RESEARCH ARTICLE

Differential quality and technical/managerial advice relationships in Andalusian (Spain) olive oil protected designations of origin

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Abstract

A relevant topic investigated in 'Local Agro-Food Systems' studies (LAFS) is the key role of collective action in the dissemination of innovations and knowledge aimed at the organization of quality on a local scale. The scope of this article deals with the methodological tools for typifying the relationships made, in LAFS hosting a Protected Designation of Origin (PDO), between the relational social capital and the differential quality of firms. The objective of this work is to categorize the agro-industrial firms into hierarchies for implementing rural development policies, with respect to their technical and managerial advice relationships and their score achieved in terms of product and process quality. The study takes into account the LAFS of "Estepa" and "Sierra de Segura", Andalusia (S Spain), corresponding to two important olive oil PDOs. The methodological approach comprises, firstly, the elaboration of a quality synthetic indicator on processes and products of the mills. Secondly, social network analysis is applied to the technical/managerial advice networks of the mills. Thirdly, a mill typology was established by means of factor analysis which employs quality and relational indicators. It is proved that the Regulatory Boards, as well as the second-step cooperatives, can assume a role of integrating poles with respect to the collective action developed in the LAFS, particularly in terms of dissemination of knowledge and innovations, which enhances the process and product quality of local firms. The existence of networks is a necessary condition to improve and homogenize the quality in a diffuse local agro-food structure.

Additional key words: local agro-food systems; social network analysis; factor analysis.

Introduction

The implementation of territorial labels of quality as Protected Designations of Origin (PDOs), Protected Geographical Indications (PGIs), has various effects not only at firm level, but also, at a territorial level, in the Local Agro-food Systems (LAFS) and, in general, on rural development. We understand the LAFS as a spatial concentration of locally-networked farms, firms and institutions, particular to the production of an identity-based quality food, that take charge of collective regulatory tasks such as, among others, the characterisation of the typical food, the dissemination of techniques, knowledge and know-how or the collective organisation of promotional and marketing related activities. The Geographical Indications (GIs) are relevant examples of territorial/institutional organisation of the LAFS.

This work has one supplementary figure and one supplementary table that do not appear in the printed article but that accompany the paper online.

Abbreviations used: API (Integrated Production Association); ATPI Olivar (Technical Association of Integrated Production in Olive Cultivation); ATRIA (Integrated Treatment of Agriculture Association); EU (European Union); GI (Geographical Indication); LAFS (Local Agro-Food Systems); OCA (Local Agricultural Offices); PDO (Protected Designation of Origin); PGI (Protected Geographical Indication); QSI (Quality Synthetic Indicator); RB (Regulatory Board); SNA (Social Network Analysis).

GIs involve processes of collective organisation and partnership among economic stakeholders and institutions that are devoted to the normalisation of quality standards, quality control tasks and promotion of the collective marketing of a territorially differentiated quality product. Connected with the collective action issued from around the Regulatory Board (RB)[1] and other local collective institutions aimed at the certification related activities, GIs can boost other kinds of inter-professional activities on a local scale that promote processes of territorial governance. The dissemination of innovations and traditional knowledge, the protection of biological resources, the enhancement of joint-marketing strategies of local firms, the collective action aimed at fighting against environmental externalities and the generation of local agro-food social capital, are some examples of spillover effects and territorial externalities enhanced by quality certification systems. Consequently, it seems necessary to explore, both at research and political level, whether the RB of the PDOs, as institutions for concerted action between economic and public players, might become institutions favourable to the development of territorial governance, that implies, among other aspects, to develop relational linkages not only in the internal coordination of differential quality, but also in terms of other spillover effects and territorial externalities.

International literature has made contributions to the research of the territorial effects of GIs on rural development, mainly since the end of the nineties (Allaire & Sylvander, 1997; Barjolle & Sylvander, 2000; Sylvander, 2004; Tregear *et al*., 2007; Vakoufaris, 2010; Belletti *et al*., 2011). Some references deal particularly about the effects on rural development of the olive oil GIs, as well as on multifuncionality or sustainability impacts of olive LAFS (Sanz-Cañada & Macías, 2005; Arriaza & Nekhay, 2009; Fleskens *et al*., 2009; Rocamora-Montiel *et al*., 2013; Carmona-Torres *et al*., 2014). Nonetheless, the empirical evidence is still far from reflecting properly the great diversity of LAFS worldwide, both in agricultural, environmental, organisational, socio-economic and cultural terms. One of the most relevant topics investigated in LAFS' studies is the role of local knowledge and innovation and collective action aimed at the organization of the

quality product on a local scale, not only from a technical/productive point of view but from a commercial one as well (Muchnik *et al*., 2008; Requier-Desjardins, 2012; Chiffoleau & Touzard, 2014).

While the LAFS' studies highlight the key role of collective action in the dissemination of innovations and knowledge, some research has measured and detailed the structure and characteristics of these relationships for a particular LAFS (Giuliani & Bell, 2005; Giuliani, 2007; Casieri *et al*., 2008; Chiffoleau, 2009; Chiffoleau & Touzard, 2014; Crespo *et al*., 2014). These contributions have used Social Network Analysis (SNA) techniques applied to the relationships of advice between the firms and the institutions of the LAFS, as tools for the dissemination of knowledge and innovations. In this sense, the technical and managerial networks of advice are not the relational social capital in its entirety, but are a compulsory condition to achieve a certain level of relational food social capital (Ashley & Maxwell, 2001; Garcia-Valdecasas, 2011). This approach seems to be useful for understanding the relational dimension inherent in the concept of LAFS. This body of literature, concerning the use of SNA in LAFS, has focused particularly on the links between the relational indicators and innovational capacity (Chiffoleau & Touzard, 2014), or the absorptive capacity of the firms, defined as the propensity of a firm to be a local source of knowledge (Giuliani & Bell, 2005).

The scope of this article deals with the relationships made, in LAFS hosting a Protected Designation of Origin (PDO), between the relational social capital and the differential quality of the firms. In this context, the objective of the article is to categorize the agro-industrial firms into hierarchies for implementing rural development policies, with respect to their technical and managerial advice relationships, as an indicator of the relational social capital, and their score achieved in terms of product and process quality. The study takes into account two geographical areas, concerning the LAFS of "Estepa" and "Sierra de Segura", in Andalusia, corresponding to two important Spanish olive oil PDOs. It is intended to verify the following hypothesis: the Regulatory Boards, as well as the second-step cooperative companies, can assume a role of integrating poles with respect to the collective action developed

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[1] The RB of the GIs, in a production area, are legally responsible for drawing up the reference standards or regulations of the label, registering the farmers and companies that belong to it, sealing the product wishing to use the official label, legally protecting the official label from use by third parties, and promoting it. Their partners are farmers, cooperatives, private industry, sales and marketing companies, supplying companies and the public administration.

Table 1. Number and size of firms, employment and production in the LAFS of Sierra de Segura and Estepa

	Sierra de Segura		Estepa
	With PDO	Without PDO	
Number of olive oil mills	21	7	19
Employees	147	43	178
Production of olive oil (t)	22,800	5,366	29,005
Average olive oil production per mill (t)	1,086	767	1,527

in the LAFS, particularly in terms of dissemination of knowledge and innovations, which enhances the process and product quality of local firms.

A first methodological contribution of this article is the elaboration of synthetic indicators on the level of process and product quality attained by the firms. A second contribution refers to the novel development of integrating simultaneously in the analysis, relational indicators, which are linked to the transmission of innovation and knowledge obtained by means of SNA, and synthesis indicators on quality in processes and products of the firms in a LAFS. A third contribution is the special attention paid to the relational role of the institutions enhancing the inter-professional activities of the LAFS, such as the RB and the second-step cooperative companies.

Material and methods

In 2012, 28 olive oil PDOs were listed in Spain, covering a registered area of 657,481 ha, comprising 376 olive oil mills and 136,000 t of protected olive oil. Nevertheless, only 26,069 t were commercialised with a label, mainly in the domestic market (MAGRAMA, 2013). In Andalusia there are twelve PDOs (see Suppl. Fig. S1 [pdf online]). The LAFS of Sierra de Segura and Estepa constitute prominent examples of "comarcas" (counties) highly specialized in olive groves as monoculture. In the LAFS of Sierra de Segura extensive mountain olive groves predominate with high and medium slopes and a Natural Park within its territory (Cazorla, Segura and Las Villas). Lowland and hill

olive groves, with moderate slopes and an intermediate level of intensification, prevail in Estepa.

In both LAFS there are three core institutions: i) the Regulatory Board; ii) the second-step cooperative, whose associates are cooperative firms, not individuals, that is primarily focused on the bottling and marketing of an important part of the olive oil produced locally (Olivar de Segura in Sierra the Segura and Oleoestepa in Estepa); iii) the ATRIAs (in Sierra de Segura) and the APIs (in Estepa) are farmers' associations which come together to contract agricultural technicians who provide advice for farmers and professionalize the cultivation of the land: the former in the area of conventional olive farming, fundamentally in the treatment of pests, and the latter provide broader agricultural advice on the integrated production farming system. In addition, within the "comarca" itself or nearby there are an important number of local institutions oriented towards rural and olive oil development: i) local organizations of the Agricultural Administration of the Andalusian Government (Oficinas Comarcales Agrarias, OCA); ii) Rural Development Groups; iii) local offices of professional associations of cooperatives, agricultural unions and technicians[2]; research, innovation and agro-food training centres and universities[3]. Table 1 summarizes some basic structural data which characterize the LAFS of Sierra de Segura and Estepa in terms of number of mills, size, employment and production.

A qualitative and quantitative study was designed with empirical work on two LAFS (Estepa and Sierra de Segura), which in both cases host a PDO and a second-step cooperative that groups the commercial

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[2] "Federación Andaluza de Empresas Cooperativas Agrarias" (FAECA), "Asociación Agraria Jóvenes Agricultores" (ASAJA), "Unión de Pequeños Agricultores y Ganaderos" (UPA) and "Asociación Técnica de Producción Integrada de Olivar" (ATPI Olivar).
[3] Instituto Andaluz de Investigación y Formación Agraria y Pesquera (IFAPA), Consejo Superior de Investigaciones Científicas (CSIC) and Centro Tecnológico del Olivar y del Aceite de Mengíbar (CITOLIVA). Universities which are more related to LAFS which are examined are Jaen, Córdoba, Sevilla and Granada. With the exception of a number of small groups related to organic agriculture and consumption in Sierra de Segura, the civil society associations do not have very much influence on either LAFS.

activity related to a significant number of local firms. The field work was done in 2012. The primary information sources employed for this study were the following:

a) Long duration, in depth semi-directive interviews with the key stakeholders from the olive oil LAFS (29 in Sierra de Segura and 25 in Estepa). The main subjects addressed refer to the internal organization of the institutions and firms, inter-institutional relationships (hierarchy, coordination, cooperation, etc.), the organization of the local olive oil chain and the systems of adoption and dissemination of innovation and knowledge. A broad selection of actors was made, particularly in the sphere of the local olive oil development institutions (RB and second-step cooperatives), the most innovative mills in technical and commercial terms, the technicians belonging to the Integrated Treatment of Agriculture Associations (ATRIAs) or to the Integrated Production Associations (APIs), as well as the representatives of institutions of local development (Local Development Groups and Town Councils), trade unions and local associations.

b) Surveys with all the olive oil mills located in the LAFS of Estepa (19) and Sierra de Segura (28), from which the following types of indicators are obtained: i) the productive process, the internal organization of the firm, the transfer of knowledge and innovation, as well as environmental and commercial aspects; ii) social capital, advice networks and territorial governance.

The methodological sequence comprised three subsequent phases: i) construction of a Quality Synthetic Indicator (QSI) on processes and products of the oil mills; ii) applying SNA to the technical/managerial advice networks of the mills; iii) establishment of a mill typology by means of factor analysis which employs quality and centrality indicators of the mills. The results of the interviews allowed to obtain qualitative information for: i) selecting the variables to carry out the QSI, the SNA

and the factor analysis; ii) providing an interpretative framework of the quantitative results. The data collected through the surveys have been used for building the variables related to the QSI and to the SNA.

The QSI was constructed as the statistical mean of eight normalized variables which define the quality in processes and products in the production of olive oil. We made a selection of indicators[4], firstly, among the outcome variables on the quality of the product: the "percentage of extra virgin olive oil produced" and, concerning a higher level of quality, the "number of awards" received by the companies, and "other quality certifications" obtained which are distinct from the PDO label – organic and "Natural Park" labels, ISO standards, etc.[5]

Secondly, in the area of quality of processes, we can confirm that, while the technological resources in machinery and equipment are quite satisfactory in the Spanish olive oil sector, a emphasis is needed in the implementation of good practices, especially in the most critical phases of the olive oil chain: i) advancing the "date of the beginning of harvesting" influences particularly the sensorial characteristics of the olive oil[6]; ii) the "separation of olives by quality", between olives collected from the tree and from the ground, is a dummy variable and appears as a minimum condition for the production of quality oil, as the olives collected from the ground produces lampante olive oil; iii) the "milling of olives within 24 hours after harvesting" is a basic practice which aims at avoiding the action of microorganisms and the oxidation of the fruit[7]; iv) it is highly recommended that industrial processes – mainly the malaxing of the paste, but also the centrifugation – are carried out under 30°C, as at higher temperatures the volume of olive oil obtained is greater, but a loss in aroma and oxidation phenomena occur[8]. Finally, the variable of "training in tasting courses" for the technicians of the mill and, especially, for the masters of the mills, is a dummy variable that indicates that the

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[4] Some of the bibliographic references which support the selection of indicators are the following: Sanz-Cañada, 2007; Jimenez-Herrera & Carpio-Dueñas, 2008; Uceda *et al.,* 2008; Sanz-Cañada *et al.,* 2012. The carrying out of physical-chemical analysis was excluded from the indicators as they are compulsory controls.

[5] These variables have been normalised according to the formula: $(X - Xmin) / (Xmax - Xmin)$ [1].

[6] The earlier the date, after the veraison – moment in which the olive changes colour from green to deep red or purple –, the lesser the polyphenols content, fragrance and "fruitiness" characteristics. This variable has been constructed as follows: value 6, end of October; 5, 1-10 of November; 4, 11-20 of November; 3, 21-30 November; 2, 1-10 December; 1, 11-20 December; 0, 21 December and after. This variable has also been normalised according to the formula [1].

[7] This variable has been constructed as follows: 3, always; 2, most of the times; 1, only at the beginning of the campaign; 0, never. This variable has also been normalised according to the formula [1].

[8] The variable "temperature of the milling industrial operations" has been normalised according to the formula: $1 - [(X - Xmin) / (Xmax - Xmin)]$

company is in an advanced stage in the process of adoption of differential quality strategies.

The second phase consisted in examining, through SNA, the technical/managerial advice networks demanded by the mills, as well as those which derive from the main institutions of the LAFS – the RB or the second-step cooperative. The SNA allows analysing the set of actors and their links with a systemic view, as well as the attributive characteristics of the nodes, the identification of key, peripheral and isolated actors, etc. The particularity of SNA lies in the emphasis on the study of the relationships among the studied elements and among their relational properties (Wasserman & Faust; 1994; Molina & Avila, 2011). In recent years, SNA has developed extensively. It has been applied to regional sociology and economics in, among others, the following areas: i) the local productive systems, clusters and inter-firm networks of small and medium companies (García-Macías, 2002; Casanueva-Rocha, 2003; Semitiel-García & Noguera-Méndez, 2004; Mateos *et al.*, 2006; Koo & Park, 2012); ii) the study of social capital (Lin, 1999; García-Valdecasas, 2011); iii) the processes of dissemination and adoption of innovations linked to collaboration relationships and the technical board in the LAFS (see the Introduction section). According to Woolcock & Narayan (2000), the LAFS with denser social networks are in a stronger position to face rural vulnerability, resolve conflicts and obtain benefits from collective action in the areas of exchanging information, gaining trust or finding new market opportunities.

In the information collected through the survey, relational indicators were achieved from the advice network. These variables correspond to the advice relationships in agricultural, agro-industrial and managerial/commercial areas, obtained from the next questions from the survey: Which stakeholders, firms or institutions do the farmers or the mills turn to, when they need guidance or advice?, i) regarding techniques of olive grove cultivation – addressed to persons in charge of the agricultural production in the mill, to ATRIA/API technicians or to agriculture experts; ii) related to the improvement of olive oil quality and other agro-industrial aspects – addressed to the masters of the mills; iii) concerning management of the firm or marketing activities – question put to the firm's managers. The respondents were requested in all cases to evaluate the frequency with which the advice is made according to the following scale: 0 = none; 1 = occasionally; 2 = on various occasions; 3 = very frequently.

All these relationships were combined in relational matrixes and in single multi-graphs[9] that reflect a visualization of the social network of each LAFS: the nodes are the actors (persons, firms, institutions, etc.) and the lines define the advice links between them. From this, the different indicators were calculated (see Suppl. Table S1 [pdf online]). The indicators of the whole network structure offer information about his size and connectivity, being useful for comparative analysis of the relative cohesiveness of the network. The relative position of each of the nodes can be measured by the centrality indicators, which permit to analyse the hierarchy of the actors, identify their role in the dissemination of the advice and to detect the existence of "integrating poles". The analysis was supplemented by a simulation of the technical/managerial advice network to which the central actors are removed, in their condition of integrating poles, and all their direct relationships, in order to highlight the changes in the network structure. Additionally, the direct collaboration relationships which the firm has with other mills (supplying inputs, sharing capital goods, hiring or managing services, etc.) are analysed.

Finally, a factor analysis was carried out. It was based on the variables achieved in the previous phases of the work: on the one hand, those relating to quality in processes and products of the mills – six of the eight indicators, excluding the binary variables "tasting" and "separation of olives" – and, on the other, the centrality indicators of the advice network-input degree, weighted input degree, centrality of closeness and centrality of betweenness. Typologies of firms, useful for implementing territorial policies, were obtained according to the values obtained with regard to the two first factors[10].

Results

Membership relations to the Regulatory Board and to second-step cooperatives

Fig. 1 shows the membership relationships of the mills to the RB and to the second-step cooperatives

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[9] The programs UCINET VI and Pajek were employed to make the calculations concerning SNA.
[10] Factor analysis has been used only as a method of Descriptive Statistics, without any purpose of making inference
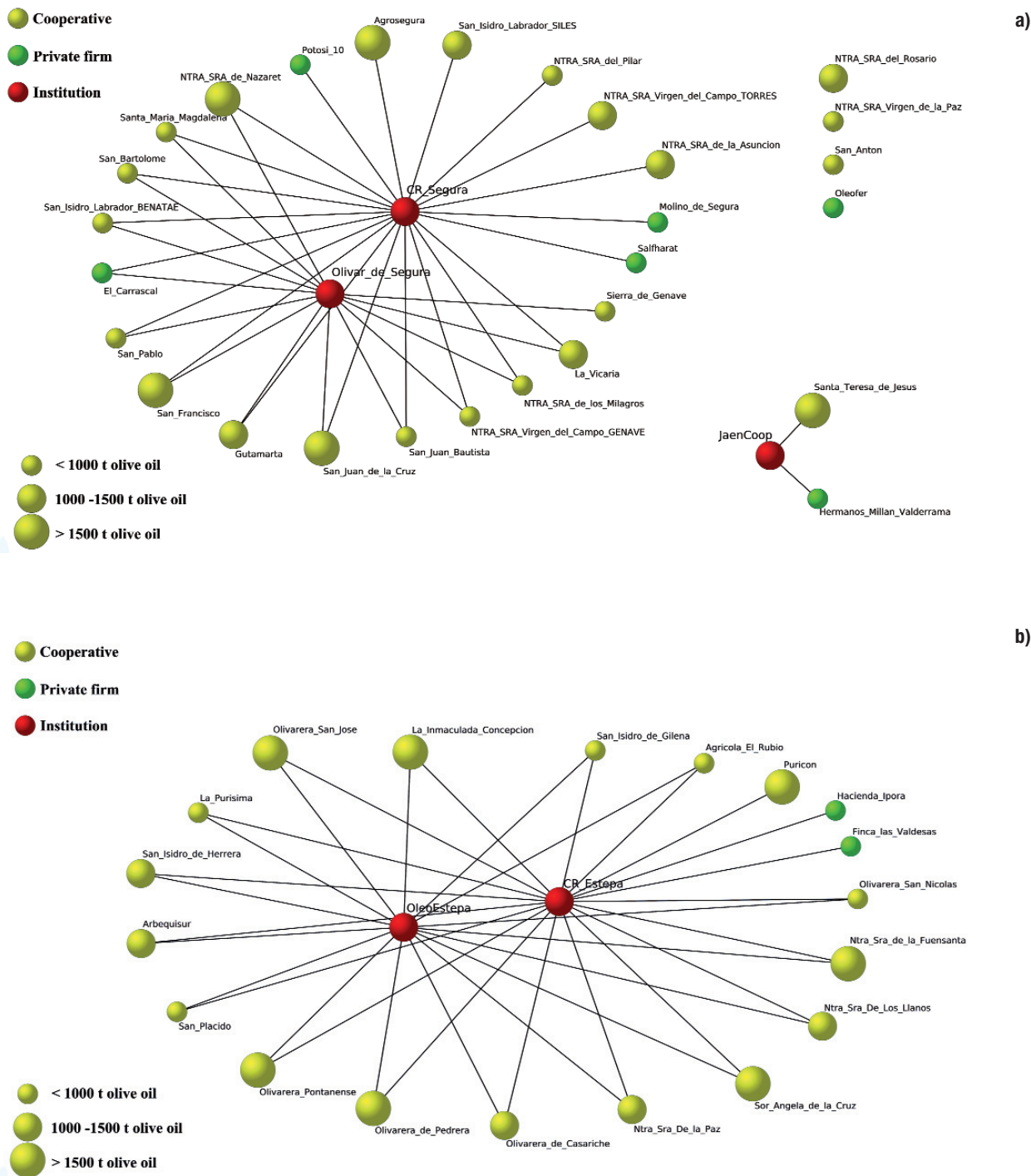
Figure 1. Membership network of olive oil mills to the Regulatory Board and the second-step cooperatives: (a) Local Agro-Food System of Sierra de Segura, (b) Local Agro-Food System of Estepa. Size Attribute: small olive oil mill (<1000 t average olive oil in the last five years); medium olive oil mill (between 1000 and 1500 t); large olive oil mill (>1500 t). Legal entity: attribute red, institution; yellow, cooperative; green, private firm.

(Olivar de Segura and JaenCoop in Sierra de Segura and Oleostepa in Estepa). Nevertheless, despite the

inter-professional development carried out in collective marketing and PDOs, very rare in other olive

oil Spanish production areas, only 10.7% of the production of extra virgin olive oil which is potentially labelled as PDO, is commercialized as such in Sierra de Segura, and 15.6% in Estepa (MAGRAMA, 2013)[11]. The labelled olive oil in PDOs has, as a minimum requirement, to correspond to the extra virgin category[12].

The PDO of Sierra de Segura (38,400 ha, North-East of the province of Jaen) was created in 1979 – the second oldest olive oil geographic denomination in Spain–, and recognized by the Spanish Government in 1993 and by the EU in 1996. A total of 13 of 21 cooperatives belonging to the PDO are also part of Olivar de Segura, two belong to other second-step cooperative (JaenCoop, centred in neighbouring "comarcas"), while the other four are not part of collective firms (Fig. 1a). Another six traditional cooperatives, as well as the cooperative Sierra de Génave, pioneer as organic olive oil cooperative in Spain since 1989, do not belong to the PDO. Sierra de Génave has promoted an associative network on organic agriculture and belongs to Olivar de Segura[13], for which it is the supplier of organic olive oil. There are two other small firms producing organic oil in Sierra de Segura. Olivar de Segura, constituted by 14 cooperatives, was created in the 1980s on the initiative of the RB with the objective of grouping together the marketing of the local olive oil; it has a bottling plant, laboratory, export department and cosmetics production, and has a significant presence in the Big Retailers' stores. Of the 28 olive oil mills located in the LAFS, only five small firms are privately held and most of them develop differential quality strategies. The ATRIAs are part of the RB and have extended to a great number of farmers on the initiative of this institution.

The PDO of Estepa (38,000 ha, South-East of the province of Seville and part of the municipality of Puente Genil, in the province of Córdoba) was officially recognized at regional and national level in 2004 and by the EU in 2010. However, the beginning of inter-professional olive oil activity in the "comarca", a crucial milestone in local collective action, dates back to 1986, when the second-step cooperative Oleostepa was created; it is dedicated to the bottling and marketing of the local olive oil and has a bottling plant, laboratory and export department. On the other hand, the creation of the PDO was promoted precisely due to the request of Oleoestepa. Practically the whole of its cultivation is carried out using integrated production, as this system has become widespread locally on the initiative of Oleoestepa, who promoted within the firm the creation of APIs. All the firms existing in the PDO territory (19) are part of the RB and 16 of them also belong to Oleostepa (Fig. 1b). The three remaining firms (two private and one cooperative) are small or medium sized mills whose strategy is oriented at niche quality products and, although they are not part of the cooperative, they use the quality control and bottling services provided by it.

The above analysis confirms that in both LAFS a considerable degree of adhesion to its integrating poles: very high, practically total, in Estepa, as well as high in Sierra de Segura, although in the latter area some mills are in neither of the two institutions (RB and Olivar de Segura), nor do all the others belong to both of them. The information provided from the interviews outlines also a significant spatial density of firms[14] and an institutional structure quite complete for rural and olive oil development. Moreover, there is a degree of inter-institutional collaboration relatively high in both LAFS.

Quality synthetic indicator (QSI) of the olive oil mills

The QSI was created from a group of eight variables (Table 2). This indicator surpasses the reliability

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[11] Moreover, second-step cooperatives still market most of their olive oil in bulk – 80% of Oleoestepa and 73% of Olivar de Segura –, according to the information obtained from our surveys. Nevertheless, collective organization is also of key importance when selling in bulk.

[12] The typicity of olive oils is determined to a large extent by their varietal composition: Picual variety in the PDO of Sierra de Segura and, in the case of the PDO de Estepa, at least 50% of the Hojiblanca, and between 20% and 30% of the Arbequina variety, as well as a number of minority varieties, such as Lechín from Seville. Moreover, the respective regulations dictate a number of physio-chemical characteristics for acidity, peroxide index, K270 index, humidity and impurities.

[13] This cooperative belonged previously to the PDO, later it left and returned at the end of 2013. When the data was collected in 2012, it did not belong to the PDO, therefore in this paper it does not appear as part of it.

[14] In addition to the farms, companies and institutions mentioned, there are some firms of concentric diversification (cosmetics based on olive oil , olive oil tourism, etc.) and companies dedicated to the exploitation of sub-products (olive pomace) in the nearby regional environment of both LAFS.

Table 2. Quality synthetic indicator (QSI). Values according to territory and Regulatory Board membership.

	PDO Estepa	Sierra de Segura			Total				
		With PDO	Without PDO[a]	Coop. Sierra de Génave	Total	Mean	Max	Min	CV[b]
Quality of the product	**0.45**	**0.26**	**0.11**	**0.67**	**0.24**	**0.33**	**0.85**	**0.06**	**0.61**
— Number of other quality and environmental certifications	0.37	0.31	0.00	0.80	0.26	0.30	1	0	0.78
— Number of oil awards obtained by the firm	0.12	0.09	0.01	0.23	0.07	0.09	1	0	1.89
— % of extra virgin olive oil. Average for the last five years	0.86	0.39	0.32	0.99	0.40	0.58	1	0	0.55
Quality of the process	**0.74**	**0.56**	**0.44**	**0.73**	**0.54**	**0.62**	**0.96**	**0.15**	**0.31**
— Training by tasting courses	0.68	0.15	0.17	0.00	0.14	0.36	1	0	1.34
— Early harvesting: date of the beginning of harvesting	0.78	0.51	0.53	1	0.54	0.63	1	0	0.42
— Separation of olives by quality: coming from the tree or from the ground	0.95	0.90	0.67	1	0.86	0.89	1	0	0.35
— Milling within 24 hours after harvesting	0.88	0.81	0.44	1	0.74	0.80	1	0	0.28
— Temperature of the milling industrial operations: malaxing and centrifugation	0.41	0.41	0.40	0.64	0.42	0.41	1	0	0.37
QSI	**0.63** CV:0.16	**0.45** CV:0.38	**0.32** CV:0.53	**0.71**	**0.43** CV:0.42	**0.51**	**0.89**	**0.13**	**0.36**

[a] In this average, the Sierra de Génave Cooperative is excluded, as its behaviour is very different to the other olive oil mills which belong to the PDO Sierra de Segura. [b] CV: Coefficient of variation

threshold, being proven that variables are significantly correlated among each other[15]. It is important to point out that the LAFS of Estepa and Sierra de Segura have been selected for our research for having an organizational trajectory focused on obtaining quality olive oil over more than two decades: i) they are two of the four Spanish "comarcas" where a PDO and a second-step cooperative exist simultaneously and cover an important part of local mills; ii) there are few Spanish "comarcas" where the integration of the activity of ATRIAs and APIs have been promoted from within an inter-professional organization and, therefore, extended to a good number of local farmers.

The greatest differences, regarding the average values for the four categories, take place in the next variables: i) "percentage of virgin olive oil" and "early harvesting", in which the cooperative Sierra de Génave and the PDO of Estepa achieve the highest values (between 0.78 and 1), while the firms of Sierra de Segura obtain the lowest; ii) "training in tasting courses", directed at technicians and masters of the mills, where the PDO of Estepa stands out for having a high level of activity, fundamental for obtaining premium quality olive oils[16]. In the case of the variables about "other quality certificates", "awards"[17], "separation of olives by quality" and "milling within 24 hours", the mills which belong to the PDO of Estepa and Sierra de Segura (as well as Sierra de Génave) obtain values higher than those which do not belong to a PDO (Sierra de Segura). Conversely, the indicator "production

[15] The reliability of the indicator was verified through the utilization of the alfa internal consistency method of Cronbach: the coefficient is 0.818, with a confidence level of 95% ($p \leq 0.05$). The closer the value of alfa is to 1, the greater is the internal consistency and the correlation among the variables used.

[16] In the case of the variable related to the percentage of virgin olive oil, it has to be taken into account, however, that in the mountain olive groves of Sierra de Segura, the high frequency of frost in some years has a negative influence on the percentage of olives available for extra virgin olive oil. Also, from the point of view of the promotion of marketing quality aimed at the consumer, the activity developed by the PDO of Estepa called "school of olive oil" has to be noted, whose aim is to show local and regional consumers and the vectors of dissemination – education centres, consumer associations, individual consumers and cooking and catering schools – how to taste olive oil and the inherent qualities of an extra virgin olive oil.

[17] Few companies obtain awards (Oleoestepa, Potosí 10, Olivar de Segura, Sierra de Génave, etc.), although they are frequently of national and international importance.

Table 3. Number and percentage of olive oil mills according to quality synthetic indicator (QSI) value strata per area and belonging to the Regulatory Board

	PDO Estepa	Sierra de Segura		
		With PDO	Without PDO[a]	Total
High (QSI > 0.6)	11 (58%)	4 (19%)	0	7 (18%)
Medium (0.4 ≤ QSI ≤ 0.6)	8 (42%)	8 (38%)	1 (17%)	9 (32%)
Low (QSI < 0.4)	0	9 (43%)	5 (83%)	14 (50%)
Total	19 (100%)	21 (100%)	6 (100%)	28 (100%)

[a] Excluding the cooperative Sierra de Génave which obtains high values in QSI.

temperatures" obtains values which are similar in order of magnitude, except for Sierra de Génave, as this practice has been disseminated in a more general manner[18]. Globally, the values achieved by the QSI for Sierra de Génave (0.71) and PDO of Estepa (0.63) stand out with respect to PDO of Sierra de Segura (0.45), and more so, to the mills of Sierra de Segura which do not belong to the PDO (0.32). Conversely, the coefficient of variation of the QSI is the smallest for the PDO of Estepa (0.16), intermediate for the PDO of Sierra de Segura (0.38) and the highest for the firms of Sierra de Segura which are not member of the PDO (CV = 0.53).

In Table 3, the mills were classified into three strata – high, medium and low – depending on the value obtained with regard to the QSI: the mean value is 0.51. It is worth noting that 58% of the olive oil mills of Estepa have a high QSI, which only occurs in 18% of the firms of Sierra de Segura. Conversely, 83% of the mills of Sierra de Segura without PDO have low quality, which affects 43% of firms of Sierra de Segura with PDO and none in the case of the PDO of Estepa.

Analysis of the technical/managerial advice network through Social Network Analysis

We have analysed the collaboration networks between the mills of the LAFS of Estepa and Sierra de Segura (Fig. 2). Firms were asked about carrying out joint measures with other mills in terms of purchasing of inputs, management and hiring of common services or joint investments, among other aspects. It is possible to observe quite a weak system of relationships of direct collaboration in both areas: only 13 lines appear

in Estepa and 8 in Sierra de Segura, compared to the 408 and 286 lines, respectively, of their advice networks. This does not mean that no collective measures are generated by the integrating poles, RB and second-step cooperatives, as well as other actors (ATRIAs/APIs, OCA, etc.). The information obtained shows that these relationships are developed mainly in activities with a low degree of specialization in the area of the purchase of inputs (phytosanitaries, fertilizers, packaging or spare parts for machinery).

On this basis, the technical/managerial advice network was analysed. With regard to its *general structure*, it was corroborated, firstly, that the consultations of a technical nature (agricultural and agro-industrial practices) predominate (79% in Estepa and 57% in Sierra de Segura), over those of a managerial/marketing nature. A fact influencing the predominance of technical concerns, mainly in Estepa, is the high trust of the firms in second-step cooperatives or in RBs. The services offered by the ATRIAs or by the APIs stand out as the most important agricultural advices in the LAFS. From the agro-industrial perspective, the consultations related to malaxing techniques, centrifugation and bottling predominate. In the area of organizational/marketing advice, enquiries related to administrative questions (*i.e.* CAP) and to certification processes prevail.

Fig. 3 presents a general overview of the technical and managerial advice networks. The nodes are differentiated by colours, according to their type, and size, depending on the weighted input degree of each actor. The links imply transference of knowledge flows, but can also be considered as authority positions, understanding this as the possession of certain knowledge considered as valid and useful: in the graphs the arrow

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[18] Only a limited percentage of mills in both LAFS reduce even more the temperatures, mainly at malaxing stage for the elaboration of premium quality extra virgin oils. This is the case of Sierra de Génave.
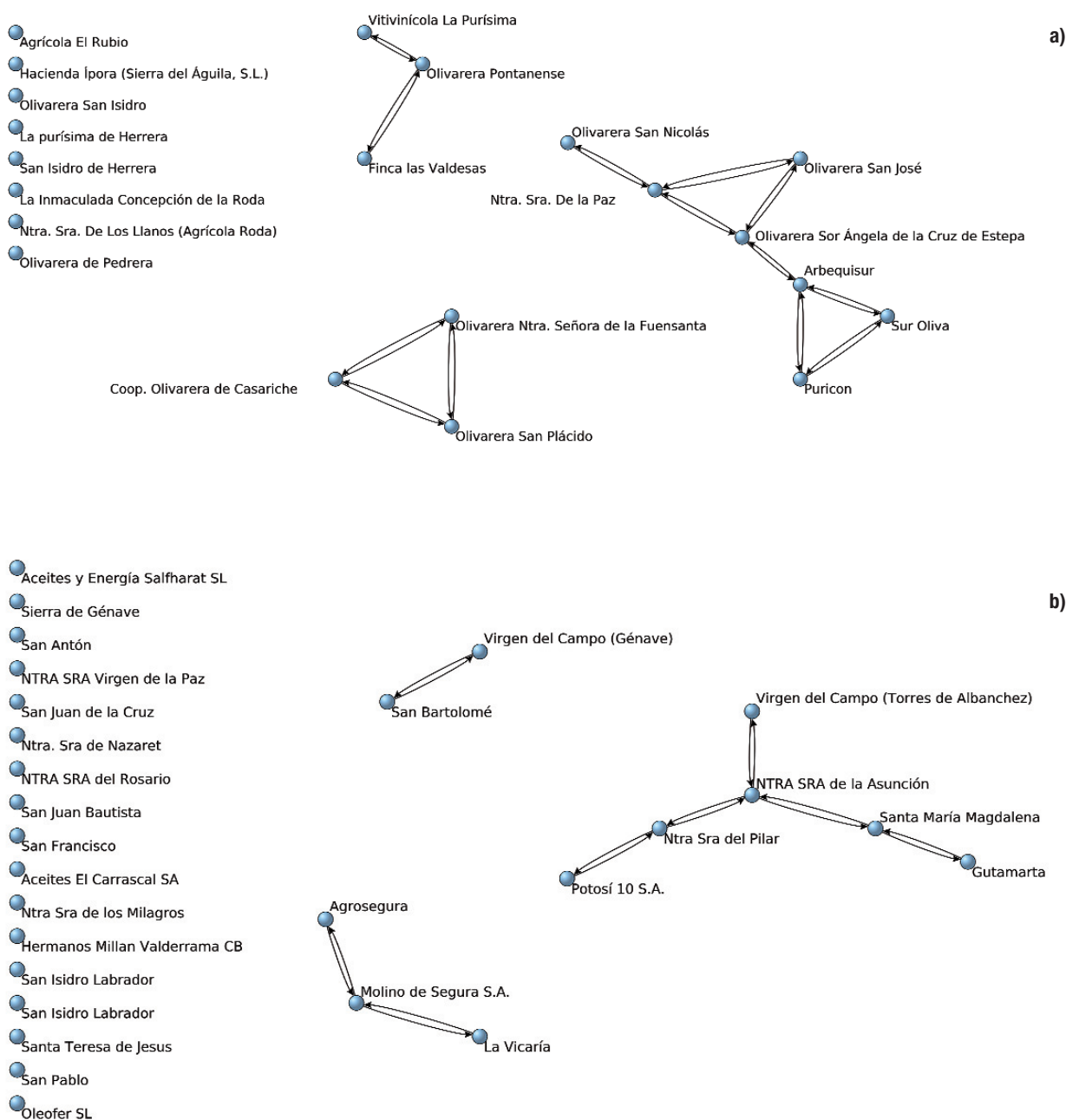
Figure 2. Direct collaboration networks between the olive oil mills: (a) Local Agro-Food System of Estepa, (b) Local Agro-Food System of Sierra de Segura.

goes from the actor requesting advice to the supplier of information. It has to be noted that there is a high degree of unidirectionality in the relationships between the nodes, as only 10.5% of the links are reciprocal in Estepa and 4.4% in Sierra de Segura.

The network of Estepa (128 nodes, 408 lines) is larger than Sierra de Segura (99, 286) and more compact, because the average degree is bigger and the dia-

meter and the average distance between reachable pairs are lesser with regard to Sierra de Segura (Table 4). Only one component is strongly connected in each of the networks, formed by 21% of the nodes in Estepa and 28% in Sierra de Segura. There is a sole bicomponent in both areas, with a relative similar size (56.25% in Estepa and 56.56% in Sierra de Segura). These results corroborate the existence of a robust nu-
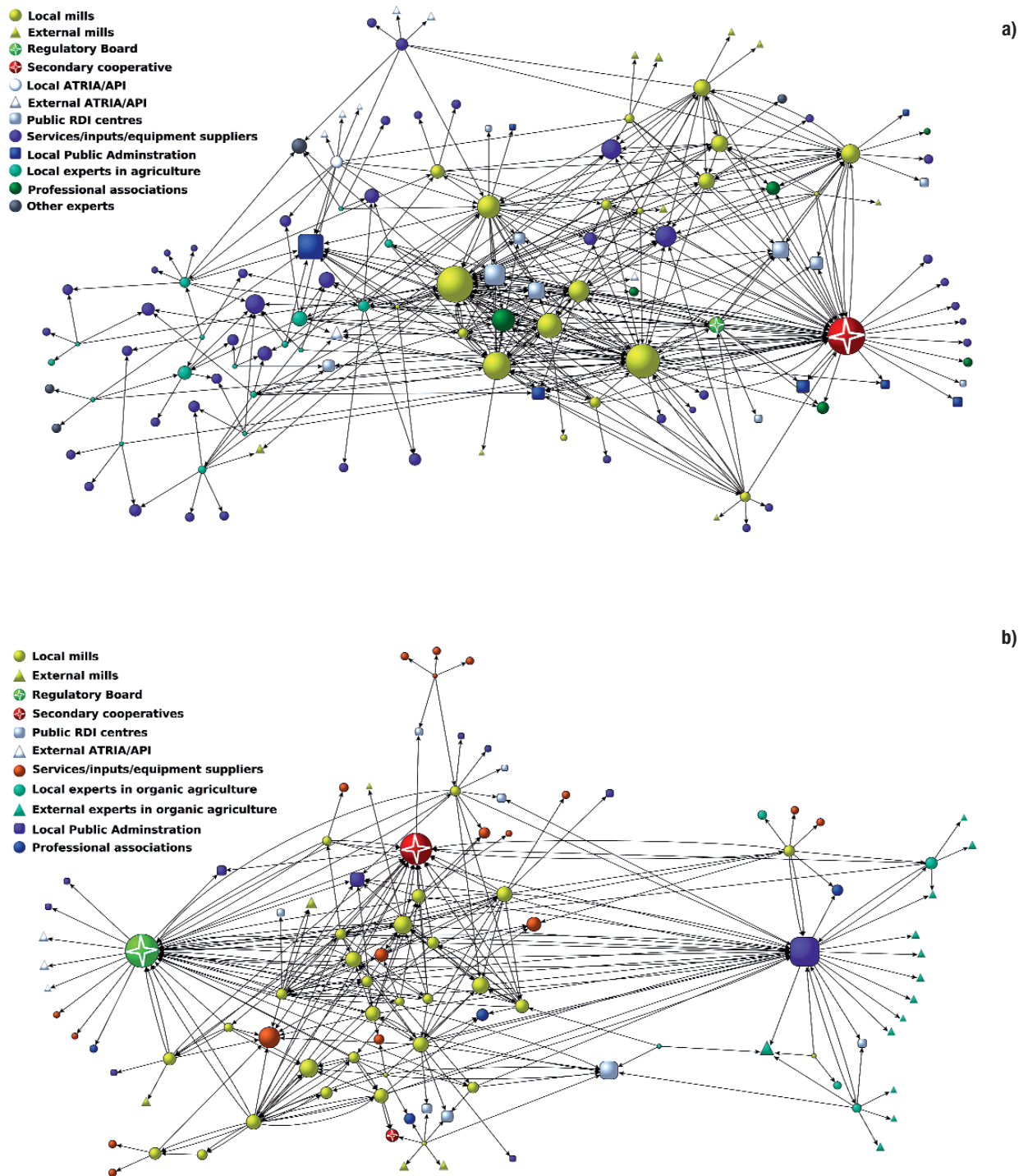
Figure 3. Technical/managerial advice network according to the number and frequency of consultations received: (a) Local Agro-Food System of Estepa, (b) Local Agro-Food System of Sierra de Segura.

cleus in both networks, characterized by the multiplicity of contact paths and by the relational reciprocity between pairs of nodes.

Table 5 shows the indicators of relative position of the actors. They are obtained for each of the categories in which the stakeholders have been grouped according

Table 4. Indicators of the structure of the technical/managerial advice network

Indicators	Sierra de Segura	Estepa
Size of the network		
— Number of nodes	99	128
— Total lines	286	408
— Average degree	5.78	6.34
— Diameter	9	7
Network connectivity		
— Average distance between reachable pairs	3.40	2.97
— Number of strongly connected components	1	1
— Number of bicomponents	1	1

Table 5. Input degree, closeness and betweenness centrality of the actors belonging to the Local Agro-Food Systems (LAFS) of Estepa and Sierra de Segura.

Type of actor	Estepa				Sierra de Segura			
	ID	WID	CC	BC	ID	WID	CC	BC
Regulatory board	4	11	0.13	0.004	27	55	0.21	0.15
Oleoestepa	32	69	0.20	0.05				
Olivar de Segura					22	49	0.18	0.01
JaenCoop					3	7	0.06	0.00
LAFS' mills	7.3	16.05	0.11	0.02	3.2	6.7	0.08	0.01
Mills external to LAFS	1.1	2.1	0.07	0.00	1.2	3	0.05	0.00
Professional associations (agricultural unions, etc.)	3	7	0.13	0.00	2	4.5	0.10	0.00
Local public administration	4.29	8.71	0.13	0.00	4.3	6.9	0.12	0.01
Public RDI centres	4.3	7.8	0.13	0.00	3	5.14	0.13	0.00
Services, inputs and equipment suppliers	1.98	4.68	0.08	0.00	2	4.06	0.08	0.00
ATRIAs/APIs	1.6	3.6	0.08	0.00	1	2.3	0.13	0.00
Experts in agricultural production	1.14	2.5	0.05	0.003	1.15	2.3	0.11	0.05

ID: input degree, WID: weighted input degree, CC: closeness centrality, BC: betweenness centrality.

to their professional typology and their role in the LAFS. The analysis of the Table 5, together with Fig. 3, allow us to study the role of integrating poles exercised by, among other actors, RBs and second-step coope-ratives.

The input degree, indicator of the number of links reaching a node, and the weighted input degree, which also includes the frequency with which an actor is consulted, are understood, as well as recognized nodes of access to innovation, as confidence and authority po-sitions of the actors. We can confirm that there is a high degree of concentration of the functions of advice in a limited number of actors in both areas. Thus, if the actors of each LAFS are arranged according to their respective weighted input degree value, the first decile

(13 actors in Estepa and 10 in Sierra de Segura) obtains 42.1% of the total value corresponding to the LAFS of Estepa, as well as 46.6% in the case of Sierra de Segura.

These main actors, as receivers of advice, are, firstly, the local inter-professional institutions (RB and second-step cooperatives) and some local agricultural administration bodies (OCA Sierra de Segura and Regional Plant Health Service in Estepa). Conversely, advices are mostly demanded by the olive oil mills in both LAFS. In Estepa, the second-step cooperative Oleo-estepa, as an integrating pole, stands out well above the rest of the institutional structure both for being the most consulted node (ID = 32) and for the frequency of those advices (WID = 69); the RB has lower scores in the input degree indicators (4, 11)[19]. In Sierra de Segura, the

[19] In the analysis of the input degree of RB it is necessary to take into account that the functions of quality control have been traditionally carried out by the Oleoestepa and, particularly, by its quality control laboratory, while the RB carries out specifically the fostering, vigilance and promotion of quality.

central position in the network is occupied by the RB (27, 55), followed very closely by the second-step cooperative Olivar de Segura (22, 49): they are the integrating poles. Within the group of the local agricultural public Administration, the agency OCA stands out as other important pole of advice (27, 47), becoming a key institution of the LAFS in the area of organic olive oil production and collective organisation[20].

Secondly, 6 mills in Estepa and 5 in Sierra de Segura also belong to the first decile of nodes. In Estepa, these mills also occupy very high positions in the ranking of actors of the LAFS, only slightly lower than Oleoestepa. As we see in Table 5, the whole group of local mills gets a relatively high rank in Estepa (7.3, 16.05) and intermediate in Sierra de Segura (3.2, 6.7). The fact that a core group of olive oil mills has gained a central role in the dissemination of information to the whole LAFS, beyond the local inter-professional institutions, is a positive element which proves a certain level of self-sufficiency of some local companies with respect to the institutions. Thirdly, other groups of nodes reach significant input degree indicators – ID between 3 and 4.5: the public RDI centres (particularly IFAPA) and the local public Administration in both LAFS, as well as the professional associations in Estepa (mainly the ATPI, devoted to integrated production technicians) and the second-step cooperative Jaencoop in Sierra de Segura[21].

The analysis of closeness centrality offers information on the capacity of actors as knowledge dissemination vectors in the whole network: i) in Estepa, Oleoestepa (0.2) and at a certain distance behind (0.11 to 0.13), the RB, the public RDI centres, the local public Administration, the professional associations and the local mills; ii) in Sierra de Segura, the OCA (0.24), the RB (0.21) and Olivar de Segura (0.18) are at the top and, at certain distance behind (0.11 to 0.13), the public RDI centres, the ATRIAs/APIs and the local independent experts in agriculture.

The analysis of betweenness centrality serves to identify the nodes which play a role as mediator in the dissemination of knowledge between other nodes of the same group which do not know each other. Only worthy of note are the values of the indicator achieved in Sierra de Segura by the RB (0.15), the OCA (0.08) and the experts in agriculture, mainly in organic production (0.05). In Estepa, due to the influence of the greater relational closeness of the core group of firms, the betweenness values are more moderate compared to Sierra de Segura. Only the value of Oleoestepa (0.05) and, further behind, the local mills (0.02) are worthy of being mentioned. Nevertheless, these average values blur the fact that a limited number of mills have individually a significant betweenness centrality: three mills in Estepa and two in Sierra de Segura surpass the value 0.05.

It is important to add that as centrality indicators are obtained at local level and from the closest regional surroundings those indicators may in fact be underestimated in the case of the organic production of Sierra de Segura. In fact, they are immersed in a network which is geographically wider, as was clearly reflected in the interviews[22].

Finally, we examine what would happen with the networks and their level of cohesiveness if these central actors – RB and second-step cooperatives – ceased to exist. A simulation of the advice network was made in which those key actors and their direct links were removed. The indicators of the structure of the network after the simulation are presented in Table 6. Firstly, as was expected, a reduction in the size of the network occurs, – both in the number of nodes, lines, diameter and average degree –, which turns out to be greater in Sierra de Segura (between 12 and 26%) than in Estepa (between 2 and 18%). The most significant fact is that, as a result of the simulation, the component strongly connected becomes divided into three subgroups in Sierra de Segura, whose most important component only agglutinates 10% of the nodes of the network[23].

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[20] The importance of this agency lies not only on its functions, but mainly on the characteristics of its director in 2012, Manuel Pajarón, a great expert on the subject, who encourages collective action and who is a great disseminator of knowledge about organic olive oil production.

[21] Some machinery and equipment firms for olive oil mills, as Peralisi and Westfalia, are also ranked in the first decile of nodes regarding their weighted input degree.

[22] Thus, many collaboration and advice relationships within this group of actors take place with actors external to the LAFS, due to the existence of a high level of relational capital among the various organic production territories in Andalusia. Ecovalia, nonprofit associative institution for the promotion, training and innovation on organic agriculture, located in Andalusia and neighbouring regions, has an influence on the existence of many associative links at national and international level.

[23] This subgroup refers to a number of mills belonging to the PDO. A second subgroup includes a collective of organic production and consumption stakeholders. The third one corresponds to a section delimited territorially which does not form part neither to the PDO nor to the second-step cooperative.

Table 6. Indicators of the structure of the technical/managerial advice network: simulation after removal of the key actors

Indicators	Sierra de Segura	Estepa
Size of the network		
— Number of nodes	87 (–12%)	117 (–9%)
— Total lines	214 (–25%)	337 (–18%)
— Average degree	4.92 (–15%)	5.74 (–9%)
Connectivity of the network		
— Average distance between reachable pairs	2.52 (–26%)	3.02 (2%)
— Number of components strongly connected	3	1
— Number of bicomponents	1	1

Note: the percentage decrease in value of the size and density of the indicators after the simulation are shown in brackets.

After the simulation, this indicator in Estepa and the number of bicomponents in both areas remain unaltered. This allows us to confirm that the RB of Sierra de Segura is not only the main agent capable of influencing other actors of the LAFS with regard to the dissemination of knowledge, but it also acts as the main element of cohesion in the LAFS: if it disappears[24], the network becomes fragmented into three components, each one integrated by not many elements. However, the LAFS of Estepa, due to a tradition of cohesive collective inter-professional organization, is found in a second evolutionary phase in which there are more nodes of dissemination of knowledge and innovation beyond the integrating poles, as the local mills have begun to acquire a significant role of intermediation.

Typology of mills according to their quality level and position in the advice network: factor analysis

In this section, a factor analysis was carried out in order to rank, through synthesis indicators, olive oil mills according to their quality level (quality score) and their position in the technical/managerial network (relational score). Contrasts have been made in order to measure the sampling adequacy (Kaiser-Meyer-Olkin value: 0.734), as well as to establish the existence of common factors (Bartlett's sphericity test: *p*-value 0.000) and the validity of the model (χ^2 test: *p*-value 0.211). The two factors explain 54.79% of the total variance. Table 7 shows the correlation coefficients of the variables with the factors.

Table 7. Correlation coefficients between variables and factors

	Factor	
	1	2
% Extra virgin olive oil	0.135	**0.768**
Other quality certifications	0.242	**0.648**
Early harvesting	0.027	**0.825**
Number of awards	0.229	**0.544**
Milling within 24 hours	0.140	**0.571**
Temperature in the industrial processes	–0.059	**0.509**
Input degree	**0.981**	0.166
Weighted input degree	**0.967**	0.176
Closeness centrality	**0.707**	0.153
Betweenness centrality	**0.524**	0.022
% of the variance explained by factors	**28.25**	**26.54**

Extraction method: maximum likelihood. Rotation method: Varimax with Kaiser normalization. Rotation converged in 3 iterations.

The first factor (abscissa axis) can be interpreted as an indicator of the position of the actors in the technical advice networks (relational indicator) and explains 28.25% of the total variance. The variables "input degree", "weighted input degree" and "closeness centrality", particularly the two first ones (0.98 and 0.97), obtain correlation coefficients quite high with regard to the first factor. On a second level, the coefficient related to the "betweenness centrality" also achieves a significant value. This factor differentiates those mills with a greater degree of centrality in the advice networks from those which have opposite characteristics.

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[24] Olivar de Segura has also been removed from the network, but has, otherwise, a very low betweennes centrality (0.01).
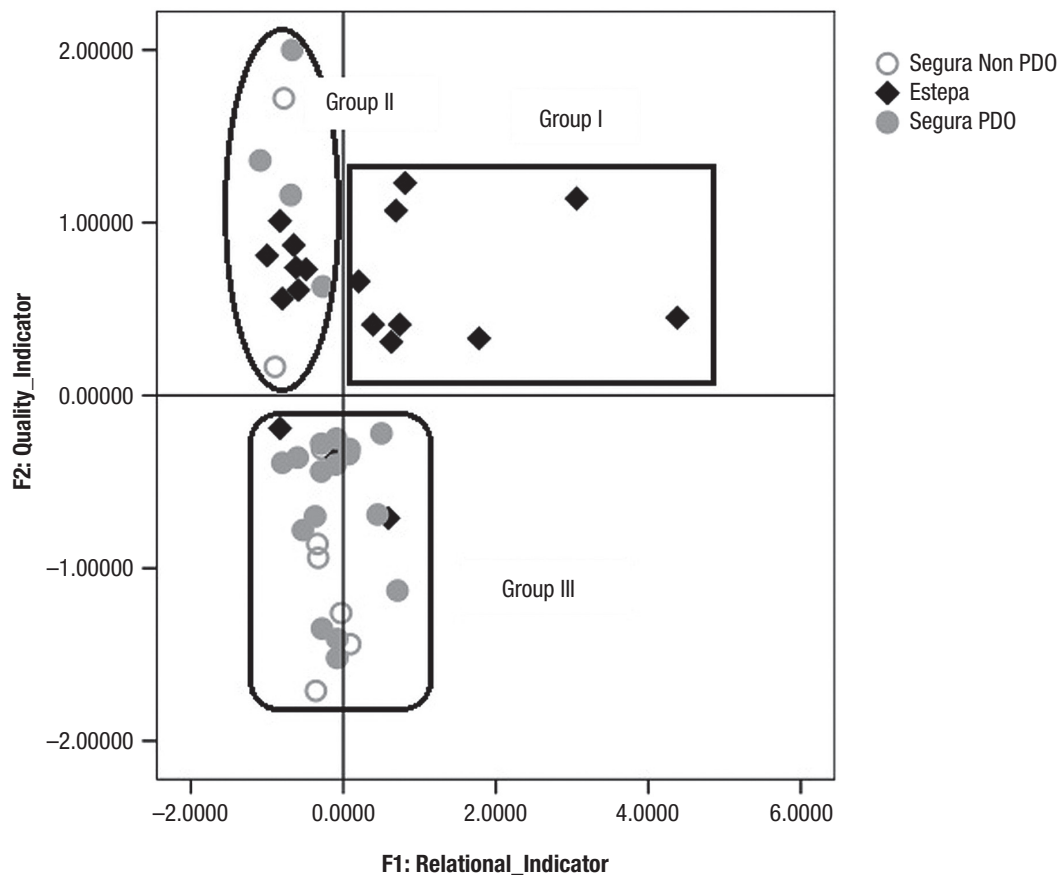
Figure 4. Factorial plan: values obtained by olive oil mills in the two first factors

The second factor (ordinate axis) represents the quality level reached by the firms (quality indicator) and concentrates 26.54% of the total variance. The "early harvesting" and the "percentage of extra virgin olive oil" have high correlation coefficients with the factor (0.83 and 0.77). On a second level, "existence of other quality certifications", "milling within 24 hours", "awards" and "temperature of processing" obtain significant values of correlation coefficient. This factor differentiates the mills which obtain a greater value in quality of processes and products from those which have opposite characteristics.

Fig. 4 is a factorial plan which includes the values obtained by the mills with regard to the two first factors. We use a different symbol to represent the categories of olive oil mills depending on whether they belong to a PDO or not, and their territory of origin ("PDO Sierra de Segura", "Non PDO Sierra de Segura" and "PDO Estepa"). The mills are classified into three groups according to their factorial scores. To characterize the groups we have also used other

variables obtained from the survey to the mills: "size of the firm", "development of activities in collaboration with other mills" and if the firm has a "manager" and a "commercial team".

Group I includes 9 firms which are characterized for having a level of relational capital from medium-high to very high, and for a value of quality level from medium-high to high. All belong to the PDO of Estepa, as well as to Oleoestepa. Large cooperatives predominate (56%). Most of these have a manager (70%) and 80% also develop some kind of collaboration activity with other mills. Here are found the olive oil mills of Estepa which provide advice.

Group II includes 13 mills which are identified by obtaining medium-high to high values in the quality indicator and medium-low values in the relational indicator, despite the fact that many of them have consolidated links with other innovator non-local agents, as is reflected in the interviews. This group is characterized by being constituted mainly by small sized mills (70%), which are distinguished by having a professio-

nal management strategy, as 80% have a manager and some of them have a commercial team; the latter is clearly a differentiating element with respect to the other groups. Most of the firms do not carry out collaboration activities (77%). Within this group are included privately held firms from both PDOs and some smaller cooperatives which are professionalizing their companies gradually, as well as the three organic mills of Sierra de Segura.

Group III includes 25 firms and is characterized for having its mills with negative values in the quality indicator, from moderate to quite negatives, as well as having an intermediate position in the technical-managerial networks. This group refers, in general, to the traditional cooperatives, 60% small sized and 25% medium sized. It includes an important part of the cooperatives of the PDO of Sierra de Segura and only three from the PDO of Estepa, as well as the cooperatives of Sierra de Segura which do not belong to the PDO. A large majority of the mills neither carry out collaboration activities (80%) nor have a manager (84%).[25]

Discussion

The local olive oil development institutions, whose aim is collective action, such as the RBs or second-step cooperatives, have a privileged role in the local organization of quality. The results of the empirical analysis, through the elaboration of a quality synthetic indicator for the mills and the information provided from the interviews, show that the LAFS of Sierra de Segura is still immersed in the phase of making good quality practices widespread among all the local olive oil mills. It has progressed well in a good part of the firms, but not completely. On the one hand, a limited number of mills are at the forefront regarding differential quality production in Spain and, on the other, there is still an important group that has not been able to get over this first phase: the firms stratum of the PDO which is falling behind and the mills which do not belong to the PDO. The LAFS of Estepa is in an advanced stage of local organization and promotion of quality, in which the phase of spread of good quality

practices among local farmers and mills has concluded. At present, it is in a second evolutionary phase, in which the differentiation of olive oils by their quality is being emphasised in order to enhance its value in the market.

A certain body of geographical and socio-economic literature dedicated to the study of LAFS has highlighted the inter-professional role of some local agro-food institutions that enhance local collective action devoted to the organization of quality, such as the PDO Regulatory Boards or the second-step cooperative companies. Particularly, some contributions focus on the institutional analysis of local networks of knowledge and innovation (Sanz-Cañada & Macías-Vázquez, 2005; Tregear *et al.,* 2007; Muchnik *et al.,* 2008; Barham & Sylvander, 2011; Chiffoleau & Touzard, 2014; Crespo *et al.,* 2014). These theoretical approaches and empirical studies have in common the existence of a dense spatial entrepreneurial network and a diversified and locally specialized institutional ambience. Empirical analyses reveal that the collective action structured around the organisation of local quality (*i.e.,* certification, marketing) can generate territorial externalities in areas of non-compulsory action.

The cases studied in this article also correspond to the model of LAFS which have a dense spatial entrepreneurial network and a diversified, complete and locally-specialized institutional framework. Moreover, belonging to collective institutions is quite relevant in both cases, practically entirely in the case of Estepa. In addition, the technical/managerial advice networks of both LAFS can be described as cohesive and the graphs as connected. As a result, there is more than one path for the information to flow from one actor to another and a significant relational reciprocity between pairs of nodes. However, this connectivity is strong in the LAFS of Estepa, but weaker in Sierra de Segura. In the latter, when the integrating poles are removed, the results of network simulation indicate that the strongly connected component is fragmented into three components, which in turn are formed respectively by few actors. It is worth noting the existence of a significant level of advice provided by the regional research and innovation centres, the local institutions for agri-

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[25] The differential behaviour of the olive oil mills in both territories – Estepa and Sierra de Segura –, showed by the factor analysis, was also found by performing a Pearson correlation test between the QSI and the four relational indicators issued from the SNA. Whereas there is a significant correlation between QSI and the "input degree" (0.53, $p < 0.01$), as well as between QSI and the "weighted input degree" (0.61, $p < 0.01$) in the Estepa case, there are no significant correlations among any of the variables in Sierra de Segura.

food development and the professional associations, which benefits the professionalization of advice in both LAFS.

Modes of local organization of quality and marketing vary widely at international level, due to a great diversity of institutional local models and to a great range of historical, cultural, agricultural, socio-economic or environmental factors. The core objective of developing a local network of knowledge and innovation is to foster a high level system of quality for the whole population of farmers, companies and other local stakeholders. Consequently, advice relationships also follow different local organisational patterns, according to the level of concentration of the functions of advice in the different agents, the directionality of the assessments or the type of information given, among other aspects.

In the LAFS of Estepa and Sierra de Segura, the pattern of advice has been developed in a "top-down" direction, which is also frequent in other Spanish PDO areas. In fact, the relations are mainly unidirectional, as the consultations go in general from the mills to the inter-professional institutions. Advice in technical aspects predominates over that of the organizational/commercial type, although the latter has in these LAFS an increasing importance, higher than in many Spanish olive oil production areas. In contrast to the poorly and little specialized density of direct collaboration relationships between local mills in both cases, the institutions which have historically promoted interprofessional organization at local level are in turn the main recipients of requests for advice. The indicators of the input degree prove that there is a high level of concentration of advice functions in a limited number of actors in both areas.

On this point, our analysis is concerned about the existence of networks as a necessary condition to improve and homogenize quality in a diffuse local agrofood structure. In the case of Estepa and Sierra de Segura, as organizational models of local quality that follow a top-down pattern, we have tested the hypothesis that the Regulatory Boards, as well as the second-step cooperatives, can assume a role of integrating poles with respect to the collective action developed in the LAFS, particularly in terms of dissemination of knowledge and innovations, which enhances the processes and product quality of local firms. We have used the quantitative information from the SNA and the factor analysis, as well as the qualitative information obtained from the interviews with the key

actors. An integrating pole means a clear prominence in the coordination relationships of the actors of the LAFS, in the stimulation of innovative initiatives and in the control of information flows. We summarize in the next two paragraphs the main findings concerning the verification of the hypothesis.

Firstly, the main integrating pole of the LAFS of Estepa is the second-step cooperative Oleoestepa, although the RB maintains close relationships of collaboration with it: both institutions combine efforts in the same direction for the promotion of olive oil quality. In Sierra de Segura, the RB and the second-step cooperative Olivar de Segura are the main integrating poles. In addition, the OCA, together with firms, associations and institutions dedicated to organic olive oil, constitute an emergent pole in Sierra de Segura which has multiple relationships of transference of knowledge with the external world of organic agriculture. However, the institutions and mills are interconnected with each other in Sierra de Segura, but without the cohesiveness that appears in Estepa: not all the mills belong to both institutions and the connectivity of the local network has points of potential fragmentation. On the other hand, the integration of ATRIAs or APIs in these institutions – Oleoestepa and the RB of Sierra de Segura –, is a crucial organizational innovation in the dissemination of the technical progress in olive farming.

Secondly, through the elaboration of the olive oil mills typology according to relational and quality indicators, it was verified that the mills which do not belong to a PDO, as well as most of those which do not belong to a second-step cooperative, obtain values lower than the average in those indicators. Thus, the LAFS of Estepa has a very high and generalized level of quality in most of its firms and also has a central core of cooperative mills which disseminate knowledge and innovation beyond the integrating poles. In the case of Sierra de Segura, the mills which have a high level of quality – privately owned, organic and some cooperatives – do not become actors of reference, due to their medium-low centrality level. As a result, the potential for dissemination of innovations and knowledge of the latter group of mills is not transmitted with fluidity to all the other mills of the LAFS and, particularly, to the traditional cooperatives (those included in Group III).

Nonetheless, the top-down pattern of the local organisation of quality shows significant differences in both areas. Although the LAFS of Estepa has an inter-professional organizational model which is

monocentric, around the second-step cooperative, local cooperatives obtain high values in the indicators of the relative position of the actors and even a central core of firms obtain very high indicators in the input degree. A positive fact is the emergence of new intermediation nodes of firms in the dissemination of knowledge, which can transcend and complete the "top-down" initiative of the local inter-professional organizations: it also signifies democratization in the innovation and knowledge. The LAFS of Sierra de Segura shows an organizational model more polycentric. Its three integrating poles obtain high values in the indicators of relative position, as it is the case, but at a lower level, of some mill cooperatives.

The article has intended to provide a methodological tool aimed at typifying firms and institutions according to their connectivity and their results with regard to the quality of processes and products. These entrepreneurial typologies may have various forms of usefulness when applied to the design of public territorial policies. For example, we can detect which group of companies it is necessary to strengthen, from the point of view of connectivity, in order to disseminate knowledge more homogeneously and obtain collective synergies in technical and commercial quality. Moreover, a contribution has been made to the creation of various synthetic indicators on agro-food firms focusing on LAFS, both regarding quality of processes and products – the QSI, made with an additive scale, and the quality indicator of the factor analysis – and the technical/managerial advice links – the relational indicator of the factor analysis.

Nevertheless, we can firstly emphasize, as limitations of the study, the difficulties of extrapolating results when analyzing only two territories. These two "top-cases" of PDOs have been chosen because of their explanatory power, as a possible pattern for other PDOs having a smaller degree of territorial governance. In order to obtain more robust results, further applications of this methodology are needed for PDOs with different schemes of governance. Secondly, further developments in SNA techniques appeal to the possibility of using methods of "structural equivalence" in order to detect regularities in the patterns of relations among actors. Therefore, it might serve to characterise better the different territorial governance models of integrating poles assumed by Regulatory Boards or by second-step cooperatives.

Finally, we consider it necessary to continue providing research and empirical evidence on the role of collective action in the dissemination of innovations and knowledge, particularly in local systems of inter-professional organization of quality, which is the backbone of the literature on LAFS. In this sense, we have wished to contribute to the demands of quantification and typification of the inter-institutional relations in the LAFS, using relational social capital indicators. We consider that this line of research is important to advance in the characterization of the great variability of organization structures and mechanisms for the dissemination of knowledge, to which is added the variability of the natural environment, cultures and local agriculture. The progressive construction of more connected networks of innovations and knowledge, as well as the consolidation of the role of local firms more self-sufficient with regard to information, are key functions of the PDOs and other local inter-professional organizations devoted to the enhancement of agro-food quality.

Acknowledgments

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