -pose	Beef- cattle	Beekeep- ing	Sheep and goats	Dairy	Irrigation	Natural resources

	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Financial services							
In-kind credit	77.8	29.2	30.2	30.0	42.9	38.7	10.5
Cash loans	88.3	41.7	39.7	46.7	47.6	46.8	15.8
Insurance	1.11	0	0	0	14.3	0	0
Dividend	47.2	29.2	17.5	10.0	19.0	14.4	0
Input services							
Fertilizers	98.9	4.2	4.8	3.3	14.3	36.0	10.5
Pesticides	13.3	0	0	0	4.8	6.3	0
Herbicides	27.8	4.2	0	0	4.8	8.1	0
Improved seed	71.7	4.2	3.2	3.3	9.5	28.8	10.5
Farm tools	51.7	4.2	0	0	0	0.9	0
Farm implements	73.3	4.2	0	0	0	14.4	0
Dairy equipment	1.11	0	0	3.3	42.9	0	0
Beekeeping equipment	42.2	4.2	24.6	0	0	1.8	0
Grass	0	4.2	15.1	0	0	7.2	15.8
Animal feed	9.4	8.3	24.6	40.0	61.9	13.5	73.7
Information and training services							
Training	34.4	45.8	32.5	40.0	61.9	39.6	31.6
Technical advice	45.0	58.3	76.2	50.0	66.7	63.1	47.4
Production information	36.1	16.7	26.2	43.3	19.0	45.9	21.1
Market information	53.9	50.0	66.7	50.0	66.7	66.7	36.8
Marketing services							
Marketing	3.3	0	1.6	0	19.0	1.8	0
Payment	32.2	8.3	19.0	26.7	52.4	27.0	0
Collaboration	67.2	29.2	42.9	70.0	28.6	47.7	31.6
Social services							
Consumable goods	90.0	4.2	0	0	0	0	0
Community services	29.4	29.2	12.7	27.6	23.8	22.5	10.5
External relation	53.3	20.8	55.6	76.6	52.4	47.7	31.6
Employment	97.8	58.3	50.8	63.3	76.2	42.3	73.7

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Table 7 – Service portfolios compared across different types of cooperative

Portfolio	Types of cooperative	n	Mean	F-statistics
Financial services	Multipurpose	180	0.54 ^a	31.597***
	Beef cattle fattening	24	0.25 ^b	
	Beekeeping	126	0.22 ^b	
	Sheep and goat fattening	30	0.22 ^b	
	Dairy	21	0.31 ^b	
	Irrigation	111	0.25 ^b	
	Natural resources	19	0.07 ^c	
	Total	511	0.34	
Input services	Multipurpose	180	0.39 ^a	112.48***
	Beef-cattle fattening	24	0.04 ^d	
	Beekeeping	126	0.07 ^{cd}	
	Sheep and goat fattening	30	0.05 ^d	
	Dairy	21	0.14 ^a	

	Irrigation	111	0.12 ^{bc}	
	Natural resources	19	0.07 ^{cd}	
	Total	511	0.19	
Information and training services	Multipurpose	180	0.42 ^{ab}	
	Beef-cattle fattening	24	0.43 ^{ab}	
	Beekeeping	126	0.50 ^a	
	Sheep and goat fattening	30	0.46 ^{ab}	
	Dairy	21	0.54 ^a	2.94***
	Irrigation	111	0.54 ^a	
	Natural resources	19	0.34 ^b	
	Total	511	0.47	
Marketing services	Multipurpose	180	0.34 ^a	
	Beef-cattle fattening	24	0.13 ^c	
	Beekeeping	126	0.21 ^{bc}	
	Sheep and goat fattening	30	0.32 ^{ab}	
	Dairy	21	0.33 ^a	8.06***
	Irrigation	111	0.26 ^{ab}	
	Natural resources	19	0.11 ^c	
	Total	511	0.27	
Social services	Multipurpose	173	0.67 ^a	
	Beef-cattle fattening	24	0.28 ^c	
	Beekeeping	116	0.30 ^c	
	Sheep and goat fattening	29	0.42 ^b	
	Dairy	19	0.38 ^{bc}	56.337***
	Irrigation	107	0.28 ^c	
	Natural resources	19	0.29 ^c	
	Total	487	0.44	
Total service portfolio	Multipurpose	173	0.47 ^a	
	Beef-cattle fattening	24	0.22 ^{cd}	
	Beekeeping	116	0.26 ^c	
	Sheep and goat fattening	29	0.22 ^{bc}	
	Dairy	19	0.34 ^b	45.516***
	Irrigation	107	0.29 ^{bc}	
	Natural resources	19	0.18 ^d	
	Total	487	0.34	

Note: *** F-statistics significant at 1% level; ^{a,b,c,d,e}; the means in the same service portfolio with the same letter are not significantly different and the means in the same service portfolio without a common letter are different at P < 10% using Duncan's test. (estimated by Duncan tests, P < 0.05).

3.3 Characteristics of service portfolios

Table 8 gives the marginal effects of the six estimated tobit models. The maximum likelihood estimates are presented in Table A1 in the Appendix.

The model results suggest that member-initiated cooperatives provide a less diverse portfolio of financial, marketing and social services as compared to those initiated by the government or NGOs. The results also show that multipurpose cooperatives (which are the base category of the

cooperative type dummies) serve members with a wide range of input provisions and marketing services compared to other cooperative types. They have a wide portfolio of financial services compared to other cooperatives, apart from the natural resource cooperatives. They provide less diverse training and information services compared to irrigation services.

With regard to the control variables, we find a robust positive relationship between the age of the cooperative and its membership size. The older the cooperative, the more diverse their financial portfolio. Field experience shows that the money borrowed by members is mostly used to purchase agricultural inputs, to support dairy and poultry farms, and for petty trading. Older cooperatives are also more likely to pay dividends to their members. Also, Karami and Rezaei-Moghaddam (2005) found that cooperative age was positively associated with agricultural service provision. The coefficient of membership size is significant and has a positive effect on the diversity of the portfolios for input provision, marketing services, and social services, and on total service portfolios. This is not surprising given that a large membership size allows cooperatives to reduce implementation and transaction costs by pooling services related to input purchase and processing and/or marketing of their members' produce. Thus, a large membership allows cooperatives to provide and manage a more diverse set of services compared to smaller cooperatives.

The cooperative size measured by their assets has a U-shaped relationship with portfolio diversity. This is shown for input provision, social services, and total service portfolios. The non-linear relationship is checked by using the u-test command, as suggested by Lind and Mehlum (2010). The test result rejects the null hypothesis that the relationship is inversely U-shaped or monotone (*t-value*= 1.13, *p-value*=0.086 for input service; *t-value*= 1.55, *p-value*=0.060 for social service; *t-value*= 2.93, *p-value*=0.001 for total service). This suggests that the diversity of the total service portfolios decreases until cooperative assets reach a minimum, and then starts to increase. Calculations show that the turning point is at very low levels of assets.

Next, as expected, the number of young people in the cooperative's management board has a positive and statistically significant effect on portfolio diversity for financial services, input provision, social services, and on the total service portfolio. The findings also reveal that the availability of an office is associated with increased diversity of financial services, input provision, social and total service portfolios. The cooperatives that have adopted a closed membership policy appear to show a positive and statistically significant effect on the diversity of their financial portfolio. This is because closed cooperatives have a smaller membership, which could create opportunities for members to quickly rotate in terms of access to diverse financial services (e.g. credit and dividends). The cooperatives that mentioned experiencing conflict tend to have a negative and statistically significant impact on the diversity of information and training, marketing services, social services, and total service portfolios.

Table 8 – Marginal effects on the determinants of cooperatives' service portfolio (n=486)

Independent variables	Dependent variables – Service portfolio					
	Financial	Input	Information and training	Marketing	Social	Total
Member-initiated	-0.060* (0.031)	-0.010 (0.015)	-0.104*** (0.035)	-0.002 (0.059)	-0.053** (0.023)	-0.030*** (0.009)
Chair characteristics						
Age of chair	0.002 (0.002)	0.001 (0.009)	0.0011 (0.0019)	-0.0002 (0.0031)	0.001 (0.001)	0.001 (0.001)

Chair exposure visit	0.030 (0.031)	0.029* (0.015)	0.0633* (0.0351)	0.1100* (0.0596)	-0.019 (0.023)	0.016* (0.009)
Structural characteristics						
Age of cooperative	0.009*** (0.003)	0.002 (0.002)	-0.001 (0.004)	-0.002 (0.006)	0.005 (0.002)	0.002** (0.001)
Membership size	0.0001 (0.0001)	0.0001* (0.0001)	-0.0001 (0.0001)	0.0002* (0.0001)	0.0001** (0.0001)	0.0001* (0.0001)
Ln(cooperative size in asset)	-0.011 (0.015)	-0.008 (0.007)	-0.020 (0.016)	-0.028 (0.028)	-0.017 (0.011)	-0.012*** (0.004)
Ln(cooperative size squared)	0.001 (0.001)	0.001* (0.001)	0.001 (0.001)	0.003 (0.002)	0.002* (0.001)	0.001*** (0.000)
Youth involvement in leadership	0.042*** (0.011)	0.011* (0.005)	0.001 (0.012)	-0.003 (0.021)	0.015* (0.008)	0.009*** (0.003)
Office	0.168*** (0.043)	0.043** (0.022)	0.027 (0.049)	0.116 (0.082)	0.053* (0.032)	0.039*** (0.012)
Governance characteristics						
Membership policy	0.026** (0.042)	-0.013 (0.021)	0.026 (0.046)	-0.057 (0.079)	0.019 (0.030)	0.009 (0.012)
Audited	0.103*** (0.039)	0.011 (0.020)	-0.033 (0.044)	0.177** (0.074)	0.040 (0.029)	0.014 (0.011)
Audit committee	0.095 (0.059)	0.013 (0.030)	0.070 (0.067)	0.162 (0.108)	0.097** (0.042)	0.040** (0.017)
Conflict	-0.046 (0.033)	-0.018 (0.016)	-0.115*** (0.037)	-0.216*** (0.063)	-0.097*** (0.024)	-0.038*** (0.010)
External link and formation						
Business link with other coop	0.0042 (0.034)	-0.018 (0.016)	0.196*** (0.038)	-0.062 (0.064)	0.153*** (0.024)	0.053*** (0.010)
Union membership	0.097** (0.044)	-0.016 (0.022)	-0.0430 (0.050)	0.168** (0.084)	0.026 (0.032)	0.013 (0.013)
Location-zone dummies						
Central zone	0.016 (0.046)	0.054** (0.023)	0.026 (0.051)	0.135 (0.088)	-0.046 (0.033)	0.004 (0.013)
South Southeast zone	0.023 (0.045)	0.087*** (0.022)	0.106** (0.051)	0.253*** (0.086)	-0.052 (0.033)	0.018 (0.013)
West North-West zone	0.118*** (0.044)	0.070*** (0.022)	0.0067 (0.049)	0.194** (0.085)	-0.024 (0.032)	0.025* (0.013)
Cooperative type-dummies						
Beef-cattle fattening	0.024 (0.095)	-0.362*** (0.054)	0.088 (0.109)	0.390** (0.186)	-0.170** (0.071)	-0.070** (0.028)
Beekeeping	0.017 (0.075)	-0.243*** (0.037)	0.120 (0.087)	0.499*** (0.147)	-0.158*** (0.056)	-0.062*** (0.022)
Sheep and goat fattening	-0.046 (0.095)	-0.284*** (0.048)	0.011 (0.108)	0.723*** (0.180)	-0.098 (0.070)	-0.079*** (0.027)
Dairy	-0.062 (0.097)	-0.191*** (0.047)	0.170 (0.110)	1.014*** (0.177)	-0.097 (0.071)	-0.050* (0.028)
Irrigation	0.017 (0.073)	-0.206*** (0.036)	0.155* (0.085)	0.474*** (0.144)	-0.199*** (0.055)	-0.046** (0.022)
Natural resources	-0.396*** (0.137)	-0.274*** (0.056)	-0.108 (0.126)	0.057 (0.235)	-0.108 (0.080)	-0.125*** (0.032)
Constant	-0.227* (0.134)	0.133** (0.065)	0.361** (0.150)	-0.701*** (0.257)	0.330*** (0.096)	0.327*** (0.038)

Note: Figures in the table indicate the estimated marginal effect and standard errors in parentheses. Symbols indicate significant differences at *** ≤ 0.001 ; ** ≤ 0.05 ; * ≤ 0.10 . Base category zone dummies are eastern zone and base category cooperative type dummies are multipurpose cooperatives.

4 Discussion

The main finding in the descriptive part of the analysis is the wide diversity in services observed across the different cooperative types. While this may have been expected for multipurpose cooperatives which – by definition – should provide a wide array of multiple services (Bernard et al. 2010, Mojo et al. 2017), we found other cooperatives offering services beyond their focal area. To our knowledge, no other papers have explored cooperatives' service portfolios in the same way as this paper. It is, therefore, not possible to compare our results with those of similar studies.

Cooperatives that were established by the government or an NGO tend to provide a wider set of services (such as training, technical advice, and credit) compared to own-initiated cooperatives. Our results suggest that cooperatives established externally by the government or by NGOs provide more diverse services that include training, technical advice and credit. These cooperatives also provide services to the community, such as the provision of consumer goods (e.g. cooking oil, sugar) and contribute to public goods (such as the construction of schools, health centers and local roads). This is consistent with the results of previous studies indicating that cooperatives initiated externally by the government or NGOs received financial, material, and training support. Cooperatives, in turn, provide some kind of social services to the community to which they belong (Karami and Rezaei-Moghaddam 2005, Bernard et al. 2008a, Bernard and Spielman 2009).

With regard to cooperative characteristics that are associated with portfolio diversity, two interesting results stand out; first, outward-looking cooperatives seem to have more diverse service portfolios and second, the way in which the cooperative was established affects the diversity of their service portfolio. Exposure visits to known cooperatives are associated with more diverse input provision, information and training, and marketing services. This also results in a diverse total service portfolio. This finding appears to be consistent with other findings reported in the literature - namely, that participation by cooperative leaders in experience sharing and exposure visits is an effective mechanism for strengthening leadership skills and cooperative development (Karunakaran and Huka 2018). The establishment of business links with other cooperatives and membership of second-tier cooperatives are expected to improve not only the performance of the cooperatives in providing services to members but could also increase members' total service portfolios. In particular, horizontal business links with other cooperatives have a strong influence on the diversity of service portfolios, such as information and training, social services, and the total service portfolio. Networking with other cooperatives can be instrumental in tapping into resources. For example, the horizontal business link between multipurpose and financial cooperatives enables members of the former to deposit small monthly payments into savings and credit cooperatives and to access farm inputs during the production season. Similarly, business links between natural resource and livestock cooperatives allow members of the latter to access fodder for their animals. Some studies (e.g. Beuchelt and Zeller 2013) suggest that horizontal coordination among cooperatives on marketing, services or input provision improves the delivery of services to their members. The union is the source of credit funds for cooperatives and links cooperatives to the domestic and international markets. The positive effect of membership in the higher-level organization is in line with the findings of Rezaee and Kedia (2012) who found that members of umbrella organizations had a positive effect on the service provision of rural producer organizations in DR Congo.

Moreover, the estimation results for a number of control variables give interesting results. A large membership allows cooperatives to provide and manage greater service provision compared to small cooperatives. This result is consistent with the findings of Ragasa and Golan (2014), which show that membership size is positively associated with agricultural cooperative service provision. However, this finding contradicts observations by Bernard and Spielman (2009) in Ethiopia, who find that large membership size has a negative effect on cooperatives' marketing services. The cooperative size in assets has a U-shaped relationship with portfolio diversity. This may not be surprising for cooperatives in Ethiopia, where most cooperatives' assets (e.g. equipment, machinery, infrastructure) were not created through normal business operations, but instead obtained from the government and NGOs (Bernard and Spielman 2009). We argue that cooperatives may not need such assets to provide services to their members. This finding refutes the results of Bernard and Spielman (2009), who find an insignificant relationship between assets and marketing services.

5 Conclusions

This paper set out to analyze cooperatives' service portfolios with a particular interest in how multipurpose cooperatives compare to other cooperative types and member-initiated cooperatives to those initiated by the government or NGOs. Based on the services provided by cooperatives to their members, we calculated a service index for the five types of services, namely, financial, input provision, information and training, marketing, and social services. Using data from cooperatives in the Tigray region in Ethiopia and two-limit tobit models, we describe the diversity of the service portfolio. Multipurpose cooperatives were found to have the most diverse service package. This may be no surprise given the origin (and even name) of these cooperatives. This was also confirmed by the results of the Tobit model. The diversity of service portfolios is largely determined by the type of cooperative and its location. Results suggest that the characteristics of the chair, such as exposure visits to other best-performing cooperatives, only matter to a limited extent. Other cooperative characteristics, such as the age of the cooperative, membership size, its size in terms of cooperative assets, number of young members in leadership positions, having an office, the adoption of a closed membership policy, the presence of an audit committee, and the provision of patronage dividends to members are associated with more diverse portfolios. The existence of conflict among members results in a reduced service portfolio.

In sum, this paper shows that underlying the heterogeneity in cooperatives is the diversity of services they deliver. Cooperatives may have a product-specific orientation, but will still have a diverse portfolio. As such, we bring an extra dimension to cooperative-level impact studies. The literature tends to limit description of the cooperatives studied to the bare essential services they provide for members. Yet, we show that service provision by cooperatives goes beyond the standard expected packages. Cooperatives, and in our study in particular, multipurpose cooperatives, serve their members with a service portfolio that may determine the cooperative impact most often measured.

Heterogeneity found in member-level impact studies may, therefore, be attributed to the diversity of the service packages the cooperatives deliver. Because of the structure of our data, we were not able to evidence the latter, which is an avenue for future research. Yet, we call upon researchers to increasingly open the cooperative-service black box when measuring development impacts.

Based on our results, we suggest some policy recommendations to improve the role of agricultural cooperatives in service provision to their members in Ethiopia. First, visiting successful cooperatives is very important for chairs to explore the innovative services other cooperatives offer to their members and to adopt best practices in order to manage a broader service portfolio. Second, the findings show that cooperatives established by the government or NGOs have played a significant role in providing services to their members, compared to self-initiated cooperatives. However, too much external support from government and NGOs enables cooperatives to develop a dependency syndrome and fails to inspire members with cooperative principles and values. Such a top-down approach does not allow cooperatives to develop a vision of development to ensure both institutional and financial sustainability. Therefore, the government-led cooperative agency should review its cooperative development procedures and focus on the extent of outsider involvement during the establishment process. Third, the government-led cooperative agency should encourage grassroots cooperatives to join the union through a partial or instalment-based payment scheme. Such measures are particularly appropriate to enhance their development and performance and to provide members with efficient and high-quality services on a competitive basis. Finally, existing cooperatives' services are limited to farm inputs, training, and consumer goods. Deploying crop and livestock insurance that some dairy cooperatives (dairy cattle insurance) have already introduced against losses and accidents is another important measure by which cooperatives can improve their services.

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Table A1 – The maximum likelihood estimates of the two- limit Tobit model

Independent variables	Dependent variables – Service portfolio					
	Financial	Input	Information and training	Marketing	Social	Total
Member-initiated	-0.0598* (0.0312)	-0.0099 (0.0154)	-0.1040*** (0.0352)	-0.0019 (0.0592)	-0.0534** (0.0229)	-0.0299*** (0.0089)
Chair characteristics						
Age of chair	0.0023 (0.0017)	0.0010 (0.0008)	0.0011 (0.0019)	-0.0002 (0.0031)	0.0014 (0.0012)	0.0007 (0.0005)
Chair exposure visit	0.0300 (0.0313)	0.0293* (0.0154)	0.0633* (0.0351)	0.1100* (0.0596)	-0.0194 (0.0229)	0.0163* (0.0089)
Structural characteristics						
Age of cooperative	0.0092*** (0.0032)	0.0017 (0.0016)	-0.0008 (0.0037)	-0.0016 (0.0062)	0.0036 (0.0024)	0.0024** (0.0009)
Membership size	0.0001 (0.0001)	0.0001* (0.0001)	-0.0001 (0.00001)	0.0001* (0.0001)	0.0001** (0.0001)	0.0001* (0.0001)
Ln(cooperative size in asset)	-0.0105 (0.01470)	-0.0082* (0.0073)	-0.0203 (0.0164)	-0.0283 (0.0278)	-0.0168 (0.0108)	-0.0123*** (0.0042)
Ln(cooperative size squared)	0.0012 (0.0011)	0.0009* (0.0005)	0.0014 (0.0012)	0.0026 (0.0020)	0.0015* (0.0008)	0.0010*** (0.0003)
Youth involvement in leadership	0.0417*** (0.0110)	0.0106* (0.0054)	0.0010 (0.0123)	-0.0028 (0.0209)	0.0148* (0.0080)	0.0091*** (0.0031)
Office	0.1680*** (0.0431)	0.0428** (0.0217)	0.0271 (0.0485)	0.1160 (0.0820)	0.0526* (0.0315)	0.0392*** (0.0123)
Governance characteristics						
Membership policy	0.0263** (0.0419)	-0.0125 (0.0210)	0.0257 (0.0459)	-0.0571 (0.0789)	0.0192 (0.0300)	0.0085 (0.0117)
Audited	0.1030*** (0.0392)	0.0106 (0.0195)	-0.0331 (0.0439)	0.1770** (0.0738)	0.0404 (0.0285)	0.0144 (0.0111)
Audit committee	0.0946 (0.0589)	0.0135 (0.0297)	0.0702 (0.0667)	0.1620 (0.108)	0.0966** (0.0424)	0.0403** (0.0167)
Conflict	-0.0464 (0.0329)	-0.0184 (0.0161)	-0.1150*** (0.0369)	-0.2160*** (0.0633)	-0.0973*** (0.0239)	-0.0377*** (0.0094)
External link and formation						
Business link with other coop	0.0042 (0.0335)	-0.0178 (0.0164)	0.1960*** (0.0380)	-0.0621 (0.0638)	0.1530*** (0.0243)	0.0532*** (0.0095)
Union membership	0.0965** (0.0439)	-0.0159 (0.0224)	-0.0425 (0.0495)	0.168** (0.0835)	0.0258 (0.0321)	0.0127 (0.0126)
Location-zone dummies						
Central zone	0.0160 (0.0455)	0.0544** (0.0227)	0.0263 (0.0509)	0.135 (0.0883)	-0.0466 (0.0334)	0.00439 (0.0130)
South Southeast zone	0.0227 (0.0454)	0.0873*** (0.0223)	0.1060** (0.0508)	0.2530*** (0.0855)	-0.0519 (0.0331)	0.0175 (0.0129)
West North-West zone	0.1180*** (0.0436)	0.0703*** (0.0220)	0.0067 (0.0493)	0.1940** (0.0846)	-0.0238 (0.0323)	0.0246* (0.0126)
Cooperative type-dummies						
Beef-cattle fattening	0.0235 (0.0950)	-0.3620*** (0.0537)	0.0881 (0.1090)	0.3900** (0.1860)	-0.1700* (0.0705)	-0.0697** (0.0275)
Beekeeping	-0.0174 (0.0749)	-0.2430*** (0.0370)	0.1200 (0.0868)	0.4990*** (0.1470)	-0.1580** (0.0557)	-0.0623*** (0.0219)
Sheep and goat fattening	-0.0463 (0.0949)	-0.2840*** (0.0483)	0.0114 (0.1080)	0.7230*** (0.1800)	-0.0980 (0.0696)	-0.0790*** (0.0274)
Dairy	-0.0617	-0.1910***	0.1700	1.0140***	-0.0965	-0.0502*

	(0.0965)	(0.0465)	(0.1100)	(0.1770)	(0.0707)	(0.0278)
Irrigation	0.0172	-0.2060***	0.1550*	0.4740***	-0.1990***	-0.0459**
	(0.0732)	(0.0363)	(0.0852)	(0.1440)	(0.0549)	(0.0215)
Natural resource	-0.3960***	-0.2740***	-0.1080	0.0566	-0.1080	-0.1250***
	(0.1370)	(0.0558)	(0.1260)	(0.235)	(0.0804)	(0.0317)
Constant	-0.2270*	0.1330**	0.3610**	-0.7010***	0.3300***	0.3270***
	(0.1340)	(0.0652)	(0.1500)	(0.2570)	(0.0960)	(0.0378)
Sigma constant	0.3050***	0.1520***	0.3570***	0.5370***	0.2330***	0.0931***
	(0.0130)	(0.0061)	(0.0146)	(0.0306)	(0.0090)	(0.0030)
Number of observations	486	486	486	486	486	486
LR chi2	256.61	426.53	80.19	99.48	359.84	421.91
Prob. > chi2	0.000	0.000	0.000	0.000	0.000	0.000
Log likelihood	-198.997	63.4340	-283.498	-338.667	-93.176	464.024
Pseudo R-squared	0.3920	1.423	0.1239	0.1281	0.6588	-0.8336

Note: Standard errors in parentheses. Symbols indicate significant differences at *** ≤ 0.001 ; ** ≤ 0.05 ; * ≤ 0.10 . Base category zone dummies are eastern zone and base category cooperative type dummies are multipurpose cooperatives.

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