Article

Economic Efficiency in the Tunisian Olive Oil Sector

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Abstract: This study aims to assess the economic efficiency of Tunisian olive oil firms in order to identify the organizational and technological variables that are directly associated with greater efficiency. The Data Envelopment Analysis (DEA) and fuzzy sets Qualitative Comparative Analysis (fsQCA) method were used to achieve this. We find the managing director’s education level and information and communication technologies (ICT) training, the longevity of the company in inverse relationship with efficiency, the company’s presence on and use of virtual social networks, and the outsourcing of ICT management in combination have significant explanatory power in the companies that display greater economic efficiency.

Keywords: olive oil sector; information and communication technologies (ICT); efficiency

1. Introduction

The olive is a crop native to the Mediterranean basin, where its main products, olive oil and table olives, are key staples of what is commonly referred to as the “Mediterranean diet”. Olive oil production is undergoing constant growth on an international level, tied not only to a steady worldwide increase of the olive growing area, with more intensive plantations, but also to improvements in irrigation systems and technological advances [1]. In terms of demand, the benefits and attributes associated with olive oil have boosted consumption, although olive oil still represents scarcely 2% of total worldwide consumption of oils and fats [2,3]. However, consumption has been growing at between 2% and 3.9% per year, which is why companies are interested in this product [4]. According to the International Olive Council [5], total world consumption of olive oil is expected to reach 3,094,000 tons by 2019–20 and production 3,144,000 tons. The most widely consumed oils in the world are soybean and palm, which together account for more than 50% of total consumption [2,3].

Nevertheless, it remains a key strategic sector, due to the important weight it carries within the agricultural sectors of the main producing countries. Tunisia is the second largest producer after the European Union [5], hence the importance of its analysis. However, there is much room for improvement in the profitability of the sector, which is facing serious commercial problems due to its failure to market to the end consumer, the majority of producers opting instead to sell their oil to distributors in bulk.

The olive oil sector plays a highly significant role in Tunisia, not only economically but also in environmental and social terms. Olive groves occupy 36% of the total arable land and 79% of...
the total area dedicated to arboriculture, stretching across the whole country from north to south, with varying density depending on rainfall. In the south, where rainfall is very low, the olive is a highly drought-resistant growing option and therefore plays a vital environmental role. Indeed, 95% of Tunisian olive groves use traditional dryland farming techniques with almost no chemical fertilizers. Despite its negative repercussions on yields and fluctuating production stability, this farming system has contributed significantly to the uptake of organic growing as it is easy to convert to the organic system. A large part of the traditional dryland growing area (254,411 ha. at the time of study) has therefore now been converted to the organic system, making Tunisia one of the largest producers and exporters of organic olive oil in the world [6].

The main problem in the olive sector, both in Tunisia and in other producing countries such as Spain (the world’s leading producer), is that of trade. The lack of concentration in the production sector means that many suppliers are faced with few distribution chains that act as demanders and the latter have the bargaining power to offer lower prices [7]. On the other hand, the marketing of Tunisian olive oil has long followed a traditional model with little added value. This model, based mainly on the sale of olive oil in bulk, mainly to Italy and Spain, has shown its shortcomings, thus affecting negatively the image of Tunisian olive oil. In addition, there are other structural and organisational weaknesses of olive farms, such as their longevity, small size and low level of training and professionalization of human capital [8]. The State, aware of the importance of reversing this situation, has taken many measures among which the programmes of incentives for the bottling of olive oil and the programmes for the improvement and modernisation of the companies and the olive groves stand out [9].

However, the consumption of olive oil is hampered by three problems, which are aggravated when this product is organic [10–12]: the first one is the misinformation of the consumer, who does not know the attributes and benefits of this product for health; the second one is the price, ignorance of the advantages and qualities of the olive oil leads the consumer to acquire other more economic substitute products; and the third great problem is the distribution channel, whereby the lack of proximity of the offer to the consumer makes the great distribution companies the main sales channel of the olive oil, so that the producer has very little negotiation power with these companies. One of the possible solutions to all these problems can be found in the use of information and communication technologies (ICT henceforth) [13,14]. Farmers have at their disposal tools that can help them move more easily through the value chain for this product. In addition, certain agricultural products, which are experiential due to their intrinsic characteristics, are particularly suitable for marketing on the Internet [15].

In the current commercial climate, technology plays a key part in firms’ strategies to compete and improve. The Internet has driven a technological revolution in the use and distribution of information. Information and communication technologies have come to be regarded as a powerful competitive tool and, in fact, a basic necessity to successfully compete in the current market [16]. The World Economic Forum [17] ranked Tunisia first in Africa in terms of the use of ICTs in several strategic sectors, namely the industrial and service sectors.

Taking full advantage of these media—especially the Internet, which now reaches more than 55% of the world population (Found on: https://www.internetworldstats.com/stats.htm. Revised in August 2020)—makes good business sense in the context of an increasingly technological society. Several theories, such as that of transaction costs, have been used as a springboard from which to argue how ICTs benefit company performance [13]. Indeed, the costs of search and information, bargaining and enforcement have been reduced through the use of these media, allowing firms to provide more economical, personalized and efficient customer care [18,19].

It follows from the above that the use of ICTs should, in principle, contribute in itself to raising the performance of firms investing in this type of asset. However, empirical work shows no conclusive results in this respect [20]. Many studies suggest that ICT is a necessary, but not sufficient, factor for improving productivity in firms [21–23]. Indeed, investment in ICT alone cannot explain the productivity gains of ICT-using firms, but must be accompanied by a series of additional measures, such as investments in
training and other organizational or strategic factors [24,25]. Along these lines, the work carried out by Bernal et al. [26,27], focusing on the Spanish olive sector, identifies a series of variables, such as business size, the outsourcing of ICT management or human capital training, which, combined with the use of ICTs, are associated with greater efficiency of the organisations which use them.

Against this backdrop, this study aims to assess the economic efficiency of Tunisian olive oil firms in order to identify the organizational and technological variables that are directly associated with greater efficiency. The Data Envelopment Analysis method was used to achieve this, taking into consideration the most typical and relevant variables associated with business outcomes. For this purpose, a classic economic efficiency model was used, considering as output the volume of invoicing and as inputs the main expense items of the company. Subsequently, in the second stage of analysis, the fuzzy sets Qualitative Comparative Analysis (fsQCA) method was applied to the efficiency scores obtained in order to identify the factors that explain a higher level of efficiency. The organizational and technological variables used in this second phase of study were: the age of the organization and the academic and ICT training of the management, the use of social networks and the technological management, whether internal or external to the organization. This research contributes to the scientific literature by indicating the variables associated with greater economic efficiency, as a guideline for the development of this sector in Tunisia. The results follow a line of research that has been pointed out in other studies and the conclusions coincide with previous studies in other countries [8,19,28].

In accordance with the study objectives, this paper is structured as follows: following this introduction, the contextual framework is described, setting out the study hypotheses; the methodology section then describes the technical characteristics of the research; following this, the results are reported; and to finish, the corresponding conclusions are drawn.

2. Theoretical Argumentation of the Proposals

2.1. The Tunisian Olive Oil Sector

Olive growing plays a very important social role in Tunisia, with more than 309,000 growers accounting for 20% of the active population in the primary sector [29]. Furthermore, this sector significantly strengthens the industrial and commercial infrastructure of the country. It currently boasts more than 1750 oil mills, 15 refining plants, 14 olive pumice oil extractors, over 35 bottling plants and more than 200 private sector traders and exporters, as well as the national oil office and state-owned public domains [30]. There are few producers that have control over the whole value chain except for a handful of large producers, organic producers and state-owned agro-complexes [31].

Olive oil is a strategic product both for Tunisian agriculture and for its economy as a whole. Indeed, it is the first agri-food product to be exported. In the last five years (2015–2019) the production of olive oil has been estimated at 196,000 tons, of which 165,000 tons have been exported, representing 84% of the total produced. The volume of oil exported by Tunisia represents 20% of world exports (without taking into account intra-community exports) [32]. The export of olive oil occupies first place in the Tunisian agro-food trade balance, both in quantities and in value of exports, and represents more than 50% of the total value of the agro-food exports of this country [33] (Table 1). With an average value of 1277 million Tunisian dinars (average 2014/2018) [33], olive oil exports represent about 5% of total Tunisian exports and about 1.4% of the country’s GDP.

| Indicator                  | 2014  | 2015  | 2016  | 2017  | 2018  |
|----------------------------|-------|-------|-------|-------|-------|
| Olive oil                  | 490.2 | 1891.9| 872.4 | 1009.4| 2125  |
| Fish, crustaceans and molluscs | 231.5 | 252.3 | 270.9 | 357.3 | 463.7 |
| Dates                      | 388.4 | 445.3 | 486.5 | 557.3 | 744.1 |
| Citrus fruit               | 21.8  | 23    | 24.7  | 21.1  | 22.6  |

Source: Institut National de Statistique Tunisien [33].

Table 1. Main products exported (in millions of dinars).
This situation is the result of public policies to incentivize olive oil exports. Until 1962, the domestic market for vegetable oils was fully supplied by olive oil produced in the country. From this date onwards the Tunisian government resorted to a policy of exporting olive oil in bulk and importing seed oils, with the twofold objective of protecting the purchasing power of low-income households and promoting olive oil exports. This policy made it possible, on the one hand, to stabilize the balance of payments, and, on the other to promote the olive oil sector by widening the olive-growing area and modernizing the corresponding industrial infrastructure, increasing both processing and storage capacity [34].

As a result of this policy and the preferential export deals signed with the EU in the 1980s, Tunisian olive oil exports saw a steady increase in their share of international markets, which currently stands at 19% of total world olive oil trade. However, for a long time these exports were highly concentrated geographically and were sold in bulk with low added value. Indeed, historically Tunisia only exported olive oil to a few EU countries (the traditional markets), namely Italy, Spain and France. These target markets are now much more diversified thanks to their new strategic approach of modernizing production facilities and adding greater value to the product, either through packaging or quality labels, such as the label that certifies organic origin [35].

In response to its new challenges, the Tunisian olive oil sector now benefits from a national development strategy that aims to boost production and reduce fluctuations in annual output by expanding the growing area into more adequate soils, improve olive oil quality through the modernization of production processes, improve international market positioning to gain greater product visibility through diversifying end markets and targeting markets with greater added value, and improve export shares of bottled oil and organic olive oil. A series of innovative and promising measures and initiatives have been implemented to fulfil these objectives. In this regard, various funds have been set up to support export activity and provide a favorable framework for investors [30].

2.2. Proposed Development Factors for the Tunisian Olive Sector

One of the key factors identified for modernizing olive oil enterprises is the use of ICT and e-commerce. In the Tunisian olive oil sector, there is very little information available on the role of ICTs in firms, their management and level of training of heads of company in order to maximize their potential. Among the few existing studies on this topic, we should highlight these [8,36–38]. The first three papers stress the importance of ICTs in industrial firms in Tunisia and their role as facilitators of new opportunities for socioeconomic growth and regional balance. As regards the olive oil sector, the study conducted by Bakir et al. [8] on olive oil producers in the Sfax area (Tunisia) argues that the profile of the head of the company is of paramount importance for its development of ICTs. In this regard, it highlights the role of younger companies in developing ICTs as they have led the way in this trend. The managers of these firms are generally graduates with a higher level of education and specific training in ICT, while the majority only operate at user level.

In this regard, we should point out that the managing director/CEO of the organization has often been flagged as a determining variable of business success [28]. To be more specific, numerous studies have argued the relevance of the education level of managing directors as a determinant of the economic efficiency of organizations [39], as their knowledge will stimulate their drive to innovate and implement more efficient business practices [40]. Similarly, a managing director’s training in ICT is vital in order for the organization to adopt these tools and improve economic performance [41]. Directors who are trained in these technologies will be more aware of their importance and will devote greater effort to using them properly and to fostering innovation, thus contributing to greater economic efficiency in the firm [42]. Arguments such as these lead us to formulate the following hypotheses:

Hypothesis 1 (H1). The high education level of the head of an organization favors its economic efficiency.

Hypothesis 2 (H2). The specific ICT training of the head of an organization favors its economic efficiency.
The longevity of an organization is also considered to affect its stance on innovation [43]. In this regard, authors such as Pavitt [44] argue that older companies may find it more difficult to innovate, since they have become entrenched in organizational and commercial automatisms that make them more reticent to change, thereby resulting in a worse business performance. Innovation and market targeting are key to profitability in the agri-food sector [45]. Moreover, it has also been pointed out that younger companies are more likely to innovate and adapt better to markets [46], which translates into better organizational practices and greater economic efficiency. In the same vein, Czarnitzki and Delanote [47] indicate that young companies tend to grow faster and thus achieve better performance, especially those that are committed to innovation. In view of these assertions, the following hypothesis is proposed:

**Hypothesis 3 (H3).** Younger and more innovative companies are more economically efficient.

ICT has the potential to reduce transaction costs by improving the efficiency of business actions along the value chain [48]. Numerous studies agree that a high level of innovation and a commitment to ICT improve the productivity of organizations and allow them to operate more efficiently [40]. Social networks are a powerful tool that can generate considerable economic value in an organization by attracting consumers and building customer loyalty [17]. The use of virtual social networks as a communication channel and relationship marketing strategy boosts sector competitiveness and thus the efficiency of the organization [49]. So, a proper use of these media can lead to increased productivity in the organization [18,50]. However, it is essential to bear in mind that a company merely being present on social media is not enough, if it does not go hand in hand with a solid commitment to them [51]. These arguments lead to the following hypothesis:

**Hypothesis 4 (H4).** Companies that use social networks are more economically efficient.

The internal management of an innovation is considered a relevant factor for the development of organizations, as well as for gaining competitive advantages [52]. Having members of staff who are trained and qualified in the various applications offered by the Internet will permit their efficient use and exploitation [53]. However, olive oil firms generally lack this kind of qualified personnel [54]. This problem can be addressed by outsourcing these duties to trained professionals who can manage ICTs correctly. The resources allocated to this virtual environment and the competent management of these online tools will determine the results obtained from them [55]. According to He, Wang, Chen and Zha [56], social network management requires dedicated professionals, and outsourcing these tasks is the best way to maximize their use, especially in organizations that lack the means to adopt these technologies. This line of argument leads us to formulate the following hypothesis:

**Hypothesis 5 (H5).** The external management of ICT favors economic efficiency.

3. Materials and Methods

This study focuses on analyzing the olive oil sector in Tunisia, one of the world’s top producers of olive oil. In order to define the target population, we contacted the Tunisian Agency for the Promotion of Industry and Innovation, a public institution where industrial and agri-food companies can register in order to benefit from grants, support and monitoring of their business projects. This register, which is the one that authorizes the development of the activity, indicates that in Tunisia there are 351 companies dedicated to the activity of olive oil marketing. Once the population had been determined, an Internet search was performed to determine the number of companies with their own website, resulting in a total of 90, which were taken as our target population or study universe. The managing directors were then invited to participate in a structured face-to-face survey, to which 47 companies agreed (52.22% response rate).
With regard to the methodology used, firstly an economic efficiency analysis was conducted on the Tunisian olive oil companies, applying the Data Envelopment Analysis method (DEA hereafter). DEA is considered one of the main methods of efficiency analysis in terms of popularity and use [57,58]. The purpose of this method is to compare different homogenous decision-making units (DMUs), evaluating the influence of a set of production factors or inputs used to obtain outputs and assigning a level of efficiency between 0 and 1. Therefore, based on linear programming and considering identical inputs and outputs, it allows us to determine the enterprises that are fully efficient (score equal to 1), which lie on what is referred to as the efficient frontier [59].

Of the different DEA variants, the classic BCC model was selected, which evaluates inputs and outputs considering variable scale yields [60]. Furthermore, the model chosen was output-oriented, aimed at maximizing outputs, as this was considered more fruitful in view of the considerable commercial challenges faced by these agri-food enterprises, and also of their agricultural nature in itself as the inputs are subject in part to the seasonality of the crop. Similarly, one of the main weaknesses of DEA lies in its sensitivity to extreme values [60]. To mitigate this handicap, the super-efficiency method was used, removing any observations that exceeded an efficiency threshold of 2 and could be considered atypical or outliers [61]. This process thus reduced the number of companies analyzed to 46.

The primal approach of DEA with the BCC-O model is: \( \max (\emptyset, \lambda, s^+, s^-) z_0 = \emptyset + \lambda s^+ + \varepsilon - 1 s^- \)
subject to the following conditions: \( X + s^- = X_0; 1 = 1; s^+, s^- \geq 0 \). In this case, if \( \emptyset = 1 \), the unit is considered efficient, meaning that there is no other unit that produces more or that achieves the same output using fewer resources. If this model is used, all efficient units return the same value (\( \emptyset = 1 \)), so it is not possible to establish a ranking. With the use of the super-efficiency method created by Andersen and Petersen [62] this restriction is eliminated, therefore previous studies have taken advantage of this approach to remove very distant values considered outliers.

The model used and the variables applied in this research are those commonly used in the scientific literature for the study of the economic efficiency of the productive process. The output used was sales volume and the inputs used were personnel expenses, raw material and material expenses and depreciation of tangible fixed assets. Thus, the model has been based on previous studies on efficiency in agricultural enterprises [63–67].

Moreover, a second study phase is often encountered in the literature that complements the DEA analysis, in order to characterize or strengthen the efficiency results obtained. Among the different procedures used in this second stage the use of regression models is common, with a view to determining the contextual variables that explain the resulting efficiency scores [60]. An intense debate has been generated over which statistical procedure best suits this purpose [57]. For the purposes of this study, the Qualitative Comparative Analysis (QCA) method was chosen for the second stage, using the fuzzy sets (fsQCA) approach in order to establish variables of a technological and organizational nature that in combination are associated with a higher level of efficiency. It is precisely the DEA efficiency indices obtained in the first stage that act as a dependent variable in this second stage.

The QCA technique, based on Boolean algebra, makes use of a verbal, conceptual and mathematical language that bridges both qualitative and quantitative assessment, combining the main advantages of the two [68]. QCA therefore makes it possible to systematically analyze a set of cases to determine causal patterns, in the form of relationships of necessity and sufficiency, between a set of conditions and an outcome [69]. The fuzzy sets (fsQCA) method is one of the most widely used variants of QCA, as it resolves one of the main drawbacks and criticisms of the initial approach known as csQCA, i.e., its strictly dichotomous character [70]. The fsQCA method was designed for small samples or populations [68], which does not constitute a drawback for this research as the study universe is small. The steps recommended in the literature for executing this method correctly [71] were followed: calibration of the variables where necessary, both of conditions and outcome; analysis of necessity; and analysis of sufficiency.
fsQCA reports one or more antecedent combinations which are sufficient to obtain a concrete outcome, such as: $X_1 \cdot \neg X_2 \cdot X_3$ sufficient for outcome $(Y)$, or expressed in the notation system of this method ($(X_1 \cdot \neg X_2 \cdot X_3) \rightarrow Y$), where $X_1$, $X_2$ and $X_3$ are antecedents; $Y$, the outcome; $\cdot$ indicates “AND”; and $\neg$ absence or negation, in this case the opposite value to $X_2$ ($1-\neg X_2$) [68]. In our case, we used as output the efficiency results obtained through DEA and as inputs different organizational and technological variables, such as: the managing director’s education level and ICT training, the longevity of the company, the company’s presence on and use of virtual social networks, and the outsourcing of ICT management.

4. Results and Discussion

As a first approach to the Tunisian olive oil sector, the average value was determined of the variables that were used to determine economic efficiency through DEA (Table 2). To reduce the sharp fluctuations that these variables can undergo from one year to the next due to the alternate bearing nature of the crop (Alternate bearing refers to the tendency of a tree to produce abundant fruit one year but not the next. This means that harvests alternate between higher and lower yields. Olive trees tend to be highly alternate bearing), a three-year average was calculated (for 2014, 2015 and 2016).

| Variables                          | Average Values (2014, 2015 and 2016) |
|------------------------------------|--------------------------------------|
| Input Staff costs                  | 91,994 €                             |
| Input Expenditure on raw materials and other materials | 6,371,712 €                       |
| Input Depreciation of property, plant and equipment | 34,400 €                                 |
| Output Turnover                    | 8,845,954 €                           |

Source: own data.

Table 3 shows the efficiency results obtained through DEA using the output-oriented BCC model. As we can see from the table, the number of organizations considered fully efficient is low: only 6 of the 45 are on the efficient frontier, representing 13.33% of the total number of companies analyzed. On average, the efficiency level obtained considering all DMUs is 0.60, which together with the standard deviation reveals that there is a great distance between the companies on the efficient frontier and the rest.

| Indicators                  | Values     |
|-----------------------------|------------|
| Number of efficient DMUs    | 6          |
| Percentage of efficient DMUs| 13.33%     |
| Average efficiency          | 0.60       |
| Standard deviation          | 0.23       |
| Average inefficiency        | 0.40       |

Source: own data.

We should point out that in this context the companies shown to be highly efficient are the large ones that hold more control over the value chain, such as the state-owned agro-complexes. This control involves a complete quality control process, which has an immediate and positive effect on turnover, as well as a greater control of expenditure on raw materials (purchase of olive trees in this case to supply the oil mills) [72]. Indeed, small and medium enterprises in Tunisia currently find it difficult to compete with large companies without having new strategies to differentiate and reposition themselves in the market and they seek out new forms of alliances, especially through export consortia [73]. Ben Ayed [36] also highlights the lack of efficiency of small and medium enterprises compared to large...
ones in developing countries, particularly in Tunisia, stressing the role that the export rate of such enterprises can play an important part in improving efficiency.

Continuing with the analysis, to determine the factors associated with a higher efficiency score the fsQCA method is used together with different organizational and technological variables considered in the study and which were taken into account to obtain the data. For this second analysis, the efficiency scores obtained through DEA were considered as a result variable. The rest of the variables that make up the model are listed in Table 4.

Table 4. Variables considered for the fsQCA method.

| Outcome       | Description                                                                 |
|---------------|-----------------------------------------------------------------------------|
| BCC scores    | Results of DEA economic efficiency model                                    |
|               | Continuous variable                                                         |
| Causal condition | Description                                      |
| oson          | Use or not of virtual social networks                                       |
| old           | Longevity of organization (years)                                           |
| education     | Education level of managing director                                        |
| ict.training  | ICT training of managing director                                           |
| outsourced    | Outsourcing or not of the management of social networks                     |

| Causal condition | Description                                                                 |
|------------------|-----------------------------------------------------------------------------|
| oson             | Dichotomous variable                                                        |
| old              | Continuous variable                                                         |
| education        | Categorical variable 1                                                      |
| ict.training     | Categorical variable 2                                                      |
| outsourced       | Dichotomous variable                                                        |

1 Five-level categorical variable (no education; primary level; secondary level; first-level university degree; second-level university degree). Calibrated according to Rihoux and Ragin [74]. 2 Four-level categorical variable (no knowledge; user level; intermediate level; advanced level). Calibrated according to Rihoux and Ragin [74].

Table 5 shows the main descriptive statistics of the variables used in this second phase of analysis. In the case of the variables ‘Education’ and ‘ict.training’, mode has been used, as it is the most appropriate statistic for this type of variable.

Table 5. Average value of variables considered for the fsQCA method.

| Variables    | Mean/Mode | Desviation | Max | Min |
|--------------|-----------|------------|-----|-----|
| oson         | 0.91      | 0.29       | 1   | 0   |
| old          | 25 years old | 21.23     | 88  | 4   |
| education    | first-level university degree | 0.17 | 5   | 1   |
| ict.training | intermediate level | 0.25 | 4   | 1   |
| outsourced   | 0.25      | 0.43       | 1   | 0   |

Source: own data.

From the results obtained (Table 6), we can see that the first combination displays a gross coverage of 65%, which highlights the relationships between the use of virtual social networks, the education level and the ICT training of the managing director as a set of variables that explain greater economic efficiency at this level. Similarly, the second causal combination also includes the use of virtual social networks, together with young companies and the education level of the managing director, as a set of explanatory variables for greater efficiency, with a gross coverage level of 52.58%. The presentation of fsQCA results generally entails an explanation of the two most significant causal combinations, although we can also consider explaining a third. In this case, the causal combination with the third highest gross coverage, at 41.13%, consists of young companies, outsourced ICT management and, once again, a high level of education and ICT training of the managing director as a set of explanatory variables for economic efficiency.
Table 6. Results of fsQCA analysis.

| Causal Configurations                                      | Gross Coverage | Single Coverage | Consistency |
|------------------------------------------------------------|----------------|----------------|-------------|
| Osn * education * ict.training                             | 0.650286       | 0.166343       | 0.864125    |
| Osn * ~ old * education                                    | 0.525870       | 0.015824       | 0.805545    |
| ~ old * outsourced * education * ict.training              | 0.411527       | 0.027967       | 0.901428    |
| Osn * ~ old * outsourced * ~ ict.training                  | 0.367484       | 0.030318       | 0.847013    |
| Old * outsourced * ~ education * ict.training              | 0.366444       | 0.034726       | 0.867423    |

Solution coverage 0.863237  
Solution consistency 0.780380

Source: own data.

The sign “~” denotes the absence of a condition and “*” indicates the combination of sufficiency conditions. This interpretation is typical of the fsQCA methodology and the Boolean algebra on which it is based [68]. As an example, recent articles use these same symbols and interpretation [75,76]. This model presents an overall coverage of 86.32%, which indicates the proportion of organizations that are explained by the variables considered, and a total consistency of 78.03% of cases. The results obtained are in line with previous studies which have demonstrated the positive impact of the use of ICTs on the efficiency of Tunisian firms. Indeed, Ben Ayed [36] confirms that ICT-intensive firms are more technically efficient than other firms; Kosai and Piget [37] also find a statistically significant relationship between ICT use and the profitability of small and medium-sized firms in Tunisia. However, no other studies set in Tunisia were found to address the relationship between economic efficiency and the level of education and training of managing directors or the age of companies.

5. Conclusions

As mentioned above, the world economic forum identified Tunisia as the first African country to use ICTs, setting an example for the rest of the continent. On the other hand, according to the International Olive Council, after the EU, Tunisia is the second largest producer of olive oil in the world. The trade problems that have been detected point to the use of ICTs as a tool that can lead to improving the competitiveness of Tunisian companies. This study aims to analyze the economic efficiency of olive oil marketing organizations in Tunisia in order to identify the organizational and technological variables that are directly related to greater efficiency. With regard to our objective of conducting an economic efficiency analysis of Tunisian olive oil firms, the results obtained through the DEA method show that only a very small number of firms can be considered efficient. These firms would be those that lie on the efficient frontier based on the inputs and outputs used. The fsQCA analysis allowed us to determine the proposed variables that could be considered relevant explanatory factors for achieving greater economic efficiency. Among them we find the managing director’s education level and ICT training, the longevity of the company in inverse relationship with efficiency (~old), the company’s presence on and use of virtual social networks, and the outsourcing of ICT management. These factors in combination have significant explanatory power in the companies that display greater economic efficiency.

In view of the results obtained, this study should serve as encouragement to Tunisian olive oil agri-food companies, and the olive oil agri-food industry in general, to increase their commitment to innovation and the use of new ICTs as a means of growth, development and economic efficiency. It has become increasingly clear that the incorporation of these technologies into the olive oil sector is a decisive competitive factor in ensuring the survival and profitability of companies and in tackling the challenges posed by this new digital era [77]. The use of virtual social networks, in addition to other means of communication offered by the Internet, is an essential business management strategy to guarantee success in the current environment [78,79]. Furthermore, having a managing director with a high education level and specific ICT training is a positive impact factor in business management. This is because the power conferred on them by this responsibility will determine the outcome of the organization [39].
At this point we should point out the main limitations of this study. Firstly, this research focuses specifically on firms in the olive oil sector, although we believe that the lessons drawn can be generalized to a large part of the agri-food sector, which in general terms is facing similar marketing-related challenges. Secondly, we also note as a limitation that this study was conducted on a national level. In this regard, although Tunisia holds privileged status in olive oil production, it may be a worthwhile exercise to contrast its situation with that of other producing countries.

This study opens up a wealth of opportunities for further research. These include: more in-depth study of organizational structure as a trigger for market targeting through virtual social networks and other ICTs; finding out whether this explanatory model fits other agri-food sectors; and investigating whether modifying the factors identified as key would improve the efficiency results obtained by the companies analyzed in this study.

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