Impacts of Collective Action on Smallholders' Commercialisation: Evidence from Dairy in Ethiopia

Gian Nicola Francesconi and Ruerd Ruben
gian-nicola.francesconi@wur.nl

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Gian Nicola Francesconi [abc*] *and Ruerd Ruben* [d]

Abstract.
The impacts of collective action on smallholders' commercialisation are the subject of a heated global debate. This study aims at bringing some empirical evidence into this debate. To do so we collected a unique set of bio-economic data, in 2003 and 2006, comprising information from 50 cooperative farmers and 50 individual farmers located within the same milk-shed in proximity of Addis Ababa. This dataset allowed comparing commercial performance of individual and cooperative dairy farmers, across 2003 and 2006. The empirical findings obtained with an adapted difference in difference analysis suggest that dairy cooperative farmers outperform the otherwise similar individual producers in terms of quantitative performance (market access, herd size and productivity), but also that cooperatives have an overall negative impact on milk quality (fat and protein content) and safety (bacteria contamination) at the farm gate. Finally, between 2003 and 2006, cooperatives showed horizontal expansion (increased number of cooperative members and herds size), but coop-members appeared incapable to either upgrade or intensify their farming systems.

[a] PhD student at Wageningen University (WUR), Social Science Department, Development Economics Group, PO Box 8130, Hollandseweg 1, 6706 KN Wageningen, Building no.201, Tel: +31 317 48 34 82, Fax: +31 317 48 40 37, Wageningen, The Netherlands, www.wur.nl

[b] Graduate Research Fellow at International Food Policy Research Institute (IFPRI), Ethiopia Strategy Support Program (ESSP), PO Box 5689, c/o ILRI, Tel. +251 (0)116 463215, Fax +251 (0)116 462927/464645, Addis Ababa, Ethiopia, www.ifpri.org

[c] Consultant for SNV, Netherlands Development Organisation, Kirkos Sub-City, Kebele 13/14, House no. 108, PO Box 40675, Tel.+251 (0)114 654386/7/9, Fax +251(0)114 654388, Addis Ababa, Ethiopia, Ethiopia@snvworld.org, www.snvworld.org

[d] Prof. dr. Ruerd Ruben, Chair Development Studies & Director Centre for International Development Issues, Radboud University Nijmegen, PO Box 9104, 6500 HE Nijmegen, The Netherlands, Tel. +31-0(0)24-361.58.00, Tel. +31-(0)024-361.30.58 (secretariat), Fax. +31-(0)024-3615957, Mail: r.ruben@maw.ru.nl, Website: www.ru.nl/cidin

[*] Corresponding author E-mail address: g.francesconi@cgiar.org, gian-nicola.francesconi@wur.nl
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1. Introduction

Collective action is commonly supposed to assist smallholders' engagement in markets, contributing to improvements in rural economies. Like in many other developing and transition countries, this perception is largely shared also amongst policy-makers in Ethiopia, who do not hesitate to express their overwhelming confidence in cooperative organisation as a driving force for rural development.[1] The perception that collective action may contribute to boost the Ethiopian rural economy includes the dairy sector. In Ethiopia, the Federal Cooperative Commission (FCC) reports the intention to promote as many dairy cooperatives as possible, in addition to the 100 already in place.[2] Such a mandate is inspired by experiences elsewhere - mainly from India and Kenya - where dairy exports have emerged within the framework of cooperative organisation (Belavadi and Niyogi 1999), as well as by national studies

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[1] In June (6-8) 2006, IFPRI in collaboration with EDRI (Ethiopian Development Research Institute) organised a conference at Hilton hotel in Addis Ababa, under the title: "Bridging, Balancing, and Scaling Up: Advancing the Rural Growth Agenda in Ethiopia". During the conference the question was posed whether the role of cooperatives in rural development will increase, decrease or remain with the same importance. Almost 80 % of the audience (composed of an average of 40 persons per day representing farmer organisations, government, international agencies, NGOs and civil society, business and industry, as well as research and academia) declared that cooperatives are expected to increase in importance in Ethiopia.
Furthermore, from discussions with the commissioner of the Ethiopian Federal Cooperative Commision (FCC) it emerged that FCC's mandate comprises the enrolment of 75 percent of national smallholders under various forms of cooperatives within 2011, given a current enrolment rate of 36 percent.

[2] The Federal Cooperative Commission is the governmental agency responsible for cooperative legislation and policy. According to the Ethiopian proclamation number 147 from 1998, cooperatives are defined as associations established by individuals on a voluntary basis, to collectively solve their economic and social problems and to democratically manage them. In order to achieve legal recognition a cooperative cannot have less than ten members, and must be able to show a healthy financial status. When an individual (farmer or investor) express interest in joining a cooperative the management committee has the right to evaluate the integrity and motivation of the applicant and submit the final evaluation to the general assembly (which should include the majority of the members) for approval. After registration the new member can be requested to pay an entrance fee, must purchase at least one share (but not more than 10 percent of the total shares) of the collective endowment and devolve part of his/her revenue to build an equity capital (from which he/she benefits annual interests). In exchange the new member obtain one (never more than one) vote valid in any cooperative decision-making process, while the cooperative accept the responsibility to monitor and control opportunistic behaviours among members, collect, bulk, process and sell members' supplies, and provide members with appropriate services for information, assets, inputs, training and credit provision.

showing that collective action can indeed serve as a catalyst for linking Ethiopian dairy smallholders to the market (Nicholson 1997; Holloway et al. 2000; Ahmed et al. 2003; D'Haese et al. 2005). Nonetheless, the potential of agricultural cooperatives in the context of emerging and globalising markets is still subject of heated debates.

Original reasons for the establishment of cooperatives are related to local self-help initiatives for addressing common rural challenges, such as poverty and food security. A major argument in this line of thought is that cooperatives provide a governance structure with implicit cost-savings and risk-sharing devices. Classic cooperative literature argues that the potential advantages of cooperative farming in generating economies of scale and scope give rise to higher production volumes and improved bargaining power vis-à-vis the market (Bonin et al., 1993; Dulfer, 1974; Munckner, 1988). However, after the initial optimism about the economic potential of cooperative farming, several in-depth studies highlighted the intrinsic constraints that limit cooperatives' growth potential (see Deininger, 1993 for an overview).

While the neoclassical approach (Helmberger and Hoos, 1995; Nourse, 1945) suggests that cooperatives can compete with investor-owned firms, other research building on agency and game theory suggests that traditional cooperative principles undermine optimal resources allocation and investment policies (Vitaliano, 1983), as well as the stability of members' coalition (Sexton 1986; Staatz, 1983). In other words, major problems of cooperative farming appear related to membership desertion (Barham and Childress, 1992), heterogeneous membership occasioning free-riding behaviour (Putterman and DiGiorgio, 1985) and limited investments and capital mobilization due to horizon problems. Cooperatives face in fact major challenges in terms of agency coordination, are notably deficient in providing adequate incentives to prevent free-riding behaviour (Fama, 1980), and in mobilizing equity capital towards production systems upgrading and intensification (Cook, 1995; Jensen and Meckling, 1976). Because of their elaborate decision-making structure (farmers councils and management board), cooperatives are easy to get trapped in endless, political and internal oriented discussions, limiting the capacity and speed to respond to market incentives (Henehan and Anderson, 1994). Again, given these organisational difficulties, cooperatives are expected to show major growth potential in terms of horizontal expansion (i.e. extensive growth), through the incorporation of new members or the inclusion of additional cows, rather than through the upgrading or intensification of the farming system.

This paper elaborates further on this dilemma by comparing otherwise similar cooperative and individual dairy farmers, over a three years time-frame. In order to capture the different dimensions of dairy cooperatives' performance - extensification, intensification and upgrading - we use indicators measuring the cooperative size, as well as market access, herd size and productivity, milk nutritional value and hygiene at the farm level.

2. Setting

Ethiopia has a large potential for milk production (Ahmed et al. 2003). The country has one of the largest cattle populations in Africa, estimated at 38.5 million animals. Two-thirds of the country's territory is characterised by vast plateaus ranging from 1400 up to more than 3000 meters above sea level. Biophysical attributes, like the availability of vast grazing areas, mild slopes and highly fertile soil, adequate rainfalls patterns (1000-1900 mm/year) and temperature (0-30°C) offer a relatively disease-free environment with high potential for animal feeding (Ahmed et al. 2003). The typical topography of the Ethiopian Highlands provides a suitable microclimate for the introduction of high-yielding dairy cows.

In addition to the internal potential for milk production, Ethiopia is also witnessing increasing opportunities at regional markets. Population growth, urbanisation and income growth in the Middle East, North and sub-Saharan Africa are occasioning a massive increase in demand for food of animal origin (Delgado et al. 1999). FAO-IFPRI-ILRI projections indicate that dairy consumption is estimated to grow by an average 3.8 percent per year in the sub-Saharan region, and by three percent in North Africa and the Middle East.[3]

For these reasons, Holloway et al. (2000) and Ahmed et al. (2003) argue that dairy commercialisation has the potential to promote cash and nutrients flows across Ethiopia and neighbouring countries. Perception that fits into the theory supporting the transition from subsistence to commercial agriculture, as a means of ensuring food security and rural incomes (Kurosaki 2003; Maarten *et al.* 1995; Pingali and Rosegrant 1995; Strasberg *et al.* 1995; Von Braun, 1995).

Still, in Ethiopia today the dairy market appears even less developed than in neighbouring countries with similar agro-climate and market environments, like Kenya and Uganda (Muriuki and Thorpe, 2001). The undedevelopment of the dairy market affects overall dairy production and consumption in Ethiopia. Considering that dairy

[3] It is important to note that the projected growth rate for sub-Saharan Africa is the second largest in the world after India (4.1%) (Delgado *et al.* 1999).

imports in Ethiopia constitute less than one percent of the total national dairy supply (Ahmed et al. 2003), and ignoring post-milking losses, which may be substantial, the average per capita dairy consumption can be assumed equal to the average per capita milk production, estimated at 41.6 liters per year by Taffesse et al. (2006). Value that is less than a quarter of the average per capita dairy consumption in the developed world (200 liters/year/caput in milk equivalent; Delgado 1999).

However, in era of globalisation, the transition from a subsistence-oriented to a more commercial agricultural production needs to be accompanied by appropriate adaptation of farming technology. With the downfall of the Derg (socialist) regime in 1991, the Ethiopian government has in fact embarked on policy reforms with the aim of bringing about a market-oriented economic system (Ahmed et al. 2003). Today Ethiopia is one of the eight additional least-developed countries (LDCs) in the process of accession to the WTO (2006). Although the national policy has clearly shifted towards private sector-led development, it is hard to predict if and when private business competition will really take-off in Ethiopia. Nonetheless, the great majority of the representatives of the public and private sector that participated at the IFPRI conference (2006) in Addis Ababa declared that private business will play an important role in the Ethiopian economy in the coming decade.[4]

[4] In June (6-8) 2006, IFPRI in collaboration with EDRI (Ethiopian Development Research Institute) organised a conference at the Hilton hotel in Addis Ababa, under the title: "Bridging, Balancing, and Scaling Up: Advancing the Rural Growth Agenda in Ethiopia". The conference aimed at generating and disseminating policy research on key knowledge gaps facing Ethiopia; building a stronger and more integrated rural economy knowledge support system within the country; and, strengthening the capacity of Ethiopian policy analysts and institutions to undertake this analysis. During the conference the question was posed whether the role of the private sector in the Ethiopian market will increase, decrease or remain the same. More than ninety percent of the audience (composed of an average of 40 persons per day representing farmer organisations, government, international agencies, NGOs and civil society, business and industry, as well as research and academia) responded that the private sector is expected to increase in importance in the Ethiopian market.

In such an emerging and liberalising business environment Ethiopian smallholder farmers willing to compete in the marketplace need to identify effective measures to increase scale, productivity and quality of their farming system. While the relation between production scale, productivity and market competitiveness is well understood, development literature in particular seems to pay far less attention to the economic implications of production quality and safety. Besides influencing consumer satisfaction and shopping behaviour, production quality and safety is also a valid indicator of overall post-harvest losses (in this case post-milking waste; Weaver and Kim 2001). For example, given a processing technology, when the nutritional value of raw milk at the farm gate decreases, the quantity of butter, cheese and yogurt obtained at the processor level decreases as well. Similarly, when the hygiene of raw milk decreases, the shelf life of final dairy products becomes shorter.

3. Sample

The research is conducted in the milk-shed of *Debre Zeit*, 50 km south of Addis Ababa. This area counts more than 1,000 small dairy farmers (Ministry of Agriculture, 2003), one dairy processing plant, an experimental dairy unit of the International Livestock Research Institute (ILRI), as well as the biggest dairy cooperative in Ethiopia (*the Ada'a Liben Woreda Dairy and Dairy Products Marketing Association*), both in terms of number of members (approximately 800) and volume of production (almost 8000 liters of milk per day). The area of *Debre Zeit* is certainly the most developed mil-shed of Ethiopia, providing most of the dairy products available in the market of the Addis

Ababa, the largest and most diversified market of Ethiopia. *Debre Zeit* is thus a demonstration site that shows the direction to other national dairy producing areas.

In this milk-shed, a pool of cooperative farmers as well as individual farmers were surveyed at two different points in time (2003 and 2006). Each farmer was interviewed using a pre-designed questionnaire to collect information on farm-household characteristics. In addition, two milk samples were collected from the milk bulk of each farmer and analysed for quality and safety attributes, as specified below. The available data provide an unique combination of biological, technological and socio-economic measurements of dairy farming in Ethiopia. Unfortunately, the sample does not include a baseline survey reporting similar information ex-ante the establishment of the cooperative (before 1997). This shortfall was compensated by asking recall questions to cooperative members, mainly about household characteristics before the participation in the cooperative, so as to obtain the necessary control variables to reconstruct the empirical baseline.

The sampling method used is described as follows. In July-August 2003, 20 cooperative farmers and 20 individual farmers were randomly selected from both urban and rural settings (in and around *Debre Zeit*). Urban farmers were selected from a total of 11 Kebeles (sub-cities), while rural farmers were sampled from one Peasant Association (Babogaya). Each selected area included both coop-members and individual farmers, even if in different proportions. In order to reduce seasonality effects, and to make sure that 2006 farmers were selected from the same pool of farmers sampled in 2003, we randomly selected other 30 cooperative farmers and 30 individual farmers in July-August 2006 respecting the same proportion of cooperative members and individual farmers per area adopted in 2003. Further, for the 2006 survey we selected only those coop-members that were already members of the cooperative in 2003, and those individual farmers that were already involved in non-cooperative dairy farming in 2003.

2006 and 2003 surveys were conducted by the same enumerators, applying identical questionnaire and milk sampling procedure. In both years milk samples were analysed in the laboratory of ILRI *Debre Zeit*, by the same laboratory technicians, using identical laboratory standards and techniques. Sample collection followed standard sampling procedures defined by ILRI (O'Connor 1995).[5] Nutritional value and hygiene of milk samples were analysed using laboratory grades and standards specified by ILRI (O'Connor 1995), and motivated in the following Section.[6]

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[5] In both surveys (2003-2006), milk samples were gathered and analysed within a one-month period, so as to reduce variation due to the influence of seasonal factors. Sampling steps: sanitize the equipment (planger and diper) with running water, and operator hands with alcohol (70 percent); stir milk bulk; collect a milk sample and pour it into a sterile container properly labeled; immediately store the sample in an icebox (0-4° C).

[6] *Total Bacteria Count (Standard Plate Agar):* collect 1 ml of milk with a sterile-standardised loop and dilute it progressively (1/10 - 1/100 - 1/1000 - 1/10000 - 1/100000 - 1/1000000) with "Peptone Water"; collect 2ml of the 1/1000 solution and 2ml of the 1/100 and pour it in 4 Petri dishes; add 12-15ml of "Standard Plate Agar" in each dish; when the solutions in the dishes get solid, transfer them in an incubator for 48 hours, with a temperature of 37°C; count the number of bacterial colonies grown; if the colonies are too many, compromising the accuracy of counting, repeat the same procedure using more diluted solutions.

Milk Fat Analysis (Gerber method): heat the milk samples up to 37°C, then add 10ml of Sulphuric acid 90%, 10.94 ml of milk, and 1ml of Amyl alcohol in a Gerber butyrometer (8%; 10.94 ml), and shake it; heat the butyrometer for 3-5 minutes at a temperature of 63°C, then centrifuge it for 4 minutes at 1100 RPM (revolution per minute), and heat it again for 3-5 minutes at 63°C; read the fat percentage on the butyrometer's scale.

Milk Protein Analysis (Protein Formaldehyde Titration): pour 10 ml of milk in a white ceramic container and add 0.4 ml of potassium oxalate 0.4%, and 0.5 ml of phenolphthalein solution 0.5%; after two minutes add NaOH until the solution shows a light pink colour; add 2 ml of neutral formalin 40%, which cancels the colour obtained; 4) add NaOH until the solution shows the same pink colour previously obtained; 5) compute the protein percentage, multiplying the number of ml of NaOH used by 1.78, or by 1.38 to obtain the % of casein.

4. Approach

The analytical approach of this study is built on a combination of cross-sectional and longitudinal perspectives. The cross-sectional analysis compares cooperative farmers with otherwise similar individual farmers. This comparative analysis does not take into consideration the time component of the sample available (2003-2006), which is explored in a second step (longitudinal analysis) where we look at the changes in the commercial performance of both farmers' group over the three years span. The different dimensions of the cooperative impact on farmers' commercialisation are expressed in terms of seven critical variables defined and motivated as follows.

Cooperative Size

The cooperative size, expressed as the number of member-farms, can provide an indication of collective bargaining power and efficiency.[7] When cooperatives increase in size they are expected to benefit from economy of scale and gain bargaining power, but also to lose efficiency due to increasing cooordination costs and free-riding.

Herd Size and Productivity

The herd size and productivity can offer insights about farming scale (individual bargaining power) and efficiency. Herd size is measured by inquiring farmers about the number of milk cows available at the moment of the interview, while milk productivity is computed by dividing farm production (average amount of liters of milk produced on a daily basis, over the last month) by the herd size.

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[7] Note that this indicator cannot be used for cross-sectional analysis because of the lack of a fixed comparison group.

Market Access

One way of measuring the market access of a dairy farmer, is by computing the ratio of the volume of output sold to the total volume of output produced on a daily basis (following from Von Braun 1995; Strasberg et al., 1999). A value of zero indicates a subsistent household, while the closer is the index to one, the higher is the market orientation of the farmer.

Fat and Protein Content

Milk is a complex emulsion of high nutrient density, providing large amount of energy, as well as essential amino acids and micronutrients, particularly needed in less-developed countries where diets are mainly based on staple grains or root crops (Fitzhugh 1999). The nutritional value of milk is mainly determined by water, protein, fat, sugar (lactose), vitamins, and micronutrients (Walstra, 2006). Variability among milk components is largely inter-dependent, both from a qualitative and quantitative point of view (O'Connor 1995).[8] However, most variation occurs in fat and protein content (percentage of total fat and protein per unit of milk), making of these two attributes the most important indexes to evaluate milk nutritional value, as well as the profitability of butter and cheese making (Walstra, 2006).

Total Bacteria Count

Milk is a highly perishable commodity.[9] Milk is in fact an ideal terrain for bacterial growth. Bacterial contamination of milk contributes to an increase in the public health risk related to potential outbreaks of food poisoning and diarrhoeal diseases, as well as

[8] Modifications in one component affect most of the other components.

[9] Under standard environmental conditions (15 degrees Celsius), raw milk is characterised by a shelf life of approximately one day. However, in tropical countries where environmental temperature is often above 20 degrees Celsius, the shelf life of milk can be shorter (O'Connor 1995).

other known and unknown infectious diseases (O'Connor 1995).[10] The risk of bacterial milk-borne diseases is particularly relevant in less developed countries (LDCs), where food-borne diarrhoeal diseases represent the leading cause of illness and death, killing approximately 1.8 million people annually, most of whom are children (WHO, 2000). Bacterial contamination of milk has an impact on public health, but also on processing profitability as well as on the shelf life of final dairy products. The higher the bacterial contamination, the faster is the spoilage process in milk and related dairy products, and the lesser is the capacity of milk casein to precipitate and form the cheese-mass (O'Connor 1995).[11]

5. Cross-sectional analysis

The overall analytical model largely draws from the work by Godtland et al. (2004) and Ravallion (2001). The objective of this specific analysis is to compute the Average Treatment effect on the Treated (ATT), which refers to the impact of cooperative membership on the commercial performance of small dairy farmers. The empirical problem we face in this case is the typical absence of data concerning the counter-factual: how would commercial performance of cooperative farmers have been if they had not joined the cooperative? Our challenge is to identify a suitable comparison group of non-participants whose outcomes - on average - provide an unbiased estimate of the outcomes that cooperative members would have had in the absence of the cooperative. Given the non-random selection of dairy producing areas, within the Debre

[10] Known milk borne infectious diseases are: typhoid fever, scarlet fever, septic sore throat diphtheria, tuberculosis, and brucellosis. Unknown diseases can result from bacteria mutation or cross-contamination. (O'Connor 1995).

[11] Main protein component in milk.

Zeit milk-shed, and farmer self-selection, simple comparisons of performance indicators between participants and non-participants would yield biased estimates (naïve estimation) of cooperative impact.

Based on cooperative structure and governance, there are three potential sources of bias in measuring the cooperative impact. First, coop-members are likely to differ from individual farmers in the distribution of their observed characteristics, leading to a bias related to "selection on observables". Such a bias is likely to arise because the observable differences between cooperative and independent farmers can also be expected to have a direct effect on the commercial performance even in the absence of the cooperative. We control for selection on observables in two ways.

First, the sample was designed in such a way that each selected farming area included both coop-members and individual farmers, even if in different proportions. The basic criterion for selection was that farmers in these areas were all, to a certain extent, given the opportunity to participate. Second, we measured some of the observable farm/household characteristics for both coop-members and individual farmers, where the characteristics of cooperative farmers stand for the period ex-ante the participation in the cooperative, while the characteristics of independent farmers indicate the situation at the moment of the interview (August 2003 and August 2006). Observable characteristics include education (0=illiterate, 1=literacy program or elementary school not completed, 2=primary school completed, 3=secondary school not completed, 4=secondary school completed, 5=high school not completed, 6=high school completed and more), and age (in years) of the household member responsible for dairy, household size, percentage of children and women within the household, contribution of dairy to total household income (in percentage), and a dummy controlling for the fixed effects related to urban or rural location of the farm. Figures 1a-g show that a common support (area where box-plots overlap) is found for all the characteristics observed, providing the necessary basic condition to compare the two groups of farmers.

Figure 1: Comparing observable household characteristics between cooperative members and individual farmers, Debre Zeit, Ethiopia, 2003/6.

Figure 1a: level of formal education of the household member responsible for dairy

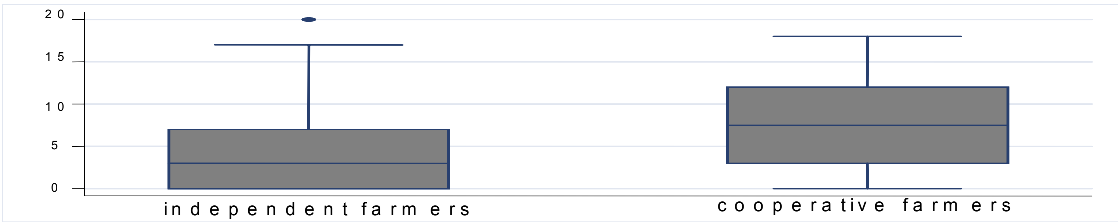


Figure 2b: age of household member responsible for dairy

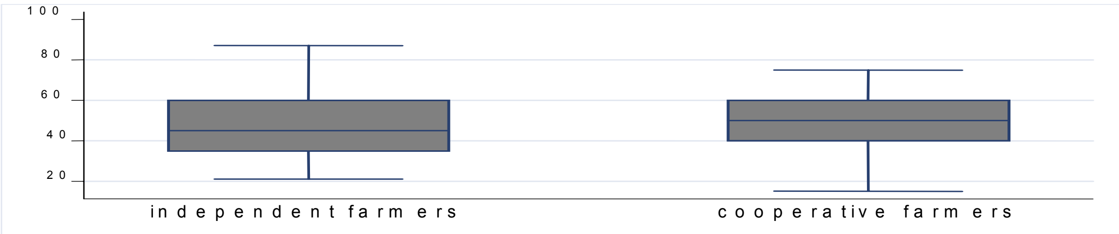


Figure 2c: household size (number of members)

Figure 2d: percentage of children < 18 years old in the household.

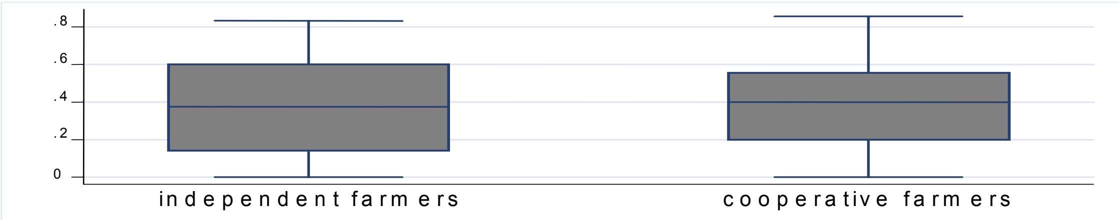


Figure 2e: percentage of women in the household

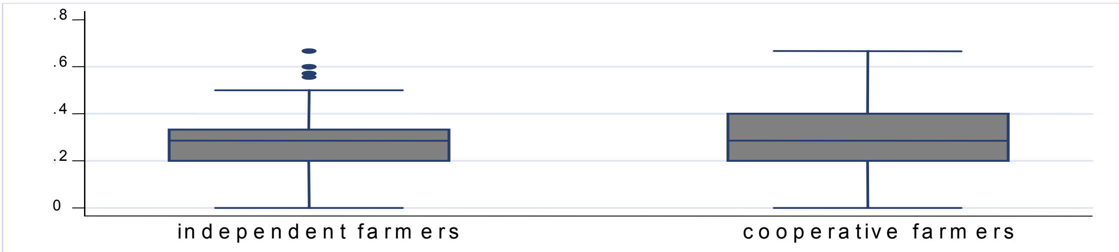


Figure 2f: contribution of dairy to total household income

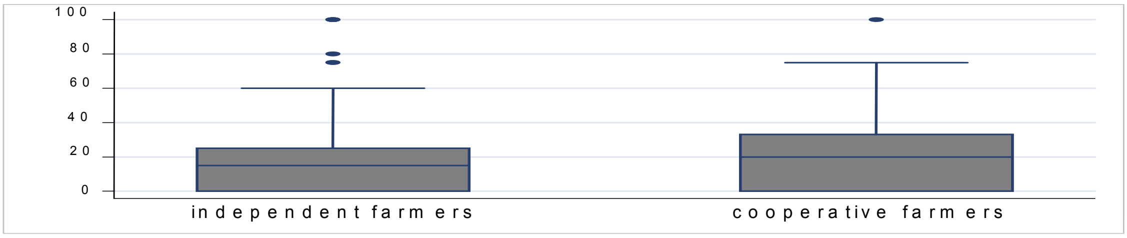
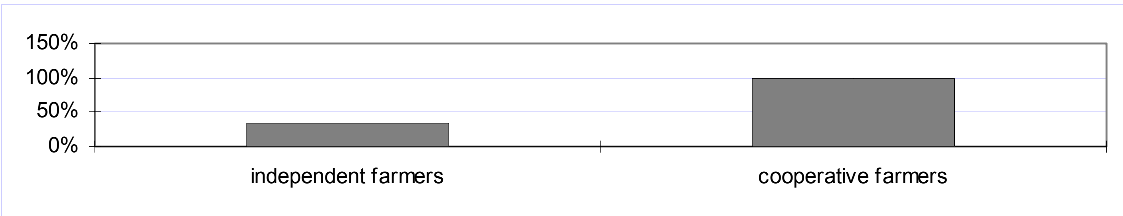


Figure 2g: Rural location of farms, Debre Zeit, Ethiopia 2006.



A second source of bias in cooperative impact can arise in case of diffusion effect within the sample area. In the presence of diffusion, comparing coop-participants with non-participants in the same area is likely to underestimate the cooperative impact. The presence of a large cooperative is likely to attract extension services as well as traders and industries in the dairy shed, influencing also the dairy commercial performance of individual farmers. Since we cannot exclude the possibility of diffusion effects across participants and non-participants, we must take into consideration that differences in outcomes between the two groups may be larger than estimated.

A third source of bias is that cooperative–participants may differ from non-participants in the distribution of unobserved characteristics (e.g. intrinsic motivation that affects the decision to join the cooperative), resulting in the "selection on unobservables" or "self-selection". In order to control for this type of bias, we need instrumental variables that explain the decision to participate in the cooperative, but does not influence the performance given participation. Such instruments are particularly needed in sorting out the likely causal effect of non-random participation like in this case study.

To address this potential sources of bias, we identified a dummy for participation in the military force (before joining the cooperative), as a valuable instrument. This instrument is theoretically justified since the cooperative under analysis was established in 1999 by a group of retired military officers, previously engaged in the national air force based in *Debre Zeit*. As a matter of fact, nowadays most of the managerial positions within the cooperative are occupied by ex-military. This may imply that households affiliated with the military force have better access to information about the cooperative, as well as stronger incentives to join in.

Table 1: Military background of cooperative and independent farmers, Ethiopia 2003/6

	Observations	Mean	Standard Deviation	Minimum	Maximum
Cooperative farmers	51	0.43	0.50	0	1
Independent farmers	49	0.10	0.31	0	1

Table 2: Probit model for cooperative membership, Debre Zeit, Ethiopia 2006

Explanatory variables	Dependent Variable Cooperative Participation
Observable Characteristics:	
Education of dairy farmers	0.10(0.10)
Quadratic term of farmers' education	- 0.00(0.01)
Age of dairy farmers	0.09(0.07)
Quadratic term of farmers' age	- 0.00(0.00)
Household size	0.30(0.21)
Quadratic term of household size	- 0.01(0.01)
% of children < 18 years old in the household	0.43(0.94)
% of women in the household	- 0.46(1.44)
Contribution of dairy to total household income	- 0.01(0.01)
Rural location of the farm	-1.54(0.41)**
Unobserved Characteristics:	
Households affiliated with the military force	0.72(0.39)*
Pseudo R-squared	0.3320
N. of observations	98

Standard error in parentheses, *denotes significance at 10% level, **denotes significance at 5% level

Table 3: Correlations across quantitative performance indices, cooperative membership, observable and unobservable characteristics, Debre Zeit, Ethiopia, 2006.

Explanatory variables	Dependent Variables		
	% Sold	Herd Size	Productivity
Cooperative Membership	0.22(0.06)**	0.88(0.34)**	6.61(1.56)**
Observed Characteristics:			
Farmer Education	-0.00(0.02)	0.23(0.09)**	-0.43(0.31)
Farmer Education^2	0.00(0.00)	-0.01(0.01)*	0.03(0.02)
Farmer Age	0.01(0.01)	-0.02(0.05)	-0.08(0.17)
Farmer Age^2	-0.00(0.00)	0.00(0.00)	0.00(0.00)
Household Size	-0.06(0.03)**	-0.28(0.18)	0.53(0.41)
Household size^2	0.00(0.00)*	0.03(0.01)**	-0.03(0.02)
% of children < 18 years old	0.15(0.16)	-1.08(0.64)*	-0.10(1.97)
% of women	0.43(0.23)*	-1.56(1.25)	2.02(3.25)
Dairy income/total income	0.00(0.00)	0.01(0.01)*	0.01(0.02)
Rural location of the farm	-0.26(0.09)**	-0.13(0.32)	2.57(2.00)
Unobserved Characteristics:			
Military affiliation	-0.01(0.06)	-0.34(0.39)	0.92(1.62)
R-squared	0.4579	0.56763	0.56763
N. of observations	98	98	98

Standard error in parentheses, *denotes significance at 10% level, **denotes significance at 5% level

Table 4: Correlations across qualitative performance indices, cooperative membership, observable and unobservable characteristics, Debre Zeit, Ethiopia, 2006

Explanatory variables	Dependent Variables		
	Fat	Protein	TBC
Cooperative Membership	-1.47(0.35)**	-0.53(0.15)**	-8506650(1.1e+07)
Observed Characteristics:			
Farmer Education	0.03(0.08)	-0.03(0.03)	-1854716(2637253)
Farmer Education^2	-0.00(0.00)	0.00(0.00)	123751(159881)
Farmer Age	0.08(0.05)*	0.03(0.02)*	560228(2025107)
Farmer Age^2	-0.00(0.00)	-0.00(0.00)**	-7160(19168)
Household Size	-0.03(0.11)	-0.07(0.06)	-587061(4533869)
Household size^2	0.00(0.01)	0.00(0.00)	-80684(218161)
% of children < 18 years old	-1.63(0.69)**	-0.09(0.29)	2825932(2.3e+07)
% of women	-1.48(1.23)	-0.12(0.54)	-2.67e+07(4.1e+07)
Dairy income/total income	-0.01(0.00)	0.00(0.00)	4188(189089)
Rural location of the farm	0.54(0.36)	-0.02(0.14)	-1.23e+07(1.2e+07)
Unobserved Characteristics:			
Military affiliation	0.03(0.28)	-0.03(0.11)	-3318395(1e+07)
R-squared	0.3655	0.2714	0.0573
N. of observations	98	98	98

Tables 1, 2, 3 and 4 indicate that the instrument choice is also statistically justified since both groups include households affiliated with the military force (Table 1); military affiliation has a strong (72 percent), positive and significant (10 percent level) correlation with cooperative membership (Table 2); while the correlation between military affiliation and the performance indicators is not significant, given cooperative's participation (Table 3 and 4). Note that in order to improve predictions (critical to matching methods) and the accuracy of the correlation analsysis, all regressions presented in Tables 2, 3 and 4 are intentionally over-parametrised, using many variables and quadratic terms.

Controlling for observed and unobserved characteristics allow us building a statistical comparison group for cooperative farmers, and to estimate the impact of cooperative participation using propensity score matching (PSM). The probit model presented in Table 2 constitutes the first step for propensity score matching. Results show the importance of the affiliation with the military force, and urban location in explaining cooperative participation. These parameters can thus be used to predict the probability of participating in the cooperative, or propensity scores, for the sample that is then used to match cooperative with individual farmers.

In order to improve the robustness of the PSM method, we restricted matches only to those cooperative and independent farmers that have a common support in the distribution of the propensity scores (Smith and Todd 2000). Consequently, block identifiers are missing for control observations outside the common support and the number of valid observations reduced the sample from 100 to 89. The number of coop-members and independent farmers per block of propensity score is described in Table 5.

Table 5: Inferior bound, number of treated and number of controls for each block, Debre Zeit, Ethiopia 2003 and 2006

Inferior of block of propensity score	Cooperative farmers	Independent farmers	Total
0.06	14	1	15
0.2	10	3	13
0.4	8	15	23
0.6	5	11	16
0.8	3	19	22
Total	40	49	89

Statistical robustness is further supported by using two different techniques for propensity scores matching (Kernel and Stratification method), and by presenting both estimates for comparison purposes.[12] This method provides an unbiased measure of cooperative impact under the assumption of conditional mean independence, whereby pre-cooperative outcomes are independent of participation given the variables used as controls for matching. Table 6 presents the ATT estimates obtained with different estimation techniques. By comparing these estimates it is possible to conclude that the naïve estimation is affected by an overall upward bias. Regardless of the estimation method considered, results consistently suggest that collective action has a positive impact on market access (% sold), herd size and productivity of small farmers; a negative impact on milk nutritional value (fat and protein content) and an insignificant impact on milk hygiene (total bacteria count) at the farm gate.[13]

Table 6: cooperative impact on farmers' commercialisation, Debre Zeit, Ethiopia, (2003+2006).

Performance	Coop-farmers	Individual farmers	Naive (t-test)	ATT[14]Kernel	ATT[14]Stratification
Herd Size	2.7(2.0)	1.5(0.7)	1.2(0.3)**	1.1(0.3)**	1.1(0.3)**
Productivity	8.0(6.1)	2.5(2.5)	5.5(0.9)**	5.2(1.4)**	5.3(1.2)**
% Sold	0.94(0.06)	0.62(0.39)	32%(6%)**	20%(10%)**	20%(8%)**
Fat	3.6(0.6)	5.2(1.8)	-1.5%(0.3%)**	-1.6%(0.6%)**	-1.7%(0.4%)**
Protein	3.0(0.3)	3.5(0.6)	-0.5%(0.1%)**	-0.5%(0.2%)**	-0.5%(0.2%)**
TBC	2.5e+07(4e+07)	3.1e+07(4.4e+07)	-5.4e+06(8.4e+06)	-3.1e+06(1.5e+07)	-3.4e+06(1.1e+07)

Standard error in parentheses, *denotes significance at 10% level, **denotes significance at 5% level

Table 7 shows that the average cooperative farmer sells 94 percent of the milk produced (approximately 17 lts/day). On average cooperative herds include 2.7 milk cows characterised by a productivity of eight liters per day. Cooperative milk is

[12] Nearest Neighbour and Radius matching methods where not use since they would discard observations from an already small sample (Becker and Ichino 2001).

[13] By comparing the results obtained with different estimation techniques it is possible to conclude that the naïve estimation is affected by an overall upward bias.

[14] ATT is equal to the outcome of cooperative farmers minus the outcome of independent farmers after Propensity Score Matching.

characterised by an average 3.6 percent of fat content, 3.0 percent of protein content, and 25 million bacteria colonies forming unit per milliliter. Compared to the commercial performance of cooperative farmers, the average individual farmer sells 32 percent less, own one cow less, rely on an daily animal productivity that is 5.5 liters lower, and his/her milk is characterised by 1.6 percent extra fat content, 0.6 percent extra protein content, and similar bacterial contamination. Overall, these empirical findings suggest that collective action provides farmers with a better market access, the opportunity to expand the production scale, but it also translates into milk poorer quality at the farm gate.

A potential explanation to these findings may be linked to the fact that collective action reduces transportation, transaction and information costs on one hand, and on the other hand it provides member-farmers with privileged access to procure high yielding cows and artificial insemination, often on credit against future revenues. [15] As a matter of fact, 98 percent of the cows owned by cooperative members show cross-breed phenotypes (a combination of Frisian and Zebu phenotypes), against the only 21 percent in individual farmers' herds. While indigenous zebu cattle are characterised by the production of small volumes of milk with high nutrient density, crossbreed cows (resulting from the inbreeding of zebus with high-yielding Frisian bulls) are characterised by larger production volumes with a more diluted nutritional value (Taneja and Aiumlamai, 1999; Walstra et al., 2006).

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[15] The artificial insemination service is a state monopoly in Ethiopia totally subsidised with public money. It produces and distributes a pretty limited amount and variety of semens from Frisian and cross-breed bulls. Cooperative farmers appear however widely discontent of this service. In most cases in fact cooperative farmers that used this service reported extremely long calving intervals that is .

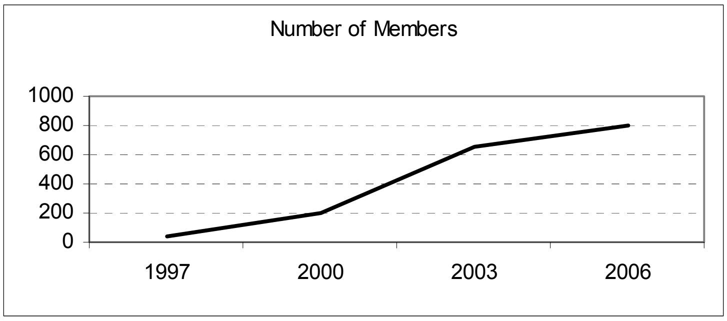
Potential co-factors, justifying in particular the positive impact of collective action herd productivity can be found in the feeding and husbandry system, veterinary care, and labour resources. The feeding system in Ethiopia can be broadly distinguished into on-barn systems, based on dry roughages and concentrate meals, and free-range systems mainly based on pastures grazing. The choice of feeding system, as well as the choice of barn type and husbandry technique, is again highly influenced by the herd phenotype. In other words, crossbred herds are usually fed and constantly kept inside a closed, rainproof type of barn, under the carefull supervision of the farmer, while zebu cattle spend most of their time grazing outside the farm (which is seldom equipped with a proper barn) with other herds composed of different animal species, under the supervision of one herders. Almost all the farmers interviewed prefer on-barn husbandry for cross-breed cows because they consider these animals less resistant to environmental risks related to contacts with other animals (infectious diseases), and accidental intake of non-edible substances like plastic. Even the type of veterinary care is strongly related to the cow phenotype. Being zebu cattle better adapted to the environment, these animals barely need any veterinary attention, and only in rare occasions are treated with traditional veterinary remedies. On the contrary crossbred cows, especially those belonging to the cooperative, are subject to regular prophylaxis (vaccines and antielmintics) carried out by the public veterinary service (free service completely subsidize by the government). Finally, minor sources of variation in cow productivity can be related to the amount and type of labour available for dairy activities, and access to professional training.

Another co-factor, besides herd genetic, justifying in particular the negative impact of collective action on milk protein is the type of feed distibuted by the cooperative to its members (also on credit against future revenues). This includes mainly hay, crop residues and molasses, which are typically low in protein (R. Leng 1999). Finally, the insignificant difference in milk bacterial contamination between the two groups may be referred to the higer resistance of zebu cattle (mainly owned by individual farmers) to infectious diseases, and mastitis in particular, which balances out the more regular use of veterinary services, the higher environmental hygiene and the better milk handling skills observed among cooperative farms. Altough we cannot exclude the occurrence of cross-contamination of milk samples during laboratory analysis.

6. Longitudinal analysis

According to the information provided by the cooperative managers, and secondary data from Tegegne (2003), the *Ada'a Liben Woreda Dairy and Dairy Products Marketing Association* was established in *Debre Zeit* in 1997-98 by 34 retired military officers of the national Air Force (also located in the *Debre Zeit*). In the last nine years the number of cooperative members has increased dramatically to almost 800, indicating a considerable horizontal expansion, especially between 2000 and 2003 (Figure 1). The cooperative expansion can depend on several pulling and deterring factors. Among these a major incentive to join the cooperative is certainly given by the possibility to gain access to input-output services. On the other hand, an important deterring factor may be internal corruption.

Figure 1: The expansion of cooperative members over time, Debre Zeit, Ethiopia.



Narrowing the focus from the cooperative down to its members, Table 7 shows an overview of the changes in commercial performance between 2003 and 2006, for both cooperative and individual dairy farmers. During the three years span cooperative farmers showed no significant changes in terms of herd productivity, market access (% sold) and fat content. The only significant trends observed are related to an increase in the average herd size, and a decrease in milk protein content and bacterial contamination.

Table 7: Dairy performance of cooperative and individual farmers across 2003 and 2006, Debre Zeit.

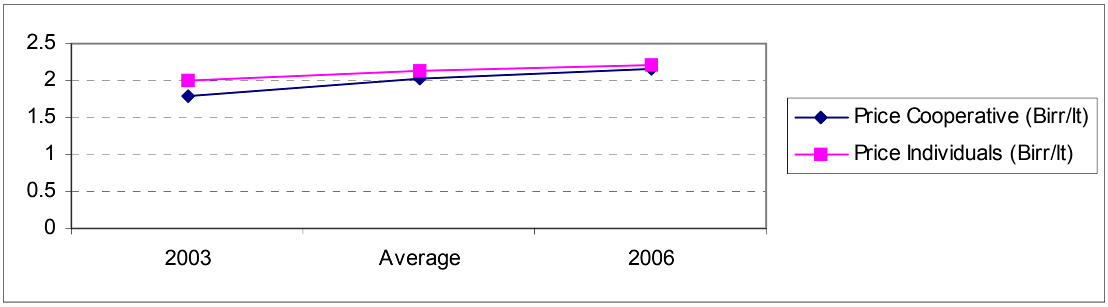
	Variable	2003 [20 obs.] Mean (Std.Dev.)	2006 [30 obs.] Mean (Std. Dev.)	t-test (2006-2003)
Cooperative Farmers	% Sold (lts sold/lts produced)	0.93(0.07)	0.94(0.06)	0.01
	Productivity (lt/day/cow)	7.9(7.6)	8.1(5.1)	0.2
	Herd size (cow/farm)	2.1(1.4)	3(2.2)	0.9*
	Fat content (%)	3.7(0.4)	3.6(0.8)	-0.1
	Protein content (%)	3.1(0.3)	2.9(0.3)	-0.2**
	Total Bacteria count (cfu/ml)	6e+07(4.3e+07)	4354735(1.6e+07)	-5.5e+07**
Individual Farmers	% Sold (lts sold/lts produced)	0.80(0.32)	0.51(0.39)	-29**
	Productivity (lt/day/cow)	3.0(3.1)	2.2(2.1)	-0.8
	Herd size (cow/farm)	1.4(0.6)	1.6(0.8)	0.2
	Fat content (%)	5.8(1.9)	4.8(1.6)	-1**
	Protein content (%)	3.5(0.6)	3.5(0.7)	0
	Total Bacteria count (cfu/ml)	7e+07(4.3e+07)	5812880(1.9e+07)	-6.4e+07**

*denotes significance at 10% level, **denotes significance at 5% level

Similar improvements in milk hygiene were simultaneously experienced by individual farmers, whose on average do not differ from cooperative farmers in terms of total bacteria count (as discussed in the previous Section). This condition automatically exclude the cooperative effect from the list of potential milk bacteria killers, which may rather include climate change, overall reduction in environmental bacterial contamination, or again inconsistencies in the laboratory analysis (see previous Section), between 2003 and 2006.

On the contrary, since the reduction in milk protein content was registered only for cooperative members, such a negative growth can indeed be linked to the cooperative impact on either herd genotype, feed usage, or mastitis prevention. As stated above, cooperative membership offers privileged access to artificial insemination and cross-breed cows. These services aim at increasing milk productivity to the detriment milk nutritional value, as discussed in the previous Section. However, given the almost costant productivity observed among cooperative farmers between 2003 and 2006, this hypothesis looses credibility. Given also the overall reduction in milk bacterial contamination and the costant level of fat content between 2003 and 2006, the hypothesis of a mastitis outbreak affecting milk protein content in 2003, or the improvement of mastitis prevention services regenerating milk protein content in 2006 are also unlikely. Hence, the most plausible cause of protein reduction in cooperative milk over time is the feeding system. In the last three years cooperative managers have in fact reported a drastic increase (100-300 percent) in concentrate feed prices that may have encouraged members to reduce the volume of concentrate feed ratios. Like in the case of milk protein content, the expansion of cooperative herds over time can be referred to the effect of collective action. As stressed above and in the prvious Section, cooperative members can in fact enjoy a privileged access to live animals and artificial insemination.

Finally, it is important to clarify that both the longitudinal and cross sectional impacts of collective action can be assumed free from price effects. As a matter of fact there is no statistical difference in the average milk price taken by cooperative and individual farmers at each point in time. The difference observable in Figure 2 is an artefact due to the cooperative policy to retain 10 percent of the milk price paid to the members for building the cooperative equity capital. Artefact apart, milk price at the farm gate is fixed all over the area surveyed and across farmers' groups, being the only significant variations registered over time (0.21 Birr/lt increase between 2003 and 2006; Figure 2).



7. Conclusions and implications

This study brings additional and up-to-date empirical evidence into the renewed policy debate on agricultural cooperatives. In particular this study evaluates the impact of the biggest Ethiopian dairy cooperative on smallholders commercialisation over 2003 and 2006. Commercial performance is investigated by looking at seven indicators including cooperative size, as well as market access, herd size and productivity, nutritional value and hygiene at the farm level.

Empirical findings suggest that cooperative farmers have better market access, and larger herds characterised by higher productivity, and that such a difference is imputable to the cooperative effect. These findings support previous literature on Ethiopian dairy (Nicholson 1997; Holloway et al. 2000; Ahmed et al. 2003; D'Haese et al. 2005), and fit in the classic cooperative theory (Bonin et al. 1993; Dulfer 1974; Munckner 1988). However, when we look at the cooperative performance over time, we discover that after the initial impact the cooperative under analysis grew only horizontally, by incorporating new farmers or additional cows. On the contrary, productivity and market access of cooperative farmers did not intensify over time. This condition reflects the presence of organizational problems limiting cooperative growth to horizontal expansion (i.e. extensive growth), as opposed to system intensification, as widely supported in international literature (Deininger 1993; Barham and Childress 1992; Cook 1995; Henhan and Anderson 1994; Jensen and Mekling 1976; Putterman and DiGiorgio 1985; Sexton 1986; Staatz 1983; Vitaliano 1983;).

Moreover, this study goes beyond the classic quantitative type of impacts evaluation, and makes a first step towards the less explored and understood impact on production quality and safety. In this regard we observe that milk nutritional value (fat and protein content) at the farm gate decreases after joining the cooperative, and does not improve (protein content keep decreasing, while fat content remain costant) over time. Finally the cooperative under analysis shows an insignificant impact on milk hygiene at the farm gate. The negative impact on milk nutritional value and the insignificant impact on milk hygiene may be surprising at first. Still, the existing theory underlining the limits of cooperatives' growth potential (in particular Cook 1995; Henhan and Anderson 1994; Jensen and Mekling 1976) implicitly support our findings, by stressing the intuition that agricultural cooperatives, unlike investor-owned firms, tend to be closer to their members than to final consumers. In a way, the negative impact of collective action on milk quality at the farm gate can be seen as part of the overall intensification failure fitting in the logical frame of this study.

To sum up, the story that emerges from this study tells that thanks to collective action, a group of retired military officers managed to create new market opportunities for milk and dairy products. As a response, neighbouring smallholder farmers began to join the cooperative group and invest in high-yielding cross-breed cows. However, the lack of public standards and private incentives to control free-riding behaviour among cooperative members resulted in a simultaneous reduction of fat and protein content, and dubious hygienic management of the milk supply. After such an initial impact the cooperative kept expanding, by adding new members and additional cows, but failed in intensifying and upgrading the farming system.

In Table 8 the key elements of this story are summarised and stylised in such a way to guide (inter)national, public and private policy-makers in setting intervention priorities to promote agricultural and dairy cooperatives in particular. Table 8 shows that the cooperative promotion process ought to selectively address issues related to production system upgrading, intensification, and extensification, following this hierarchical order of intervention.

Table 8: Setting priorities for promoting agricultural cooperatives, Ethiopia, 2006

Commercial Performance Indicators	Cross-Sectional Cooperative Impact (Cooperative - Individual)	Longitudinal Cooperative Impact (2006 - 2003)	Overall Cooperative Impact	Intervention Priority
Fat content Protein Content TBC	- - =	= - =	Upgrading =/-	1
Productivity % Sold	+ +	= =	Intensification =/+	2
Production No. of Members	+	+ +	Extensification +	3

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