

Article

A Relational Approach to Studying Collective Action in Dairy Cooperatives Producing Mountain Cheeses in the Alps: The Case of the Primiero Cooperative in the Eastern Italian Alps

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Abstract: Compared with more productive areas, mountain areas are at risk of being marginalized, particularly in the agri-food sector. To circumvent price competition, local actors in the mountains can develop specialized local products, which depends on their capacity to act collectively. Collective action, however, is complex and needs to be better understood if it is to steer initiatives towards success. This article sets out a relational approach to studying collective action in a dairy cooperative located in a mountain area: The Primiero cooperative in the Italian Alps. The common pool resources and territorial proximity frameworks were combined in a social network analysis of advice interactions among producer members, and an analysis of trust and conflict among members and between members and other actors involved in the value chain. The results show that the success of collective action can be explained by various complementary factors. Firstly, members had dense relationships, with high levels of trust and reciprocity, while the president had the role of prestige-based leader. Nonetheless, the analysis also highlighted conflicts related to the production levels of “traditional” and “intensive” producers, although members demonstrated a high capacity to resolve conflicts by creating their own rules to control further intensification. Socio-economic status did not appear to play a role in advice relationships, showing that the members interact horizontally. However, the results show that the geographical isolation of some members tended to inhibit their commitment to the collective dynamics. At a higher level, trust toward other actors involved in the value chain plays a central role in carrying out joint projects to develop and promote cheese.

Keywords: collective action; cooperative; trust; social network; mountain cheese; province of Trento

1. Introduction

Globalization and production-oriented agriculture lead to the standardization of food products [1,2], often resulting in the loss of traditional products, as well as the practices and know-how related to their production [3]. However, globalization can also awaken the creativity of local actors, inspiring them to mobilize and draw together the various resources of a territory (e.g., identity, know-how, landscapes, biophysical attributes) in order to develop products with local specificities [4]. This process

of differentiation is a means of overcoming market competition in terms of costs and prices, as regional resources are not transferable to other locations [5]. It relies, however, on the ability of local groups to organize themselves and develop original models to identify and deliver these specificities [4].

Different factors may favor or limit collective action for the differentiation of specific food products. Trust among producers is a central element in successful collective action (e.g., reference [6] in France), and the lack of trust in their failure (e.g., reference [7] in Mexico; reference [8] in Brazil). Nonetheless, conflicts are also part of the collective dynamics. According to Torre and Beuret [9], conflict should not lead to a breakdown in dialogue between parties, but should rather strengthen the resolve to find a solution. Collective action achievement relies on specific network structures. It requires high levels of density (i.e., proportion of ties in a network relative to the total number possible) and reciprocity (i.e., mutual relations) among producers. According to Merklé [10], trust is proportional to the density. Cases of low density and reciprocity associated with collective action failure are reported in the literature. For example, Faysse et al. [11] studied two dairy cooperatives in Morocco with 180 and 140 members, respectively, and found that the first had a very low density (0.35%) with two reciprocal links, and the second had a density of 0.56% with one reciprocal link. Pachoud et al. [8] showed that the advice network of 46 producer members of an association for the protection of Serrano cheese in southern Brazil had a density of only 2% and there was no reciprocity. Certain variables appear to be instrumental in increasing trust and reciprocity, and therefore contribute to the success of collective action, and these include the size of the organization and face-to-face communication [12]. In fact, size influences the frequency and regularity of face-to-face interactions, and therefore the opportunities to strengthen trust. Collective organization often requires leadership based on prestige in order to overcome problems in collective action, as for example demonstrated by [13,14]. Leaders can arbitrate in conflict resolution, can reward as well as reprimand, and can establish goals or act as coordinators. Prestige-based leadership has a less coercive and hierarchical appearance than imposed leadership [15]. At the same time, leaders may be held more accountable for the failure of collective action [16]. Next, geographical proximity can play an important role in facilitating interactions among producers. In fact, some studies have shown that geographical isolation inhibits interaction and therefore cooperation [8,17]. These factors underline the importance of taking an interest in collective organization, in order to understand success or failure of collective action and to be able to propose avenues for improvement.

This study sets out a relational approach to the process of collective action among members of a dairy cooperative located in a mountain area for the production of differentiated cheese. To this end, we drew on two frameworks: Common pool resources (CPR) and territorial proximity (TP). Firstly, we used the CPR framework to investigate the normative and multilevel institutional dimensions of collective action. This allowed us to assess the local actors' capacity for self-organization through the design of rules and establishment of norms (e.g., trust). At the same time, it allowed us to take into account the potential role of government in supporting collective action [12,18]. Secondly, the TP framework integrates the geographical and organized relationships into the analysis [9]. Our method was to first conduct an informal advice network analysis among producer members [19], as collective action requires the exchange of different kinds of relational resources, among which the sharing of advice among peers is indicative of cooperation levels [20]. However, to gain a thorough understanding of social phenomena, collective action must necessarily be analyzed both quantitatively and qualitatively [21,22], and so a complementary analysis that assessed trust and conflict was carried out. Until now, only a few studies have considered the importance of social relations in analyzing the success or failure of collective action in rural areas through a combination of quantitative and qualitative approaches. In Northern European countries, these included evaluation of the EU's LEADER initiative [23]. In southern hemisphere countries, studies were conducted in Brazil on a cheese producers' association in a context of informal production [8], and in Kenya on the sustainability of smallholder dairy cooperatives in a context of market economies [24]. The present article will add to these reflections on the form and substance of the social relations, including the institutional and

geographical dimensions, underlying successful collective action for differentiated cheese production in the Alps in western Europe.

The study was conducted in the Primiero dairy cooperative in the province of Trento in the eastern Italian Alps, where dairy cattle farming is an important economic activity sustained by the processing of milk into high value cheeses, mostly by dairy cooperatives [25]. The cooperative has 47 members, and in 2018 it had the best economic results of all the province's dairy cooperatives. It therefore constitutes an interesting case study of relational processes aimed at improving our understanding of the success of collective action and in order to identify potential threats to the collective dynamics.

2. Conceptual Framework

2.1. Applying the Common Pool Resource (CPR) Framework to a Dairy Cooperative

The common pool resource (CPR) framework was developed by Elinor Ostrom (Nobel Prize in Economic Sciences, 2009) and her colleagues from the Bloomington School. They conducted numerous studies on self-organized communities managing CPRs (e.g., pastures, fisheries, forests) to identify the preconditions for sustainable management [18]. They demonstrated that the success of collective action in managing CPRs mainly relies on norms and the design of institutional arrangements.

Firstly, norms can help resolve problems in collective action [12]. According to Ostrom, successful collective action is based on trust and reciprocity, which positively reinforce each other. Trust, defined as one individual's expectations of the behavior of others, improves the likelihood of initiating cooperation. Dupuy and Torre [26] identified three kinds of trust: (1) Community trust linked to family, religious, or ethnic characteristics; (2) interpersonal trust that relies on mutual commitments between two individuals in repeated, face-to-face situations; (3) organizational trust that is an extension of interpersonal trust to the principle of collective action, in which commitment has two dimensions: (i) Implicit, which entails repetition of the interactions, and (ii) explicit, which, in a situation of prior commitment, is formalized through internal rules. Reciprocity contributes to the development of long-term obligations between individuals [12]. When, in a repeated situation, some individuals initiate cooperation, others learn to trust them and are more willing to adopt more reciprocity norms and cooperate in the future. Thus, levels of trust and reciprocity are mutually reinforcing. Ostrom [12] identified many other variables that affect trust and reciprocity, and therefore the likelihood of collective action, such as the size of the group, the presence of leaders, and face-to-face communication.

The capacity of groups to act collectively also depends on institutions. Institutions are defined as regulations, "shared understandings among those involved that refer to enforced prescriptions about what actions are required, prohibited, or permitted" [27]. They include monitoring and sanction mechanisms [18]. For North [28], institutions "have been devised by human beings to create order and reduce uncertainty in exchange." In many cases, the success of collective action is highly dependent on institutional arrangements constituted by participants in a self-governing process, rather than imposed by external authorities [29]. Nonetheless, governments are also important in supporting local collective action by offering adequate legal frameworks, and technical or financial support [12,18].

The CPR framework will be applied in the present study to investigate the normative and multilevel institutional dimensions of collective action in the case of a dairy cooperative producing high-quality mountain cheese. This framework will be integrated with the territorial proximity framework to include further variables in the analysis of collective action.

2.2. Territorial Proximity as a Means of Deepening Understanding of Collective Action

The notion of proximity has been a research path since the 1990s, and has steadily gained prominence, especially in the French literature [9,30,31]. Since the 1990s, the French School of Proximity, composed mainly of regional economists, has played a pioneering role in this area. Its main objective is to determine the nature of the effects of proximity and to establish the endogenous role of space

in economic theory [32]. In this study, we will draw on two forms of territorial proximity (TP): Geographical and organized proximity [8,33].

Geographical proximity is a matter of distance. It corresponds to the spatial distance (e.g., number of kilometers) separating two entities. It also depends on the morphological features of space, with topography playing an important role, and can be related to the presence of transport infrastructures, and information and communication technologies. This is called the functional distance [8,34].

Organized proximity refers to the different ways actors can be close to each other, aside from their geographical relationship [30]. It is based on two essential, but not incompatible, logics: Belonging and similarity [8,35].

Belonging refers to actors of the same formal network (i.e., organizations). In this study, it corresponds to the network of producer members of the cooperative.

Similarity refers to the existence of similar representations that model the thoughts and actions of the individuals, thus facilitating collaboration. The actors linked by this logic have a certain number of common cognitive (e.g., cultural) or material (e.g., socio-economic) resources [30].

Both proximities carry potential in terms of interaction and cooperation, but unless they are activated they cannot be exploited [9,30]. They make it possible to answer these questions: How do geographical proximity and the similarity logic of organized proximity affect processes of collective action among the members of the cooperative (i.e., the belonging logic of organized proximity)? How can one act to facilitate the emergence of missing proximities to respond to challenges to cooperation?

3. Materials and Methods

3.1. The Primiero Dairy Cooperative

3.1.1. General Presentation

The Primiero dairy cooperative is located in the northeast of the province of Trento, in northeastern Italy (Figure 1). The cooperative collects milk from 47 members in five different municipalities: Canal San Bovo in the Vanoi valley, and Fiera di Primiero, Imer, Mezzano, and Sagron Mis in the Primiero valley.

The cooperative is associated to Concast-Trentingrana, a consortium of dairy cooperatives in the province of Trento. The consortium offers technical assistance to dairy farms, carries out milk and cheese analyses for the quality payment scheme, ripens and markets cheeses that are not sold directly by the dairy farms, and produces butter and milk powder. Seventeen dairy cooperatives comprising 729 farmers are currently associated to the consortium. The cooperatives process approximately 80% of the milk produced in the province (120,000 tons a year) [36]. In 2018, the Primiero cooperative paid the highest price of all 17 associated cooperatives to its members: €0.66/kg [37]. Between 2008 and 2018, the prices paid by the cooperative were on average 38.5% higher than the national reference price [38].

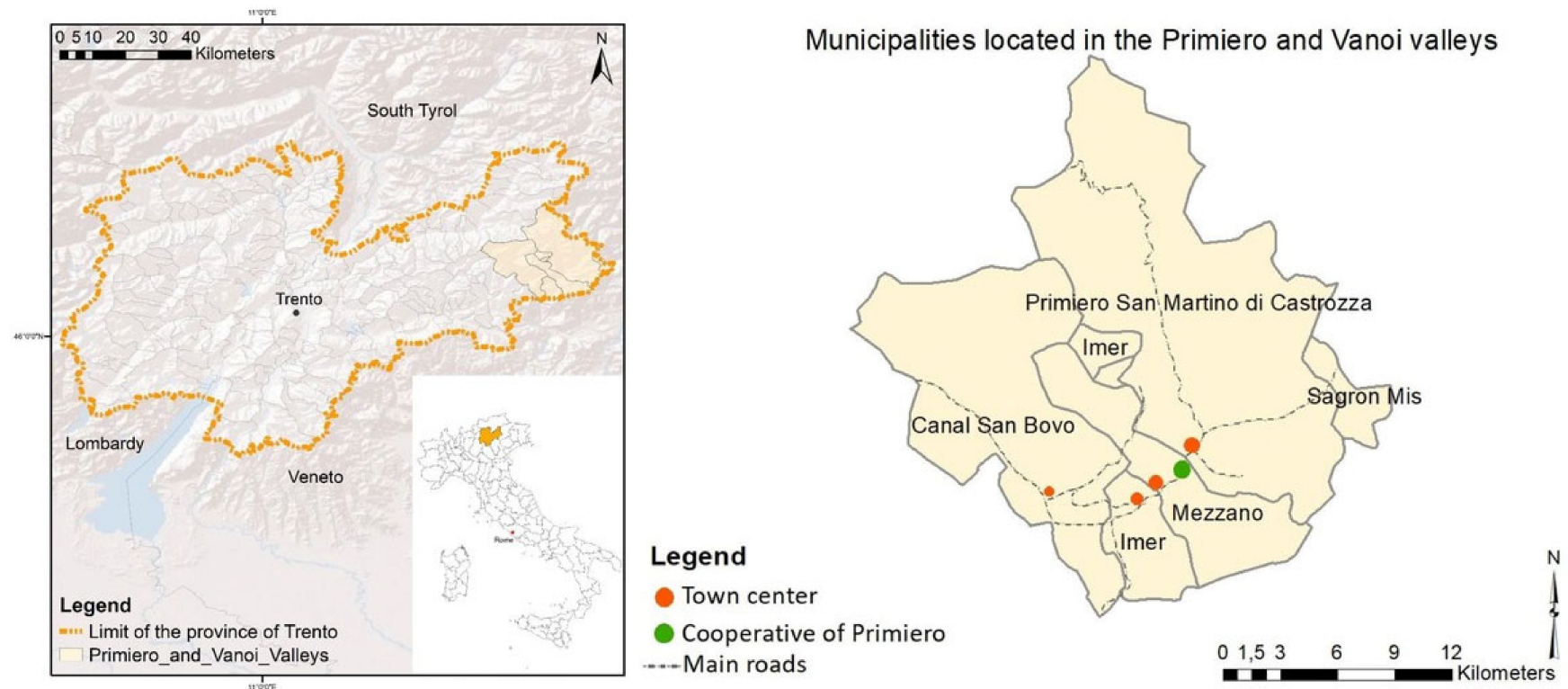


Figure 1. Location of the province of Trento and the municipalities providing milk to the Primiero cooperative (source: Own elaboration).

3.1.2. Elements of Success of Collective Action

In the Primiero and Vanoi valleys, people lived in a subsistence economy until the middle of the 20th century, with cheese destined mainly for self-consumption. From the 1960s, the “modernization” of agriculture resulted in a large increase in milk production [39]. The shift from a subsistence to a market economy was the main factor enabling the creation of the cooperative, which was founded in the village of Mezzano in 1971 by 18 producers. Cheese production began in 1981, once building construction and provision of equipment were completed. With better equipment and the expertise of professional cheese makers, the cooperative was able to significantly increase the sanitary quality and to standardize the organoleptic properties of its products. During its first year, many farmers joined the cooperative, but since then, the number of members has decreased from around 300 to 60 today (including summer farms), while the quantity of milk processed has increased from 1400 to 5400 t (Figure 2). This came about essentially from the widespread abandonment of small farms, and an increase in the productivity of the active farms, a situation that has characterized all the Alpine areas [40]. At the present time, the cooperative processes milk into different sorts of cheese (e.g., *Trentingrana* Protected Designation of Origin (PDO), *Nostrano*, *Dolomiti*, *Tosela*, *Puzzone di Moena* PDO). These days, tourism is also instrumental in promoting awareness of high-quality cheeses in the province of Trento, and especially in the Primiero valley due to its proximity to the Dolomites. More than one third of the cheese produced by the cooperative is now sold in its store, while agri-tourism on summer farms is increasing year on year. Today, eleven members of the cooperative with summer farms offer agri-tourism services in summer. Cheese making from Alpine pasture milk concerns 17.5% of the *Trentingrana* produced by the cooperative, 100% of the *Puzzone di Moena*, and 16.3% of *Nostrano*.

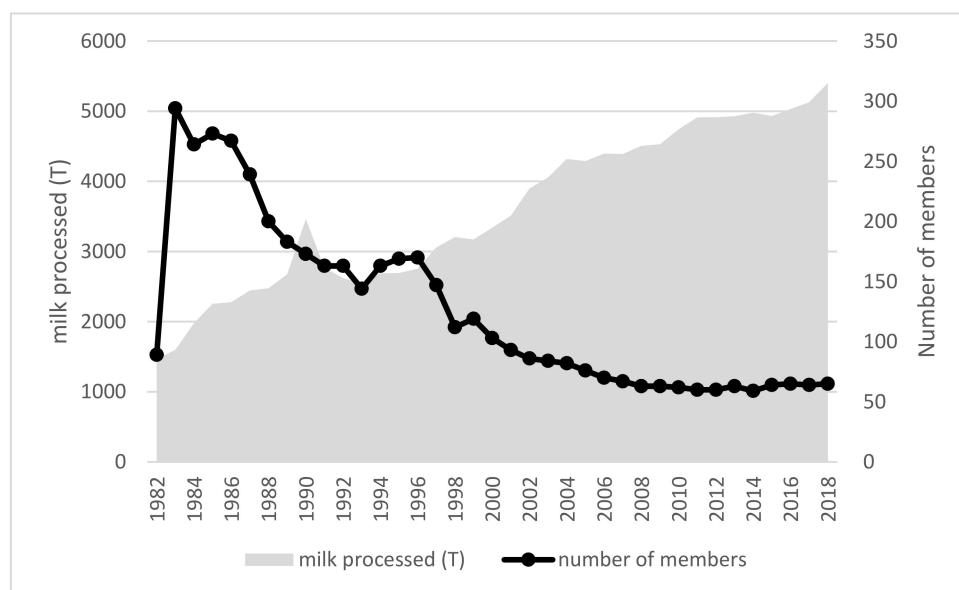


Figure 2. Evolution of the number of members and the quantity of milk processed in the Primiero cooperative from 1982 to 2018 (source: Primiero cooperative).

3.1.3. Present Characteristics and Specification Requirements of Production

All members bring their entire milk production to the cooperative for processing. No producer feeds their animals on silage. Most of the farms have mixed breed herds (i.e., Brown Swiss, Simmental, Alpine Grey, Rendena, and Holstein Friesian). According to Sturaro et al.’s [25] classification of the different dairy production systems in the province of Trento, the farms in the Primiero and Vanoi valleys follow a traditional system, small in area and herd size, and with low milk production (Table 1). Only 17 farms have free-stall housing, while the other 30 have tie-stalls, and only two use total mixed

rations (TMR; a modern feeding regime). Forty-five farms move their lactating cows to summer farms, although a quarter of these do not move the entire herd.

Table 1. Farm sizes and milk production of the dairy farm members of the Primiero cooperative in 2019.

	Average	Median	Minimum	Maximum
Utilized agricultural area (ha)	17.0	15.0	2.0	40.0
Lactating cows (<i>n</i>)	18.8	20.0	1.0	37.0
Milk production (t/year/farm)	106.0	100.8	0.0	300.0

Specification requirements for milk and cheese production are defined at different scales. First, at the European scale, the Trentingrana was PDO certified in 1987 and the Puzzone di Moena in 2014. The PDO specifications prohibit the use of silage and require that at least 75% of the forage comes from the geographical area. Second at the provincial level, the consortium developed for all the cooperative members the quality payment scheme of milk and cheese in 1972 and specifications for the production of milk in 1990 (e.g., list of authorized feeding, prohibition of silage and genetically modified organisms (GMOs), hygiene practices). Third, at the cooperative level, milk quotas were introduced in 2019. The idea emerged after the end of European quotas in 2015, which exacerbated the tendency toward intensification. According to the director, the cooperative's total production increased by 5% in 2018. Internal quotas for each farm were calculated on the basis of the average production between 2014 and 2018. Maximum production was fixed at 300 t/year, and quotas are not transferable to another member. Any member wishing to increase production, and new members, have to acquire new quotas at a cost according to their production level, as shown in Table 2. These new regulations constitute a local system of monitoring and sanctioning. If a member exceeds his/her quota, the regulations provide for a penalty of €0.10/kg of surplus milk to be imposed.

Table 2. Prices determined by the cooperative for acquiring milk quotas.

Production Level (t/year)	Price for Acquiring New Quotas (€/kg)
15 to 100	0.10
100 to 200	0.20
200 to 300	0.30

3.2. Methods

Interviews with local actors were conducted during the summer of 2019. The 47 members of the cooperative were referred to us by the director, and interviews were carried out with 45 of them, as two were unavailable during the fieldwork period. The methods used to collect and process the data are described in the following paragraphs (Sections 3.2.1 and 3.2.2).

3.2.1. Assessment of Trust and Conflicts

At the cooperative level, members were asked direct questions to assess their level of trust toward the other members on a scale from 0 (low) to 10 (high). They were then also asked to assess the level of conflict among members, on a scale from 0 (no conflict) to 10 (many conflicts). The producers had the opportunity, if they wanted, to explain the reasons for their assessment. The explanations provided were useful to get a more precise idea on the level of trust and to characterize the conflicts between the members.

At the provincial level, members were asked to assess their level of trust toward other actors involved in the value chain on a scale from 0 (low) to 10 (high). The provincial scale is relevant for the analysis because most of the actors involved in the value chain are organized at this scale and the

provincial government has implemented policies to favor cheese production and valorization [41]. These actors are public authorities, which include the provincial government, municipal authorities, and the Paneveggio-Pale di San Martino Nature Park (PPSM, a protected area of the Autonomous Province of Trento, covering about 20,000 ha in the east of the province); public institutions and other associations providing advice and services to cooperatives and farmers, which include the Federation of Cooperation of the Province of Trento (FCPT, which has the role of representing, assisting, protecting, and reviewing the balance sheets of the province's cooperatives), the Concast-Trentingrana consortium, the Federation of Breeders of the Province of Trento (FBPT, a cooperative with 800 dairy farmer associates, which provides members with monthly individual milk production and quality recordings, and assists them in marketing heifers and in collecting male calves and culled cows for beef production), the Edmund Mach Foundation (EMF, a public institution of the Province of Trento with a central role in agri-food research and in advising and training producers), and Slow Food (a nonprofit organization which has awarded “presidium” status to *Trentingrana* and *Puzzone di Moena* cheeses), the public veterinary service (PVS, which supervises compliance with health and hygiene regulations governing milk and cheese production), and private veterinaries (PV, who assist farmers in herd health management).

3.2.2. Assessment of Territorial Proximity: Social Network Analysis

Complete social network analysis (SNA) strives for exhaustive knowledge on the presence or absence of a specific relationship between all the members of an organization. We used the roster method to create the social network [42], which involves asking each participant to provide the names of those to whom they are connected. We chose to focus on the informal advice relationships among members, as it is an interesting indication of the level of cooperation among them [20]. We therefore asked each producer member to cite from a list of all the members of the cooperative the names of those whose advice they seek on how to improve their farming activities (“Who do you go to for advice in making improvements to your farm management?”). Other relationships can be highlighted depending on the focus of the study, such as friendship to analyze close personal relationships [19], although this was not the aim of the present study.

To analyze the advice network of producer members of the cooperative, we used three approaches to directed networks (“positional approach,” “structural approach,” and “exponential random graph model—ERGM” (Table 3) in R version 3.5.1, using the igraph [43] and statnet [44] packages.

Table 3. Summary of the approaches and indicators used for the social network analysis (SNA).

Approach	Indicators	How is it Analyzed?	What Question does it Answer?
Positional	Indegree centrality	Number of advice requests received	Who are the prestigious actors?
	Betweenness centrality	Number of times a node lies on the shortest path between other node pairs	Which members contribute to greater cohesion and information flow in the network?
Structural	Density	Proportion of ties in a network relative to the total number possible	What is the level of interaction, and therefore trust, among members?
	Reciprocity	Members mutually cited	What is the level of reciprocity among members?
	Community identification using the Louvain algorithm	Network partition into communities (i.e., denser groups of members) through optimization of the modularity	Are there denser groups of members within the cooperative? What are their characteristics?
ERGM	Endogenous attributes	Network-dependent effects reflecting processes of self-organization	What endogenous attributes have an effect on the structure of the network?
	Exogenous attributes	Geographical attributes linked to geographical proximity, and formal status linked to the similarity logic of organized proximity	What attributes of territorial proximity favor interactions? What are the blocking attributes?

Firstly, the positional approach is used to characterize the position of each individual in the network, and reveals whether some actors have more influence on collective action than others [8,45]. We computed the indegree centrality, which represents the number of edges incoming to a node (i.e., the number of advice requests received), and reflects the position of the individual in the network [42]. This indicator is linked to the informal status and measures the prestige of actors who have a role as leader [46,47]. Then we computed the betweenness centrality, which measures the number of times a node lies on the shortest path between other node pairs [48], thereby identifying actors who act as “bridges” between the other actors or communities of the network. Actors with high betweenness centrality play a central role in network cohesion and information flow [49].

Secondly, the structural approach is used to characterize the network’s structure and understand how it frames collective action [8,21]. In order to assess the cohesiveness of the network and the mutuality of the relationships, we computed density (proportion of ties in a network relative to the total number possible) and reciprocity (producers mutually linked). These indicators reveal the level of trust and reciprocity among the actors. We used community structure detection to assess the fragmentation of the network [45]. A community is a group of individuals that are more connected to each other compared with the rest of the network [48]. For this, we used the Louvain algorithm, which optimizes the modularity of a partition of the network. Modularity measures the density of edges within communities compared with the density of edges connecting the communities with each other [50]. The Louvain method was chosen because its performance is usually of a high level [51].

Thirdly, we used ERGM to control for the effects of endogenous and exogenous processes in shaping the advice network. These models allow us to test whether the structure of the observed network differs from what would be expected if relationships were established randomly, and to identify those variables that contribute to explaining the structure [8]. These variables can be of two kinds: Endogenous, i.e., network-dependent effects reflecting processes of self-organization; and exogenous, i.e., linked to the attributes of the nodes or independent dyadic phenomena [52,53]. The selected exogenous variables reflect the different dimensions of TP, which are geographical variables linked to geographical proximity, and socio-economic status (i.e., formal status) linked to the similarity logic of organized proximity. In addition, we analyzed homophily for some attributes to see if members who are similar for some variables tend to form denser advice relationships. All the variables selected and the associated hypotheses concerning social processes involved in the establishment of ties are listed in the Supplementary Materials (Table S1). Exogenous variables were obtained through semi-structured interviews with the members.

4. Results

4.1. Trust and Conflict Assessment

In this section we present the results on the levels of trust and conflict among members, and the levels of trust toward other actors involved in the value chain.

Within the cooperative, the median value of trust among members was 7.75 (Figure 3). Members were generally of the view that trust between them was high. Trust is both community-based and organizational, and has developed over the long term as the families involved have been established in the region for several decades and even centuries. They are gathered in villages, and they all know each other—conditions that allow community trust to be built. Moreover, a culture of cooperation has developed in the province over the centuries, which has reinforced organizational trust. Summer farms have been managed collectively for centuries, providing an important basis for cooperation, while cooperatives started to be created at the end of the 19th century to deal with the problems of poverty and environmental crisis [41]. Within the cooperative, organizational trust is reinforced by face-to-face exchanges between members (informal, or formal during assemblies) and by the internal regulations governing production [27]. Another important element in strengthening interactions and trust is participation in cultural events, linked to the similarity logic of organized proximity [8].

Cultural events related to cheese or livestock are, in fact, central to the cultural life of the cooperative's producers: forty-three out of the 45 members said that they participated in at least one local festival each year. For example, the *Desmontegada* celebrates the end of the transhumance to summer farms and is one of the most important festivals that take place in the villages.

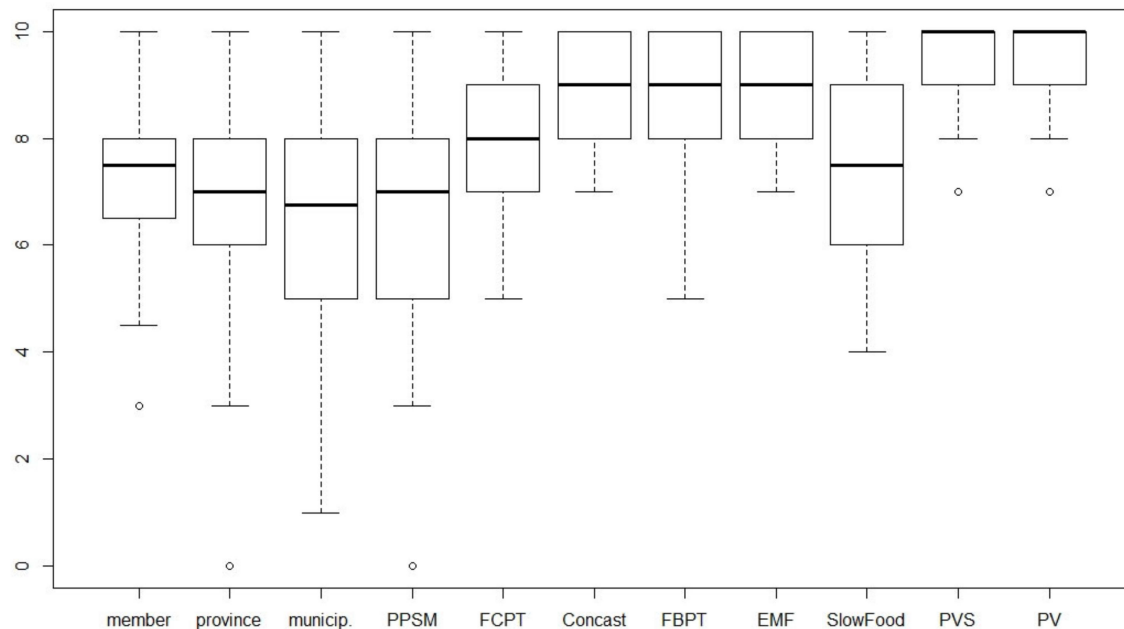


Figure 3. Boxplot of assessment of trust among members, and between members and other actors (province = provincial government; municip. = municipal authorities; PPSM = Paneveggio-Pale di San Martino Nature Park; FCPT = Federation of the Cooperation of the Province of Trento; Concast = Concast-Trentingrana consortium; FBPT = Federation of Breeders of the Province of Trento; EMF = Edmund Mach Foundation; PVS = public veterinary service; PV = private veterinarians).

Perceptions of conflict varied greatly among the members: The median value of conflict assessment was 5, with the first quartile 3, the third 7, and the total range varying from 0 to 10. Six producers thought there were no conflicts or they did not know about them. These producers are all located in the municipality of Canal San Bovo, the furthest from the cooperative (Figure 1): They are at an average distance of 12.2 km, compared with the overall average of 5.4 km. Two of them mentioned geographical isolation as inhibiting information flow, and three of them do not participate in the cooperative's general assemblies.

The main area of conflict, cited by 31 producers, was related to the production systems, and more specifically farm size. The producers described two contrasting groups: The "traditional" group with small farms and lower production levels, and the "intensive" group with larger farms and higher production levels attained through technical innovations (i.e., TMR, greater use of concentrate supplements, free stalls). "Traditional" producers were often characterized as old, and "intensive" producers as young. Most of the producers thought that some members had excessively increased their total milk production. They explained that the conditions in the mountains are not conducive to high levels of production, as grass forage is locally available, whereas cereals as feed sources are not, and the environmental conditions are unfavorable. They considered the region unable to sustain intensive milk production systems, and defended the system using on-farm forage production without dependence on imported feed. Opposed to this view, other farmers with higher milk production levels said that some producers have a closed mentality and adhere to a past model of farming rather than looking toward the future.

At the territory level, the medians of members' degrees of trust toward the various other actors were high overall, between 6.75 and 10 (Figure 3). However, some distinctions between these actors

can be drawn. Regarding public authorities, the median values of trust were 7 toward the provincial government, and 6.75 toward the municipal authorities, among the lowest values given by the producers. Seven producers complained that the province took too long to distribute subsidies, whereas previously it was faster. On the other side, four members said their expectations of the provincial government were high, and that it showed an interest in livestock breeding and cheese production (for example, government representatives attend the cooperative's general assemblies). Nonetheless, the provincial government appears decisive for promoting cheese production and valorization. Since autonomy was granted in 1948, the province has fostered cooperatives and the livestock sector [41]. For example, the provincial government offers subsidies to support cheese production, and promotes labels or brands to highlight the quality of products linked to their geographical origin (e.g., *Qualità Trentino*). The values for trust in the municipal authorities were more widely spread, between 1 and 10. Eleven producers complained that their municipality did not support farmers, had little awareness of the breeders' activities, and did not understand their circumstances (for example, some municipalities had complained about the dirt and noise emanating from farming activities). According to the producers, this lack of understanding is a problem that has worsened during recent years. It can be explained by administrations losing proximity with the producers because of the decreasing numbers of people employed in agriculture.

The median value for trust toward FCPT was 8. Producers have a generally good opinion of the Federation, and many mentioned its importance for successful cooperation in the province.

The median value for trust toward the Nature Park was 7. Eight producers complained about the park's regulations regarding environmental conservation, claiming that the park makes no attempt to understand the producers' circumstances, and that the conservation regulations are too stringent.

The median value for trust toward the Slow Food organization was 7.5. Three producers said that the production specifications for designations are too stringent and look to past production systems. For example, there are now breeds that are more productive and need diets with greater amounts of concentrates. On the other side, these producers think that Slow Food presents a good image of their products to consumers.

The median values of trust toward advisory services, which include the EMF, the FBPT, and Concast, were 9. These entities have direct and regular interactions with the members. Two EMF technicians visit the producers once a month. They currently have two projects underway with members of the cooperative: One for improving the quality of meadows and pastures, the other for improving milk quality. With regard to FBPT, visits vary from once a month to once a week for milk control. Only one producer had a conflict with this entity: His family breeds Alpine Grey cattle and he finds the FBPT puts too much interest in the Brown Swiss breed. Lastly, the Concast-Trentingrana consortium visits the farms two to three times a month to monitor milk quality, the basis on which the price paid for the milk is determined. No conflict with the consortium was reported.

Finally, trust toward the inspection services and private veterinarians were the highest and had the lowest variability, with median values of 10 (in both cases, the interquartile range is 1). Private veterinarians are contacted in case of need, while the veterinary inspectors visit every farm at least once a year to carry out blood analyses, monitor animal welfare, hygiene, and food security, and register the animals. Many producers said that the new veterinarian, who has occupied the position for 1.5 years, insists on strict compliance with the law, but they thought it fair.

4.2. Social Network Analysis

This section presents the results of the SNA, firstly on positional indicators, then on structural indicators, and thirdly on the ERGM.

4.2.1. Positional Indicators

Regarding positional indicators (Figure 4), the president of the cooperative (node 1) had the highest indegree centrality, with 22 advice requests received. He is therefore the most prestigious

member (highest informal status). Moreover, his legitimacy is all the greater as he was put forward by the members to be the new president after the sudden death of the previous incumbent. He also had the highest betweenness centrality, although producers 9, 25, 27, and 40 also had similar betweenness centrality values. The president was more often sought for advice than he was a seeker of advice: Twenty-two members cited him, whereas he sought advice only from three members. The other four producers were more often askers of advice (31 advice requests made), but they were also sought for advice, although to a lesser extent (19 advice requests received). The president's farm has a high level of production (above the cooperative's average) and uses free-stall housing. Members 9 and 25 operate a traditional system with low levels of production (below the cooperative's average), whereas members 27 and 40 have an intensive system with high levels of production. These four members are not currently on the board of directors.

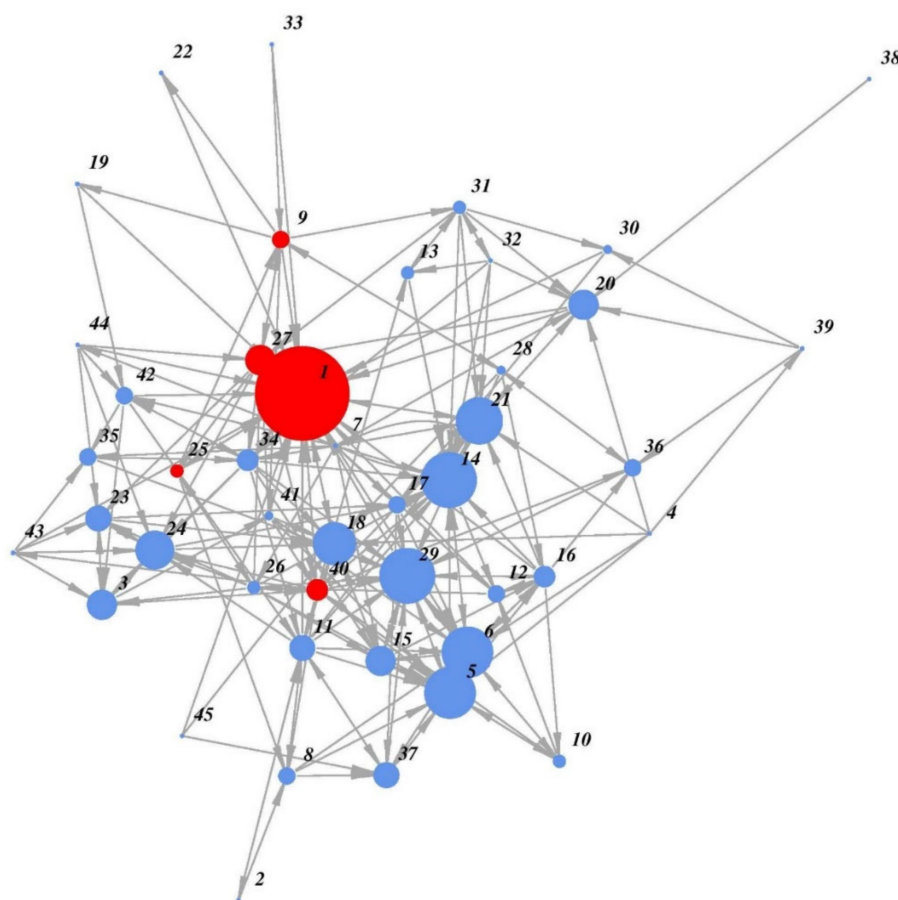


Figure 4. Network advice among the members of the Primiero cooperative (45 nodes; 220 links; size of node = indegree centrality; red = betweenness centrality value over 220).

4.2.2. Structural Indicators

Regarding structural indicators, the level of density was 11%, a high value due to the large number of producers cited: An average of five (ranging from one to 15). Reciprocity was also high (30%), as almost one third of the producers cited each other.

Regarding the fragmentation of the network, the Louvain method identified five communities (Figure 5), described in Table 4.

Table 4. Key structural indicators of the network.

		Community					Total
		A	B	C	D	E	
Number of members		11	5	12	11	6	45
Number of lactating cows		15	18	16	25	25	20
Milk production (t/farm/year)		49.0	74.0	92.9	132.8	160.2	100.8
Innovation use	Free-stall housing (% of farms)	20	0	20	60	80	38
	Total Mixed Rations (% of farms)	0	0	0	20	0	4
Proportion of cows taken to summer pastures (%)		100	100	100	100	33	100
Age of farmer (years, mean \pm SD)		60 \pm 14	50 \pm 12	52 \pm 11	42 \pm 13	34 \pm 8	48 \pm 13
Date of joining the cooperative (year)		1987	1982	2006	2002	2007	2002
% of members on the cooperative's board of directors		10	40	20	30	30	22
Distance to the cooperative (km)		11.9	2.6	2.4	2.7	2.3	2.7
Density		0.22	0.50	0.20	0.38	0.53	0.11
Reciprocity		0.30	0.40	0.37	0.67	0.50	0.30

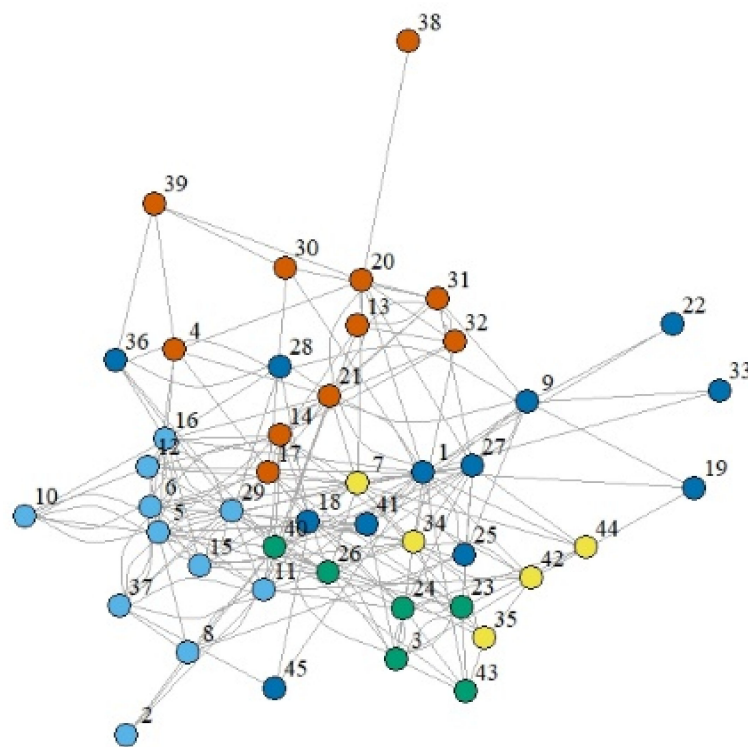


Figure 5. Community partition of the advice network using on the Louvain method.

The number of members assigned to each community ranged between 5 and 12, showing that no group is markedly dominant in size. Members of communities D and E operate farms with higher herd sizes and total milk production levels, and make greater use of technical innovations than the other communities. They differ in that farmers of group E have almost abandoned the practice of moving lactating cows to summer farms. Members of communities A, B, and C operate farms with smaller herd sizes, have low to intermediate total milk production levels, and make no or low use of technical innovations. On the basis of these features, we can divide the five communities into two groups. Communities D and E, which together have 17 members, can be called “intensive,” while communities A, B, and C, which have a total of 28 members, can be characterized as “traditional.” The producers of the “traditional” communities tend to be older than those of the “intensive” communities, among which group E has the youngest members.

Among the “traditional” communities, length of membership of the cooperative differs between the producers of A and B, who have been members since the early years of its founding, and the producers of C, who have recently joined. Other factors differentiating the various “traditional” communities are distance from the cooperative and political participation, defined as being a member of the board of directors. Members of A are located a long way from the cooperative, with 10 out of the 11 in Canal San Bovo, and have the smallest share of members on the board of directors, while those of B and C live much closer to the cooperative and have, especially B, greater representation on the board of directors. The two “intensive” communities are located near to the cooperative, and they both have the same, intermediate, numbers of members on the board of directors.

4.2.3. Exponential Random Graph Model

The model retained reciprocity and the transitive triads as endogenous attributes that have an effect in shaping the network (Table 5). The reciprocity and geometrically weighted edgewise shared partner (GWESP) terms (which capture the tendency of transitivity) are significant and positive. This indicates that trust among members plays a role in structuring the advice network. Concerning the exogenous attributes, the model retained locality, seniority in the cooperative, the number of cows,

and the distance between the nodes of a given edge. However, their values are low and have little effect on the model, except for locality. The farm's level of production was not significant. This shows that few external attributes explaining the shape of the advice network were retained. Formal status does not seem to play a role in the formation of advice ties. Moreover, no homophily played a role in the structure of the advice network, which means that producers that are in some way similar do not create significantly more advice relationships with each other. The model's goodness of fit parameters are presented in the Supplementary Materials (Figure S1).

Table 5. Estimated coefficients and standard errors for the parameters of the final exponential random graph model.

Variable		Estimates
Endogenous	Edges	−9.84 (0.28) ***
	Mutual	0.88 (0.006) ***
	GWESP (decay = 0.5)	0.77 (0.002) ***
Exogenous	Locality 2	−0.27 (0.005) ***
	Locality 3	−0.45 (0.006) ***
	Locality 4	−0.28 (0.005) ***
	Locality 5	−0.29 (0.006) ***
	Seniority in the cooperative (icov)	−0.006 (0.0001) ***
	Number of cows	0.03 (0.01) *
	Farm production	−0.0003 (0.0001)
	Distance	−0.00004 (0.00002) *

Parameter estimates are expressed in log-odds with their standard deviations (SD) in brackets. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. GWESP = geometrically weighted edgewise shared partner.

5. Discussion

In this study, we analyzed relational processes using quantitative and qualitative methods to study collective action among members of a dairy cooperative, committed to the joint production of high-quality mountain cheeses. By forming dairy cooperatives, producers in the province of Trento are able to generate a higher price for milk than in the plains through the production of prestigious cheeses, thereby providing greater economic sustainability to the local population [25]. The price paid to producer members of the Primiero cooperative for their milk was the highest out of the 17 cooperative members of the Concast-Trentingrana consortium, the result of successful collective action. In this section, we will present those elements that help us to understand this success, as well as those that constitute possible threats to the collective dynamics.

Firstly, we have shown that the relationships of trust between the members are strong. Trust is a central element in coordinating collective action to develop and promote high-quality cheeses. In this study, trust is both community-based and organizational. It has developed over the long term through life in villages, collective management of alpine pastures, and the early creation of cooperatives. Moreover, frequent face-to-face interactions, that can be formal during assemblies or informal for example in cultural events, allow strengthening trust.

Next, we found that trust toward other actors involved in the value chain was even higher than trust between members, especially toward the organizations providing the cooperatives and producers with advice and services. This is important, as it facilitates the creation of joint projects to develop and promote cheese, as demonstrated by Torre [6] in the case of *Comté* cheese, and De Roest and Mangi [54] in the case of *Parmigiano Reggiano* cheese. In addition, coordination between producers and actors in the tourism sector seems to be crucial in increasing awareness of high-quality cheeses [36]. However, trust toward the provincial government and municipal authorities was at some of the lowest levels, even though their values were around 7. Nonetheless, political support from authorities of different levels, especially provincial, appeared to be decisive in accomplishing collective action (e.g., subsidies, technical support, labels). In this sense, Pachoud et al. [8] have shown that lack of support

from political authorities of different levels played an important role in the failure of collective action to develop and promote cheese in Southern Brazil.

We went on to point out that the main conflict among members was related to some of them intensifying production. The producers who raised this issue stress the need to produce high-quality milk with their own forage instead of large quantities of milk using imported feed. This is at the very heart of the process of differentiation through construction of the link between territory and product quality [2]. In this regard, local actors were able to make their own institutional arrangements to limit internal competition among members linked to intensification through the introduction of milk quotas in 2019.

The network analysis of informal advice among members showed that the president of the cooperative was the most prestigious member, and therefore has the role of leader. The president of the cooperative also had the highest betweenness centrality, along with four other members. These members are important for collective action as they facilitate cohesion and the flow of information within the network [49].

With regard to structural indicators, we found that the advice network had high levels of density and reciprocity, and, moreover, no isolated nodes. Such network structures are fundamental to the success of collective action. The cooperative studied here appears to have an appropriate size, i.e., number of producers, to enable regular face-to-face interactions, thus generating a network with high density and reciprocity, and an absence of isolates.

With regard to the fragmentation of the network, five different communities of producers were identified: Three were characterized as “traditional” and the other two as “intensive,” based on farm size, production and management practices, and age. The variability in practices seems to engage mechanisms of social aggregation among similar individuals. Darré [55] showed that practices are mastered collectively among peers that share common perceptions, which in turn helps build a system of common norms. “Intensive” producers, who are younger and make greater use of technical innovations, can be instrumental in increasing intensification in the future, as older members cease their activity. However, these differences in practices and representations can lead to conflict, as highlighted by the conflict assessment, which can pose a threat to the collective dynamics. Nonetheless, in addition to their capacity to make their own regulations (i.e., milk quotas) in order to resolve conflicts, members are able to bring together a diversity of practices and perceptions. Indeed, among the 10 members of the board of directors, five belong to the “intensive” communities, and five to the “traditional” communities. The analysis went on to point out that geographical isolation tends to inhibit participation in collective action, which can be a threat to its success. Indeed, members located in Canal San Bovo, who form a community, are less involved in the political life of the cooperative. Only one producer is on the board of directors. They also attend fewer general assemblies: Of the six members that do not participate in every assembly, three are from Canal San Bovo. Mountains can exacerbate isolation because of limitations in the transport infrastructures as well as in information and communication technologies [56]. Including every actor in the collective dynamics appears, therefore, to be more challenging in mountain areas, and, here, leaders can play a central role in integrating isolated members. Nonetheless, isolation tends to slow the adoption of innovation and, in our case, intensification, witnessed by the community furthest from the cooperative having the lowest production level. In this regard, Zottele and Delay [57] have shown that isolation due to the mountain environment in the province of Trento can cause pockets of resistance to innovation.

The ERGM showed that reciprocity and transitivity were the endogenous variables explaining the structure of the advice network. These variables show that trust comes into play. While reciprocity demonstrates mutual engagement between two individuals, transitivity is the pattern of the relationship between three individuals that conforms to the schema: If A is in relation with B and C, then B is in relation with C [10]. This strengthens the results obtained from the trust assessment. The results regarding the external variables allow us to explore more deeply and compare the effects of geographical and organized proximity. Concerning the similarity logic of the organized

proximity, no external attributes, including homophily, were significant in structuring the network. This shows that socio-economic status does not play a role in the formation of advice relationships. However, the Louvain method identified five communities whose members have similar practices and personal attributes. This suggests that, despite the higher density of exchange within communities, this was not significant in the ERGM. In fact, the high overall density indicates strong cohesion and interdependencies among the communities identified within the cooperative [47]. This shows that the members interact horizontally, which may sound like a non-hierarchical society, as defined by MacDonald [58]. This author shows that these societies are characterized by voluntary cooperation, which leads to equivalent levels of cooperation and equality between the individuals. In the present case, voluntary cooperation among members was demonstrated when there was a fire on a farm in 2018. The other members immediately mobilized to help the family and remove the cows to other farms. Concerning geographical proximity, the location of the members appears to be the only significant external attribute. In fact, the ERGM revealed that the producers who are most sought for advice are those who live in Transacqua, which is the closest locality to the cooperative and therefore has a central position.

To sum up, it appears that the similarity logic of organized proximity acts as a lever for cooperation. Members seem to interact horizontally, without hierarchy, and the high level of participation in cultural events appears to be instrumental in strengthening the similarity logic. However, geographical isolation may be a limit to cooperation, as the most isolated members seem to be less involved in the collective dynamics, whereas members in the locality closest to the cooperative appear to be more active in the network. It seems important, therefore, to reduce functional distances among members, for example, by strengthening communication among them and encouraging greater participation on the part of the most isolated. This role can be played by the president, who enjoys a high level of popularity, and the other actors with a high betweenness centrality, as they facilitate cohesion and information flow.

Dairy cooperatives in mountain areas provide local populations with the possibility of increasing their income [25]. Moreover, they have a central social and environmental role, as they allow traditional farming systems and landscapes to be maintained, and foster biodiversity and other environmental benefits [59–61]. In this regard, dairy cooperatives can contribute to the sustainable development of mountain areas. Nonetheless, sustainability depends on the local actors' capacities for self-organization and collective action. The CPR and TP frameworks appear to be promising means of better understanding the relational processes of collective action in dairy cooperatives producing high-quality mountain cheeses, from a social and geographical point of view. Future directions would consist in extending the research, especially to the political dimension relating to the hierarchy among members, and to the issue of geographical isolation and the level of participation in the collective dynamics. Finally, some limitations of this paper need to be mentioned. For all the members of the cooperative, the farm milk production provides the most important share of the income and therefore the producers' economic concerns were not explicitly analyzed, under the assumption that the revenue was indicated by the farm size and production. We suggest that further studies should verify whether more accurate economic indicators (e.g., farm income differentiation and statement) could improve the understanding of the structure and the position of the members in the network. In addition, due to our small case study dataset, this approach should be extended in other cooperatives and at different scales in order to support our results and/or to identify further elements of success or failure of collective action. Last but not least, the Louvain method was chosen for the community detection, because of its high performance. However, it is important to note that other algorithms may result in other community boundaries.

6. Conclusions

The relational approach combining the CPR and TP frameworks based on trust and conflict assessment and SNA were found to be appropriate tools for studying collective action for cheese differentiation by the Primiero cooperative. Within the cooperative, we showed that the success

of collective action was linked to cohesive and regular interactions, which lead to high levels of reciprocity, and community and organizational trust among members. Our analysis also revealed a conflict linked to the different production systems, which saw “traditional” producers in opposition to “intensive” producers. However, the members were able to resolve the conflict through their own institutional arrangements (i.e., milk quotas) and by bringing each point of view into the discussion (i.e., parity in the board of directors). We then showed that formal status does not seem to play a role in advice relationships, and that members tend to have non-hierarchical relationships. Moreover, participation in cultural events appears to be instrumental in increasing the similarity logic of organized proximity among them. However, the geographical isolation of some members can be an obstacle to their participation, and it is therefore crucial to ensure that everybody has access to information and is integrated into the collective dynamics. This task can be undertaken by the president, who enjoys a high level of popularity, and the other actors with high betweenness centrality, who play a central role in cohesion and information flow. At the territory level, our analyses showed that good relationships among the actors involved in the value chain, which includes the tourism sector, are crucial to the success of joint projects for developing and promoting cheese by integrating knowledge, competencies and ideas from different areas. Lastly, higher administrative levels are important for the support they provide to collective action locally by offering legal frameworks and infrastructures for producing, improving, and promoting cheese. Further policy initiatives, mainly at the provincial scale, could be implemented to enhance collective action, for example by supporting collective rule design, by providing arenas for conflict resolution, or by promoting further partnership between the different stakeholders, including tourism. To sum up, successful collective action in dairy cooperatives in mountain areas allows them to specialize in high-quality cheeses and related services, which ensures increased income for the local population, while at the same time maintaining traditional farming systems and landscapes and thereby contributing to the sustainable development of these marginal regions.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/12/11/4596/s1>, Figure S1: Goodness of fit of the statistical model and results for indegree, outdegree, edge-wise shared partners, dyad-wise shared partners, triad census, and minimum geodesic distance parameters of the directed advice network among the members of the Primiero cooperative (AIC=1260), Table S1: Variables selected for the ERGM of the advice network.

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