Cooperative membership and dairy performance among smallholders in Ethiopia

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ABSTRACT

This study assesses the impact of cooperative membership among dairy producers in Selale, Ethiopia. We selected ten impact indicators: proportion of dairy income to total household income, total dairy income, proportion of crossbreed cows to the total number of cows in the herd (indicator of technological innovation), amount of feed bought (another indicator of technological innovation), milk production, milk productivity, commercialization, price per liter of milk, price per kg of butter and the share of milk production that is processed at the household level. In order to minimize the biases that may arise by simply comparing members and non-members, we employed a propensity score matching technique. The empirical analysis shows that cooperatives are strong in facilitating technological transformations and commercialization but weak in offering better prices. These findings suggest structural trade-offs between different domains of cooperatives' action. Overall, our study concludes that cooperatives can be efficient business institutions to foster rural development and food security.

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Introduction

Increasing population, urbanization, and the rise in consumers' income is expected to increase the demand for milk and milk products in Ethiopia, since they constitute an important part of the Ethiopian diet. Ethiopia has the largest cattle population in Africa and milk production is by far dominated by small-scale landholders. Such conditions create opportunities for achieving a higher level of market integration by small farmers, particularly for serving urban consumers, which could induce significant improvement in rural income. Several governmental policies and interventions by the international cooperation have been put in place recently aiming to foster the development of the incipient modern dairy value chain (which involves processing and pasteurization) supplying the growing urban market in Ethiopia. It is worth noting that currently most consumers in Ethiopia still buy raw milk (which is most of the time boiled at home).

Due to a variety of structural constraints, the incidence of transaction costs tends to be particularly high among small-scale agricultural producers. When integrating into markets, small-scale agricultural producers face a wide range of challenges, most of them related to transaction costs. This includes transportation costs, the cost of accessing high quality services, technology and inputs, the costs of meeting standards, and in general the costs associated with coordinating product attributes and delivery conditions along the value chain (Kydd and Dorward, 2004). Producers' organizations can play an important role in reducing such costs, and therefore in facilitating market integration (Staal et al., 1997). The role of producers' organizations in reducing transaction costs and facilitating market integration of small-scale farmers is expected to be particularly important in the dairy sector, since the perishable character of the products makes more likely opportunistic behavior by buyers (potentially a major source of transaction costs), in comparison with products that can be stored. Furthermore, dairy production is a risky venture, with potential high transaction costs arising from price fluctuations and the seasonal demand of milk. Uncertainties related to demand and spoilages are particularly high in Ethiopia, in part due to the fact that Orthodox Christians use to fast during holy days all along the year (up to about 200 days per annum). During fasting days, followers of the Orthodox Church refrain from consuming products derived from livestock, including dairy products (Tefera et al., 2010). During prolonged fasting periods, demand and prices are depressed. In addition, the adoption of cooling transportation for milk is still in an early stage of development in Ethiopia, which increases substantially the risks of milk spoilage.

In the study area we could identify two production systems under which dairy farmers are operating. On one hand, some

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farmers have adopted a relatively more intensive production system, which relies on a higher use of cross-bred cow varieties and agro-industrial feed. On the other hand, other farmers adopt a relatively more extensive production system with high reliance on local cow varieties and less nutritive pasture feed. As far as marketing channels are concerned, dairy farmers in the study area have numerous outlets in which they can sell their milk. The main ones include primary cooperatives and private traders or processors (e.g. Mamma milk). Other minor markets include restaurants, hotels and individual consumers. Marketing to consumers in urban areas is however only possible through the bulking, transportation and delivery services of the cooperatives. Primary cooperatives in the study area have formed a cooperative union, which gathers a large proportion of the milk produced by the primary cooperatives and supply it mainly to processors in Addis Abeba. At the time of the fieldwork, the union did not carry out any further processing of the milk, only basic quality checks, bulking and delivery.

By means of providing bulking and bargaining services, cooperatives may enhance market access and help farmers avoid the hazards associated with a perishable product with uncertain and variable demand. By means of pooling supply purchases and sales, dairy marketing cooperatives can contribute to decrease price risks and enhance bargaining power of dairy producers (Holloway et al., 1999). In addition, cooperatives can serve as a vehicle for the dissemination of dairy technologies and to gain access to a range of benefits derived from the action of agents outside the value chain, such as government subsidies, donor funds and outputs of research and development. For instance, the dairy cooperatives in the study area are assisting their members to access nutritive feed, animal vaccines and high-yielding cow varieties. In addition, many donor and non-governmental organizations organize their rural development and poverty reduction interventions through cooperatives and other farmers' organizations (Bernard and Spielman, 2009). In Ethiopia, the government has stressed the importance of cooperatives as vehicles to improve commercialization and to alleviate poverty amongst the resource-poor farmers (Getnet and Anullo, 2012), and these organizations have been targeted as key institutions in national plans to foster rural economic development.

Despite their many potential advantages, cooperatives however are prone to face a number of important challenges, such as free-riding, corruption, principal-agent problems or different sorts of mismatches between the individual and collective interests (Ortmann and King, 2007). In Ethiopia, cooperatives suffer from low managerial capacity, difficulties in accessing working capital, free-riding behavior by farmers and other major constraints that hamper their performance. Some of these problems have stemmed from the troubled history that the Ethiopian cooperatives experienced. As highlighted by Kodama (2007), the Ethiopian cooperatives have passed through many unpleasant phases. Firstly, the Imperial era (1930–1974) and the Derg period (1974–1991) when cooperatives where used as instruments for authoritarian governmental interventions. The corruption that arose from this external interference led to the collapse of many cooperatives. After the fall of the Derg regime, the new government started to revive cooperatives and allowed them to hold a higher degree of autonomy, though still under some control from the "cooperative offices" (governmental bodies in charge of regulating and monitoring cooperatives' performance). Currently however, as evidenced in the study conducted by Getnet and Anullo (2012), cooperatives in Ethiopia are growing in terms of number, type, membership size and capital.

The development impacts of cooperatives depend on their capacity to deliver good quality services and to put in place an inclusive and efficient governance system that enable them to cope with the problems mentioned above. Such impacts hence cannot be taken for granted and they are determined by the ability of cooperatives to surmount their structural and contextual problems. In order to assess the development impacts of dairy cooperatives in rural areas (the extent to which they are contributing to facilitate market integration and the economic development of small-scale producers) we need to examine two key aspects: (i) who are the members of cooperatives (what type of farmers benefit from their services) and (ii) how is the performance of such members, in comparison to non-members, influenced by the services provided by the cooperative. That is, we need to assess to what extent and how members benefit from cooperative services. The combination of these different issues will enable us not only to evaluate the effects of membership, but also to shed some light about the mechanisms through which such effects take place.

The main objective of the present study is to identify the determinants and impacts of cooperative membership among small-scale dairy producers in Ethiopia, and thus to contribute to assess to what extent and how producers' organizations can be catalyst of rural economic development. For doing so, we compare the performance of cooperative members with otherwise similar non-members dairy farmers, controlling for observable biases using matching techniques. More specifically, in this paper we address the following two main research questions: (i) What are the factors determining the probability of cooperative membership? and (ii) What are the main impacts at the household level of cooperative membership among dairy producers in Ethiopia?

The remaining of the paper is structured as follows: The next section provides some working hypotheses about determinants of membership and the impact of cooperative membership. Then, we present the methodology we have followed, including the sampling procedure, the variables considered and the econometric techniques we used. Our empirical results are presented in afterwards and finally we discuss our findings and some implications in the last section of the article.

Determinants and impacts of cooperative membership

Collective action among farmers is costly and not always leads to the expected outcomes. In the case of agricultural cooperatives, there are different sources of costs of collective action: (a) Collective decisions may require investment in time, particularly if the member of the cooperative is committed to participate in decision making stances, such as commissions and assemblies; (b) There might be temporary costs associated with being loyal to the cooperative. For instance, competitors to the coop may offer better prices during some seasons, to which loyal members cannot tap to; (c) Collective decision regarding the services provided by the cooperative may also entail some costs derived from the heterogeneity of farmers. If not all the members coincide on the demand for services from the coop, decisions may be costly for some (due to, for instance, concessions of the minority group to the request of the majority); (d) Costs may also arise from the vulnerability involved in being exposed to opportunistic behavior of other members or cooperative managers. The costs of mismanagement, in terms of capital loss, for instance, are collectively distributed. The perception and incidence of these costs, as well as of the benefits derived from cooperative membership, may vary considerably among farmers not only due to farmers' diversity with regards to production profile, size or level of market integration, but also because agricultural cooperatives are very diverse, in terms of specialization, services delivered and internal governance. Even within Ethiopia, there are significant differences between the cooperatives with regards to service delivery, market orientation, composition and socio-economic context. Due to the heterogeneity of farmers and cooperatives it is reasonable to expect that the willingness to participate is not homogeneously distributed among landholders. The analysis of the determinants of cooperative membership

aims precisely to assess how the likelihood of joining a cooperative is distributed among landholders. Since costs and benefits associated with cooperative membership are very context-dependent, generalizations about what type of farmers are more likely to be members of cooperatives are very difficult to draw. In Ethiopia, most producers have a chance to join a cooperative. The joining fee that cooperatives charge can be an entry barrier but cannot be considered as a serious hindrance to cooperative participation among small scale producers. The perceptions by farmers of other costs of collective action (outlined above) are likely far more important determinants of the willingness to join a cooperative.

The fact that collective action is only worthy when its benefits outpace its costs has some implications with regards to the type of farmers that tend to participate in cooperatives. This might explain, for example, the empirical evidence showing that the probability of cooperative membership is higher among "middle size" farmers. In places such as Ethiopia and Tanzania, recent studies have found an "inverted U" (in some cases) or simply negative (in other cases) relationship between the likelihood of cooperative membership and land size (Bernard and Spielman, 2009; Frascesconi and Heerink, 2010; Fischer and Qaim, 2012; Nugusse et al., 2013), suggesting that both relative very small-scale and (more often) larger scale farmers hold a lower probability to join a cooperative, compared to middle size land holders. A working hypothesis to explain this pattern is that collective action might be too costly for very small-scale farmers (too high transaction costs), while its benefits may not surpass its costs among relative large-scale farmers.

Agricultural cooperatives may have a major role in enhancing efficiency and productivity of processes at the farm level, as shown for example by Abate et al. (2014) for Ethiopia. Collective action might be a major force of knowledge dissemination and technological transfer, due to the spillover effects of the collective use of a particular knowledge or technology, but also due to the fact that collective endeavors facilitate innovation and learning by members of the group. In addition, cooperatives may enhance the access to and provision of agricultural inputs, by means of creating economies of scale or due to special privileges provided to them by governments or other entities. For instance, Abebaw and Haile (2013) found that cooperative membership in Ethiopia has induced higher use of fertilizers, which might be explained by the fact that Ethiopian cooperatives have a monopoly in the supply of (subsidized) fertilizers to farmers in this country. In the same line, and also in Ethiopia, Francesconi and Ruben (2012) report empirical evidence (collected in a different location to ours, and using a smaller sample size and number of milk quality indicators), showing that cooperative membership has a positive effect on milk production and productivity, though a negative effect on fat and protein content in the milk, among small-scale dairy producers.

A key driver of farmers' decisions regarding the organization of production systems, commercialization and engagement in collective action is the price they obtain for their products (Hernández-Espallardo et al., 2013). Cooperatives can induce significant changes in prices of products with which they operate through a variety of mechanisms, such as enhancing market power (by means of economies of scale gained by collective commercialization), achieving higher levels of vertical integration (and therefore excluding other value-capturing players of the value chain) or playing a role in knowledge dissemination or quality control, resulting in quality improvement. Such improvements in the quality of products often increase the chances of participation in specialty markets. There are some empirical studies reporting that agricultural cooperatives have been instrumental in the creation of new vertical marketing linkages (Devaux et al., 2009; Jia and Huang, 2011; Stattman and Mol, 2014) and the emergence of new international market channels (with stricter quality standards compared to domestic markets) in which small-scale farmers have been able to participate (Roy and Thorat, 2008). In sectors dominated by smallholders and where standards play an important role in shaping relations along the value chain, the ability to coordinate horizontally among farmers can confer cooperatives significant competitive advantages (Weatherspoon and Reardon, 2003). Several studies have shown positive synergies between certification schemes (which required horizontal coordination among farmers) and collective action (Kersting and Wollni, 2012; Pérez-Ramírez et al., 2012) in terms of facilitating market integration and ensuring better prices for small-scale landholders.

Moreover, cooperatives can also function as a "competitive yardstick" (Pascucci et al., 2012), inducing a generalized increase in prices of products in the sectors and locations where they operate, by means of increasing competition among buyers. In such cases, although there might not be significant differences between the price members and non-members receive for their products, both types of farmers benefit from the existence of cooperatives, since prices for both groups are higher, as compared to a situation where the cooperative would not be in place. To show empirically such situations is however very hard, due to the difficulties in finding a control situation.

Bernard et al. (2008a), Getnet and Anullo (2012) and Frascesconi and Heerink (2010) have gathered evidence showing that agricultural cooperatives in Ethiopia tend to offer better prices, as compared to competitors, in a variety of products. Wollini and Zeller (2007) have also found cooperative membership to impact positively on prices and participation in specialty markets among coffee growers in Costa Rica. Mujawamariya et al. (2013) and Milford (2014) report that coffee cooperatives in Rwanda and Mexico, respectively, provide higher and more stable prices to their members (in comparison with competitors). Despite this, they face stiff competition with those competitors, due to the ability of the latter to offer more convenient payment modalities and financial services (to advance loans).

Nonetheless, despite its importance in farmers' decisions, in many situations cooperatives are unable to provide better prices, as compared to competitors. Fischer and Qaim (2012), for instance, state that the effects of marketing groups on prices are very modest among banana growers in Tanzania. In such cases, differential services provided by cooperatives and dealing with other dimensions (such as access to knowledge and new technologies) are expected to be sufficient to motivate farmers to join.

The effects of cooperative membership can be also vary among members. Some examples of systematic comparisons include the work conducted by Bernard et al. (2008a), who found that grain cooperatives in Ethiopia enhanced market commercialization among members with relatively larger land size, while reduced the level of commercialization among farmers with smaller land sizes. They found that the overall effect of membership on commercialization is not significant. This occurs in spite of the finding that all types of cooperative members receive higher average prices (in comparison with non-members). Frascesconi and Heerink (2010) show additional evidence for explaining these effects not only as differentiated impacts depending on land size, but also on the type of cooperative organization the farmers belong. They distinguish between "marketing" and "livelihoods" cooperatives. The latter are specialized in the provision of public goods, and induce no significant effects on the level of market integration among the members. The dairy cooperatives our research deals with can be considered as belonging to the "marketing" category. After analyzing the effects of farmers' organizations in Senegal and Burkina Faso, Bernard et al. (2008b) also conclude that the delivery of public goods by a market-oriented organization is

associated with lower marketing performance. They state that such result is the consequence of a compromise between equity (solidarity) and efficiency. Abate et al. (2014) however report evidence showing that, overall, agricultural cooperatives significantly contribute to members' technical efficiency in Ethiopia. These studies show again that the evidence about the effects of cooperative membership is mixed and context-specific.

For the present paper we advance two working hypotheses about the determinants of membership and the impacts of cooperatives, and more specifically of dairy cooperatives in developing countries. First, following the proposition of Bernard and Spielman (2009), the poorest of the poor (normally holding the smallest land size) are not well represented in agricultural cooperatives. Instead, the membership of these organizations tends to be composed mainly by farmers with an intermediate level of assets (land, technology, education, etc.). Secondly, the effects of membership seem to be characterized by compromises between different functions (e.g. price vs commercialization; provision of public goods vs marketing, etc.), at least at early stages of cooperative development. Here we test empirically whether these hypotheses hold for our case study (among small-scale dairy producers in Selale area, Ethiopia). The following section describes the study area, as well as the methods we have followed for primary data collection and analysis.

Methodology

The study was carried out in Selale (Oromia region), one of the main dairy producing areas in Ethiopia. In this location (see Fig. 1), about 85% of the population is agrarian. Local livelihoods are mainly dependent on livestock raising and dairy production. Major crops locally grown include oat, teff, barley, wheat, beans and peas. The topography of the area provides a suitable microclimate for the introduction of high-yielding dairy cows.

A structured questionnaire was administered to collect data from a total sample of 384 smallholders (192 cooperative members and 192 non-members). Five cooperatives (Chancho, Lelistu, Nano Seyu, Debre Tsige and Torbanashe) were randomly selected from the 24 primary cooperatives operating in the area. All these cooperatives form a union, which is in charge of bulking and commercializing raw milk (mainly in the capital city, Addis Abeba). Proportional random sampling was applied to select members from the five primary cooperatives that have been chosen. Non-members were selected from the same kebeles (lower administrative unit in Ethiopia) where the 5 selected cooperatives are located. These farmers were randomly taken from a list of kebele's dwellers (every kebele holds a census of its inhabitants).

Data were analyzed using STATA version 10. A binary logistic regression model was applied to assess the relationship between membership (1 = member; 0 = non-member) and households characteristics. The probability of being a cooperative member can be modeled as a function of selected independent variables. To estimate the impact of cooperative membership on the outcome variables, we applied a Propensity Scores Matching (PSM) technique, in order to control for biases that may exist between the two groups (members and non-members). This technique has been applied also by Francesconi (2009), Getnet and Anullo (2012) and Bernard et al. (2008a) for evaluating the impact of cooperative membership among Ethiopian farmers.

The main challenge for the estimation of membership "impacts" is to construct the counterfactual $E(Y0 \mid D = 1)$. Namely, the performance cooperative members would have experienced, on average, had they not participated as members in a cooperative. Since the counterfactual can never be directly observed, statistical approaches are required to identify appropriate comparison or control groups. There are a number of biases that we face in doing so. The fact that our samples were drawn from the same areas might constitute a source of potential bias, arising from possible spillover effects. Non-members may obtain indirect benefits from cooperatives' activities in the region. In addition, members and non-members differ in several observable characteristics (such as age, education, family size and land size[1]), which may influence the probability of cooperative membership. Furthermore, cooperative members and non-members may differ along unobservable variables, which might have a direct influence on performance (the selected impact indicators). Therefore, a simple comparison of these two groups may result in serious biases and misleading conclusions. Propensity Score Matching is one of the available econometric techniques to deal with these biases (Heinrich et al., 2010). However, PSM does not address selection bias due to unobservable characteristics and therefore, we are unable to control for this type of selection biases.

In the current study, we focus on the following specific indicators as outcome variables: (1) Proportion of dairy income to total household income[2]; (2) Total dairy income; (3) Proportion of crossbreed cows to the total number of cows in the herd, as an indicator of technological choice. Sharma et al. (2009) also used the percentage of crossbred cows in dairy herd as an indicator of technology adoption. Undoubtedly, there are various indicators that may be used as a proxy for technological innovation. Nonetheless, in the current study we focus on the adoption of breed type and the quantities of feed bought due to their effects on productivity; (4) The amount of feed bought (kg) (another indicator for technological innovation); (5) Milk productivity: ratio between milk daily production and the number of milking cows available per farm; (6) Milk production; (7) Price per liter of milk; (8) Commercialization: the proportion of milk marketed in its raw state to the total milk production on a daily basis; (8) Price per kilogram of butter; and (9) Share of milk processed: the proportion of milk allocated to the elaboration of dairy products (butter; cheese) to total milk production.

For estimating each household's "propensity score", cooperative membership is modeled as a function of a number of household characteristics. The choice of the independent variables in the model is crucial in the analysis. Only variables that are unaffected by participation should be included in the model. Hence, Caliendo and Kopeinig (2005) suggest that these variables should either be fixed over time or measured before participation. Following their suggestion, the following independent variables were selected for the model: age of household head, (age of household head)[2], level of education, family size, proportion of female of working age (above 12 years old) in the household, dairying experience, land size and distance to milk collection centre. However, we acknowledge that in our case, there could be an endogeneity problem between the dependent variable (cooperative membership) and some independent variables. Endogeneity could have some implications on the p-score values of the discrete choice model, thereby making inference difficult to draw and reducing the robustness of the results.

Propensity score matching (PSM) is expected to provide a weighting scheme that yields unbiased estimates of the treatment's impact. Given the aforementioned indicators, we aim to calculate the average treatment effect on the treated (ATT) as given in Eq. (1). That is, the impact of dairy cooperative membership on

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[1] It was going to be more appropriate to use size of operation area rather than total land size but we relied on the total land size due to the unreliability of the information about the operation area (farmers were not able to provide accurate information on the operation area).

[2] Total household income in this study refers to aggregate household income from livestock sales, crop sales, dairy sales and off-farm/sideline jobs.
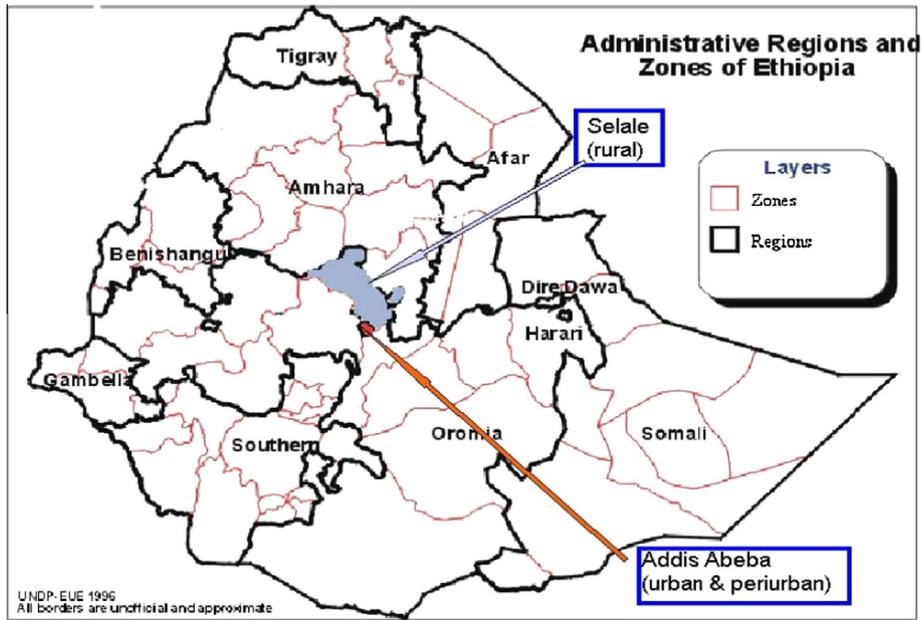
Fig. 1. Map showing the study area.

performance indicators. This effect (ATT) is denoted by Caliendo and Kopeinig (2005) as;

$$\mathcal{J}\text{ATT} = E(\mathcal{J}|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \quad (1)$$

where

Y_0 = performance in control group,
Y_1 = performance in treatment group.

Several matching algorithms are available for PSM. In this study we employ two algorithms: (1) nearest neighbor (NN) matching 'with replacement' and (2) kernel matching. In the NN matching, the individual from the control or comparison group is chosen as a matching partner for a treated individual that is closest in terms of propensity score. Unlike matching 'without replacement', matching 'with replacement' allows an untreated individual to be used more than once as a case. This is the main reason why we have applied the latter. However, matching with replacement involves a trade-off between bias and variance. Kernel matching is a non-parametric matching estimator that uses weighted averages of all individuals in the control group to construct the counterfactual outcome. In this method, each treated household is matched with the entire sample of controls. This approach uses more information, thus lowering variance. However, its drawback is that it might include observations that are bad matches. Using both methods (nearest neighbor matching with replacement and kernel matching) provides a robustness check to the disadvantages of the two matching procedures.

To ensure maximum comparability of the treatment and control groups, the sample is restricted to the common support region, defined as the values of propensity scores where both treatment and control observations can be found. By imposing a common support condition, we can minimize the main limitation of the kernel matching approach and improve the quality of the matches. Observations outside the common support are not considered in our model, by imposing a common support condition and by eliminating the 5%[3] of the treatment observations for which the propen-

sity density of the control observations is the lowest. This implies that after units are matched, the unmatched comparison units are discarded and are not directly used in estimating the treatment impact.

Results

This section presents our descriptive and econometric results. The descriptive results consist in a series of t-tests, for conducting simple comparisons between members and non-members. Later, we present the results dealing with the probability of cooperative membership (Logistic regression model), and then the results from the two matching algorithms for assessing the impact of membership on the ten selected outcome (performance) variables.

We ran a series of t-tests on a number of variables for conducting simple comparisons on household characteristics between members and non-members. Table 1 presents the outcome of the t-test analyses. We also show in the same table the t-test statistics on the impact indicators selected for the analysis.

The households of cooperative members have on average more family members, and are headed by older persons who also hold a higher level of education, as compared to non-members. In addition, the mean distance to milk collection centre or market was significantly lower among cooperative members. With the exception of the average price per liter of milk, there are significant differences between both groups for all the selected impact indicators. It is important to note however that robust conclusions can only be derived with the combination of t-test analyses with the outcomes of matching techniques, due to the potential bias problems outlined above.

Out of the 8 variables we included in the logistic regression model for assessing the likelihood of membership, 5 were significant (see Table 2). These were: age of household head, family size, land size, level of education and distance to the cooperative milk collection centre.

Our results (see Table 2) show that the distance to the milk collection centre negatively and significantly influence the probability of cooperative membership. Age and level of education of household head as well as the household size were also found to have

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[3] Though 5% is generally used, there is no consensus in the literature about which common support cut-off point is the most appropriate.

Table 1
Descriptive statistics for members and non-members.

Variable	N	Members	N	Non-members	t-test (p-value)
Control variables					
Age	192	48.67 (0.989)	192	45.55 (1.067)	2.144 (0.033)[**]
Family size	192	6.60 (0.191)	192	5.79 (0.168)	3.198 (0.002)[**]
Dairying experience (years)	192	21.44 (0.835)	192	22.09 (1.037)	−0.489 (0.625)[NS]
Distance to milk collection centre or market (km)	192	1.06 (0.019)	178	1.24 (0.035)	−4.377 (0.000)[***]
Land size (ha)	171	2.75 (1.381)	185	2.58 (1.551)	1.076 (0.283)[NS]
Impact indicators					
Proportion dairy income	192	0.69 (0.023)	192	0.57 (0.028)	3.334 (0.000)[***]
Total dairy income (Birr)	192	25067.06 (1915.90)	192	7873.03 (767.53)	8.331 (0.000)[***]
Proportion of crossbreeds	192	0.755 (0.025)	192	0.428 (0.029)	8.466 (0.000)[***]
Milk production (l/day)	190	20.12 (1.350)	183	7.53 (6.602)	8.770 (0.000)[***]
Milk productivity (l/cow/day)	190	8.33 (0.358)	183	4.34 (0.221)	9.466 (0.000)[***]
Share of processed milk (l)	190	0.06 (0.014)	181	0.47 (0.032)	−11.601 (0.000)[***]
Commercialization (share of sold liquid milk-liters)	190	0.87 (0.015)	181	0.46 (0.034)	11.186 (0.000)[***]
Average price per liter (Birr)	180	5.10 (0.021)	89	5.10 (0.029)	0.042 (0.967)[NS]
Price per kilo of butter (Birr)	**50**	67.38 (5.858)	109	80.32 (2.628)	−2.016 (0.048)[**]
Amount of feed bought (kg)	192	17944.36 (1531.016)	192	4647.12 (668.979)	7.959 (0.000)[***]

Notes: Standard error in parentheses.
Figures in bold shows the variables that were not included in the analysis due to small sample size.
[*] $P < 0.10$.
[**] $P < 0.05$.
[***] $P < 0.01$.
[NS] Not significant.

Table 2
Binary logistic regression model estimates for the probability of cooperative membership.

Membership	Coef.	Std. error	z	P > |z|
Age	.078	.037	2.13	0.033[**]
Proportion of female	.669	.409	1.64	0.102
Family size	.103	.033	3.17	0.002[***]
Education level	.431	.075	5.72	0.000[***]
Total land size	−.001	.000	−2.00	0.046[*]
Farming experience	−.008	.008	−0.97	0.333
Distance to collection centre	−.822	.210	−3.92	0.000[***]
Age^2	−.000	.000	−1.35	0.178
Constant	−3.221	.907	−3.55	0.000[***]

Number of obs = 369.
LR chi^2 (8) = 91.64.
Prob > chi^2 = 0.0000.
Pseudo R^2 = 0.1794.
Log likelihood = −209.65.
[*] $P < 0.10$.
[**] $P < 0.05$.
[***] $P < 0.01$.

a significant and positive relationship with the probability of cooperative membership. There is a negative relationship between land size and membership, implying that the probability of cooperative membership declines with an increase in land size. Dairying experience, proportion of females and age^2 were not significant in explaining membership.

In Table 3 we report the *average treatment on the treated* (ATT) – the mean impact that dairy cooperative membership has on its members along a number of variables. We found that, on average, cooperative members have between 14,799 Birr and 15,483 Birr higher total annual dairy income than the non-members ($p < 0.01$). Furthermore, we find that the proportion of crossbreed cows (technological innovation indicator) is between 0.22 and 0.27 higher among cooperative members. This variable is significant at the 1% significant level for the kernel matching and at the 5% significance level for the NN matching algorithm. For the other indicator of technological innovation, namely the amount of feed bought (kg), we find that cooperative members purchases between 9872.80 kg and 10910.50 kg more than the non-members. This variable is significant at the 1% significant level for both the kernel matching and the NN matching. The milk production, milk produc-

tivity, and level of commercialization are also higher among cooperative members. These results are significant at the 1% significance level and robust across the two matching algorithms (nearest neighbor and kernel matching). We also found, using both matching algorithms, that the share of processed milk is 0.35 higher for non-members. This means that non-members allocate a considerably higher proportion of the milk to the production of dairy products, such as butter and cheese. Lastly, based on the two matching algorithms, we found no significant impact of cooperative membership on the price per liter of milk, the price per kilogram of butter or the proportion of dairy income to total income.

Discussion

The "middle class effect" proposition states that the probability of cooperative membership is higher among landholders with intermediate levels of assets (Bernard and Spielman, 2009). This effect could be explained by the conditions under which collective action can be effective for landholders. Though the evidence is not yet conclusive, several studies have shown that collective action among farmers is more likely to be effective at intermediate levels of resources, assets or transaction costs. Our findings shed mixed evidence with regards to this proposition. Contrary to the results of Bernard and Spielman (2009), we have found a negative relationship between land size and the likelihood of cooperative membership. This means that the poorest landholders (smallest) are actually benefiting from cooperative membership, which implies that cooperatives can indeed play an important role in poverty alleviation among dairy producers. In addition, similar to what has been reported by Fischer and Qaim (2012) and Abebaw and Haile (2013), our results reveal that older and more educated farmers are more likely to join marketing cooperatives. A possible explanation for this pattern could be that older farmers are more likely to prefer lesser risk contractual arrangements with cooperatives whereas younger and energetic people may prefer not to join but to try out other alternative markets and to also engage in other non-agricultural activities.

Furthermore, we found a negative relationship between distance to the collection centers and the probability of cooperative

Table 3
Impact of cooperative membership on dairy farmers.

Outcome	Cooperative members	Non-members	t-test	ATT (NN)	ATT (Kernel)
Proportion dairy income[a]	0.69 (0.023)	0.57 (0.028)	3.334 (0.000)***	0.068 (0.058)	0.066 (0.051)
Total dairy income (Birr)[a]	25067.06 (1915.90)	7873.03 (767.53)	8.331 (0.000)***	15483.10 (2266.57)***	14799.52 (2346.53)***
Proportion of crossbreeds[a] (*Technological innovation*)	0.755 (0.025)	0.428 (0.029)	8.466 (0.000)***	0.223 (0.065)**	0.270 (0.057)***
Amount of feed bought (kg)[a] (*Technological innovation*)	17944.36 (1531.016)	4647.12 (668.979)	7.959 (0.000)***	9872.799 (2116.947)***	10910.499 (1953.581)***
Milk production (l/day)[a]	20.12 (1.350)	7.53 (6.602)	8.770 (0.000)***	10.591 (1.573)***	10.051 (1.570)***
Milk productivity (l/cow/day)[a]	8.33 (0.358)	4.34 (0.221)	9.466 (0.000)***	3.057 (0.550)***	3.237 (0.528)***
Share of processed milk (l)[a]	0.06 (0.014)	0.47 (0.032)	−11.601 (0.000)***	−0.355 (0.065)***	−0.355 (0.055)***
Commercialization (l)[a]	0.87 (0.015)	0.46 (0.034)	11.186 (0.000)***	0.360 (0.069)***	0.364 (0.059)***
Price per liter of milk (Birr)[b]	5.10 (0.021)	5.10 (0.029)	0.042 (0.967)	0.102 (0.061)NS	0.087 (0.052)NS
Price per kilo of butter (Birr)[c]	67.38 (5.858)	80.32 (2.628)	−2.334 (0.021)**	−2.469 (8.364)NS	−10.189 (7.062)NS

Notes: Standard errors in parentheses. ATT is equal to the outcome of cooperative farmers minus the outcome of individual farmers after Propensity Score Matching.
Currency for income is in Ethiopian Birr (1 USD = 16.9886 ETB as of August 2011).
Standard errors for NN and Kernel matching computed using 50 bootstrap replications.
Significance levels based on Bias-Corrected confidence intervals.
* $P < 0.10$.
[a] Number of observations = 356, common support = 347. Number of observations = 268, common support = 259. Number of observations = 149, common support = 147.
[b] The price per liter was run separately due to a relatively smaller sample size.
[c] The price per kilogram of butter was run separately due to a relatively smaller sample size.
** $P < 0.05$.
*** $P < 0.01$.

membership. Similar results have been reported for dairy farmers by Ngigi et al. (2000) in Kenya and Francesconi (2009) in Ethiopia, Sharma et al. (2009) in India. This result is also in line with the findings reported by Fischer and Qaim (2012) and Abebaw and Haile (2013), who show a non-linear relationship between the distance to the road and cooperative membership (agricultural cooperatives in general, not only in the dairy sector) among farmers in Tanzania and Ethiopia respectively. In both cases, distance to the road is positively related to cooperative membership up to a threshold level, after which a negative relationship between both variables is found. Such patterns might also arise in collective institutions for the management of common pool natural resources. Bardham (1993), for example, argues that community-based irrigation systems are more effective at intermediate levels of water scarcity.

However, Nugusse et al. (2013) report that the likelihood of cooperative membership considerably declines with the proximity to a market center. In addition, after studying some coffee cooperatives in the Sidama region (Ethiopia), Ruben and Heras (2012) conclude that cooperatives located closer to the road held both lower levels of performance and social capital when compared to cooperatives located further away. The evidence about the relationship between distance to the market center or road and cooperative membership seems to be then mixed. A possible explanation may be that proximity to the road or the market center may be a particularly critical factor among dairy producers (due to the perishable nature of their products) and not necessarily among farmers producing non-perishable products. The time of commercialization is a key source of transaction costs among producers specialized in perishable products.

Our findings suggest a positive relationship between household size and cooperative membership. Dairy production is labor intensive. A higher level of market integration requires more labor to carry out dairy production activities, such as milking, cleaning the barns and transporting the milk to the collection centers. The availability of family labor can be a critical factor determining the transformation from extensive to intensive dairy production systems. It is therefore reasonable to expect a positive relationship between household size (number of household members) and the likelihood of joining a dairy cooperative, as we have found.

Furthermore, we have found that cooperative membership has a strong and significant positive impact on the variables we have selected as proxies for technological innovation (proportion of crossbreed cows to the total number of cows and the amount of feed bought), production and productivity. These findings confirm the results of Francesconi and Ruben (2012) and can be attributed to a shift toward dairy intensification by cooperative members, achieved mainly by means of acquiring "improved" breeds of cows. As a consequence, herds of cooperative members are dominated by high-yield crossbred cows, as opposed to the zebu cattle typically found in the herds of non-member farmers. Nevertheless, these local breeds have some favorable characteristics, such as low maintenance costs and the high fat content of milk, which facilitates further processing (elaboration of butter and cheese). Dairy intensification is expected to have a positive effect on economic efficiency (Alvarez et al., 2008). Several studies have found that one of the key functions of cooperatives is to facilitate innovation and access to technology. Odoemenem and Obinne (2010), for instance, show that cooperative membership was one of the most important factors determining the adoption of improved crop production technologies among cereal growers in Nigeria. Getnet and Anullo (2012) also show that agricultural cooperatives induce the adoption of improved seeds and fertilizers among farmers in Ethiopia. Fischer and Qaim (2012) provide evidence about the positive impact of cooperative membership on technological innovation, which includes the use of tissue culture and chemical inputs among the banana producers in Kenya. Devaux et al. (2009) also report that collective action plays an important role in commercial and technological innovation among potato producers in the Andes in South America. In our case, it is clear that the cooperatives provide an environment suitable for dairy intensification by means of facilitating the dissemination and adoption of productivity enhancing technologies, and in particular new cow varieties and the use of animal feed.

Our results also show that dairy cooperatives positively influence the level of commercialization of its members. Dairy cooperatives provide marketing services to their members through bulking, transportation and securing buyers such as Shola Dairy Enterprise (a processing company in Addis Ababa). Moreover, most cooperatives are now engaged in processing of milk into less

perishable products such as cheese, yoghurt and butter. It is therefore not surprising that a higher proportion of milk is allocated to the market among cooperative members, as compared to non-members dairy farmers.

Our findings nonetheless reveal that the impact of cooperative membership on the price of milk is not significant. It is worth noting that the price reported by the cooperative members excludes the dividends that they receive at the end of the year, depending on their patronage. Similarly, the impact of cooperative membership on price per kilogram of butter is not significant. The cooperatives are not buying butter. Therefore, no impact on the price of butter can be expected. Though dairy cooperatives in our study area might induce a "competitive yardstick" effect (inducing a general higher price at the local level, among both members and non-members), the lack of significant higher prices among members probably indicates a trade-off between different cooperative functions (and more particularly in this case between technological transfer and price). Despite non-significant effects of cooperative membership on price, farmers might still prefer to sell their produce through cooperatives, since this outlet channel might offer a more reliable and consistent market (as compared to local competitors).

Gaps between different cooperative functions are well reported in the literature, and they seem to be more likely to occur in cooperatives at early stages of development (not yet well consolidated). For instance, Bernard et al. (2008b) point out that market-oriented farmers' organizations in Senegal and Burkina Faso are relatively good in providing information and advice to their members but are relatively weak in facilitating access to financial services, materials and infrastructure investment. Furthermore, Bernard et al. (2008a) and Frascesconi and Heerink (2010) show that, overall, multi-purpose cooperatives in Ethiopia can offer better prices, but have a limited capacity to enhance the level of market integration (commercialization), particularly among the smallest farmers. On the contrary, Fischer and Qaim (2012) report that marketing groups increase the level of commercialization and income among banana growers in Tanzania, but they found that the effects on prices are very modest. Mujawamariya et al. (2013) found that coffee cooperatives in Rwanda ensure higher and more stable prices (in comparison with private coffee traders). However, they were not able to pay on the spot or to offer advance credit, which explains why farmers still deliver an important share of their production to traders (who are able to provide these important services). Our results show that cooperatives in Selale are strong in facilitating technological transformations but weak in offering better prices, which might hinder their competitiveness and impose some limitations to their expansion in the long run. To deal with structural trade-offs between services is likely one of the key managerial challenges for cooperatives in early stages of development, both to achieve sizable impacts among members and to ensure long-term sustainability (members' loyalty and market competitiveness).

Overall, our findings suggest that cooperatives can be pro-poor since small scale producers with limited resources are substantially benefiting from cooperative membership, through the effects on intensification in production systems. Hence, despite the structural limitations and functional trade-offs they face, cooperatives can be regarded as suitable business institutions to foster improved livelihoods, food security and rural economic development in Ethiopia.

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