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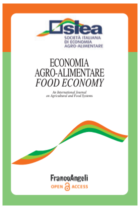

Sustainability and competitiveness in farms: An evidence of Lazio region agriculture through FADN data analysis

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Abstract

The new legislative proposals related to the Common Agricultural Policy (CAP) reform 2021-2027 aim to promote a sustainable and competitive agricultural sector. The new CAP supports agriculture in making a much stronger contribution to climate, biodiversity, environment and improving farms' competitiveness in the agri-food sector, in a European context. The importance of a strong focus on results and performance in the CAP legislation requires a continuous assessment and monitoring of the effectiveness of the measures adopted in the Rural Development Programs (RDP) with respect to the specific goals set during the CAP program. In order to assess the progress in improving the competitiveness and sustainability of the agri-food sector in reaching their targets and the objectives of the CAP, the need arises to investigate whether the RDP measures contribute to supporting the transition towards sustainable agriculture, to the competitiveness of the agri-food sector and to a balanced development of the rural areas. In this new legislative framework, where it becomes important to evaluate whether the CAP provides a much stronger contribution to achieving the specific objectives, our paper aims to describe agricultural sector in the Lazio region and to analyze the effects, in terms of sustainability and competitiveness, of the measures approved by RDP 2014-2020, which have almost expired. In particular, we

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provide a comparative analysis of the data collected by the Farm Accountancy Data Network (FADN), focusing on two different periods: one prior to the last programming and one referring to the latest available data. The collected data refer to farms, regarding their structural, economic, financial and patrimonial characteristics, as well as variables that describe attitudes and behaviour towards the environment. A multivariate analysis (clustering) is applied; it focuses on explorative factor analysis based on principal components, in order to identify homogeneous groups of farms with sustainability and competitiveness and identify similar characteristics and potential for development trajectories. The results found that farms are moving towards more sustainable and multifunctional development paths. The assessment of EU goals for social, environmental, and economic sustainability in agriculture and rural areas are a basis for discussion among public decision-makers involved in the reforming process of the explanatory measures of the new strategic objectives of the post-2020 CAP. Our results can offer a contribution to meeting the current challenges posed by the EU to ensure a smooth transition to the future CAP program. Major challenges that raise policy debate on the considerable potential of the FADN for assessing sustainability and farm competitiveness in the EU framework which places strong emphasis on results and performance.

Introduction

In recent years, the environmental damage due to impact of agro-industrial production led to farms to adopt sustainable production patterns and at the same time, environmental awareness is growing in consumer's behaviour. The widespread use of new green technologies and consumer's awareness on environmental problems caused by high amount of waste produced by the agro-food industry, encouraged the development of a sustainable consumption models (Meulenberg, 2003), in order to mitigate the environmental impact of food production. In this context, the farms competitiveness cannot disregard to the adoption of a sustainable production model. In fact, the two concepts seem to be closely interrelated in a multifunctional agriculture perspective (Toth, 2012).

However, the CAP 2014-2020 programme support sustainability and competitiveness goals, as well as provide new development opportunities related to increased consumers interest for sustainable food products. In 2017, a public consultation was also launched by the European Commission on the CAP Future. The Commission has presented a Communication to the European Parliament [COM (2017) 713] with new legislative proposals [COM (2018) 0392, 0393 and 0394 of the 1 June 2018] for the CAP 2021-2027 reform, to discuss environmental issues and farms competitiveness. The Commission included three general objectives in its reform strategy, including "to bolster environmental care and climate action and to contribute to the environmental and climate objectives of the EU" and nine strategic goals focused on social, environmental and economic factors, including "enhance market orientation and increase competitiveness including greater focus on research, technology and digitalisation" and "foster sustainable development and efficient management of natural resources such as water, soil and air" (European Commission, 2018:12). Appears clear how the CAP draft reform post 2020 aims to combine environment and competitiveness in a single goal: the sustainability. This goal highlights how multifunctional agriculture remains the key to a more balanced and sustainable CAP capable of tackling new challenges related to climate change and biodiversity, to improving competitiveness, to promoting generational turn-over, the knowledge transfers and access of young farmers to the land; measures that contribute to strength the position of farmers in the supply chain. In this new legislative framework, the CAP will adapt better to the transition to sustainable production patterns, to strength the agri-food sector competitiveness. Despite the post-2020 CAP reform strategy confirm the implementation of actions that enhance the sustainability and farm competitiveness that exalting multifunctionality in agriculture, it becomes important to investigate the measures effectiveness of RDP in terms of competitiveness, sustainable management of natural resources and the balanced development of rural areas. In view of the considerations, this paper aims to provide a representation of farms of the Lazio region and to discuss if RDP 2014-2020 supported improving sustainability and competitiveness of regional agri-food sector. As suggested by the recent scientific literature, the goal of the transition towards a fully sustainable agricultural sector is one of the main factors that influence the emergence of a new dimension of farms competitiveness (Farah *et al.*, 2014; Aceleanu, 2016). The new evaluation framework suggested by CAP reform post 2020 rises the need for explanatory databases, both of economic performance and sustainability, capable of measuring the effectiveness of CAP measures at farm level. Our paper attempts to explore the relationship between competitiveness and sustainability in farms through the use of a FADN data set, contributing to the current debate. In particular, the decision to use the FADN database is suggested by existing literature that examines its effectiveness in the evaluation of EU programs (Kelly *et al.*, 2018). Our paper aims to reinforce the idea that the FADN database has considerable potential to evaluate the sustainability and competitiveness at farm level. For this purpose, we have collected explanatory data of the structural characteristics and farms sustainable behaviour organized over two distinct periods (2011-2019) and we proposed factorial analysis focus on the principal components. In order to offer a better interpretation of emerging farms profiles, they are sorted into homogeneous groups defined by a multivariate analysis (clustering), where we associated the possible development path of the farms. The results highlight the important contribution that the FADN can provide in evaluating of European programs effectiveness increasingly focused to ambitious levels of competitiveness and sustainability. This manuscript is organized in 4 sections: the first, discusses the relationship between competitiveness and environmental sustainability through the FADN data, while section 2 argues the methods and material; in section 3 the research results and discussions are represented and, finally, in section 4 the conclusions and future research design are reported.

1. Background

1.1. *A literature review on FADN data contribution in the policy assessment*

In recent years, the globalization of production and consumption increasingly require to promote long-term sustainable interventions within the society. As a result, concerns regarding the sustainability of agriculture are becoming increasingly important to policy makers (Bockstaller *et al.*, 2009) and raises several questions about the discussions of decision-makers, including agricultural entrepreneurs, economists, managers and policy makers (Vitunskienė & Dabkienė, 2014; Vitunskienė *et al.*, 2016). The RDP of Member States EU supports actions that favour the sustainability of agricultural products. The sustainable agriculture model gained relevance from the publication of the Brundtland Report in 1987 (Tait & Morris, 2000). In Our Common Future (World Commission, 1987: 6). according to which it is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Subsequently, together with the fundamental concept of sustainable development, different definitions of sustainability were developed. In 2002, during the World Summit on Sustainable Development in Johannesburg, an unambiguous definition of sustainable development was agreed: sustainable development is considered a dynamic concept applicable at the farm level and at the decision-making farm level. This definition provides a broad interpretation of sustainable development understood as a dynamic balance between three interconnected dimensions. According to Diazabakana *et al.* (2014), these three dimensions are known as the sustainability pillar, thus sustainable development combines economic (the production of goods and services), environmental (the management of natural resources) and social sustainability (the contribution to rural dynamics). Integration of economic, social, and environmental dimensions is crucial to achieving sustainable development (United Nation, 2015). In 2007 Pingault defines sustainable development from an economic point of view as preserving or enlarging capital stock in the form of economic, social and natural capital. The proposal reform discussed by the European Commission on the CAP post 2020 confirm the priority objective of promoting a sustainable and competitive agricultural sector. From a sustainability perspective, the existence of multifunctional agriculture that provide a public goods and positive externalities justifies government intervention in a market economy through agricultural and sectoral policies (Dos Santos, 2016; 2018). In fact, in CAP programme 2014-2020 the actions aimed at improving the agriculture competitiveness and the sustainability were included in the six priorities of the national RDP and, despite the rationale of the implementation model of the new CAP is very different, the farms competitiveness and sustainability remain one of the long-term strategic goals for the post-2020 CAP. To achieve these objectives, each EU Member State will develop its own strategic plan, indicating how CAP funding will be directed towards specific objectives and how financial resources will contribute to the overall EU objectives. Programmes are country-specific because there are several endogenous and exogenous factors that influence the economic performance and farms competitiveness (Coppola *et al.*, 2018). While the objectives to achieve a multifunctional agriculture model are now clear, the post-2020 CAP reform and society's expectations of agriculture have increased the need for information on the policy effectiveness in achieving ambitious targets in the use of sustainable agricultural practices. Recent research shows the importance of studying the impact of the CAP on the economic sustainability of farms in the EU (Guth *et al.*, 2020) and, in general at farm and local level (Scozzafava & Casini, 2012). However, there are clear gaps between policy priorities and the statistical data infrastructure currently available to support policy assessments at farm level on sustainability issues. Therefore, European institutions need to monitor and evaluate EU programmes in the new CAP reform post 2020. This implies the need for a statistical database that is able to combine environmental, but also institutional and socio-economic dimensions with agricultural productivity. In this context, it becomes necessary to understand how policies can influence farmers' behaviour and decisions in a trade-off between different economic and environmental objectives but one of the most constraints is the lack of appropriate data. The literature highlights the difficulties associated with measuring sustainability at the farm level, mainly due to limitations associated with data availability. Some authors argue that accurate measurement is made difficult by the dynamism inherent in the concept of sustainability (Dillon *et al.*, 2014). There are several statistics databases in the EU that are the main sources of agricultural data, and the FADN is a good example. Vrolijk *et al.* (2016) explain how FADN data allowed identifying some sustainability pillars aspects that they are able to help identifying problems and needs of farms. At the farm level, the existing FADN database refers to aspects expressing the technical and economic efficiency of farms (Coppola *et al.*, 2020), with limited consideration of environmental, animal welfare, technology and innovation issues. These factors are particularly relevant for the evaluation of future policies assessment because farms sustainability takes into consideration the agroecological, economic and social criteria (Sulewski & Kłoczko-Gajewska, 2018). In a similar direction, Sulewski *et al.* (2018) investigate to measure and assess the interdependencies between dimensions of farms' sustainability. Due to the multidimensional nature of the concept of sustainable development, the measurement of sustainability is made on a different way. The literature on the subject offers a long list of researches to measure individual aspects of sustainability. Westbury *et al.* (2011) and Gerrard *et al.* (2012) provide the FADN contributions to sustainability questions merely in environmental terms. Highest contribution of FADN in terms of economics sustainability issues is found in Van Passel & Meul (2012) while some researches demonstrates the appropriacy of FADN data investigates the farms sustainability considering economic, environment and social pillar (Vitunskienė & Dabkienė, 2014; Barnes & Thomson, 2014; Van der Meulen *et al.*, 2014; Ryan *et al.*, 2016). In the field of agricultural sustainability assessment, Figuières *et al.* (2007) suggest to consider the interactions between farms and their business environment. In this regard, the existing literature agree on how the FADN has considerable potential to assess sustainability and competitiveness at the farm level in a European framework. Smędzik-Ambroży *et al.* (2019) determine the influence of the CAP on the level of socio-economic sustainability of farms in Poland using FADN data. Dabkienė (2016), argues on the farm sustainability assessment, in particular, the farm sustainability assessments based on EU FADN. Hennessy and Kinsella (2013) argue about the strengths of the FADN database and conclude that the FADN database provides a collection of directly comparable statistics on farms, supported by a robust data management, testing and validation infrastructure. Some authors highlight the valuable contribution that the FADN database can provide in the field of agricultural sustainability assessment and monitoring of robust on-farm performance (Mari, 2005; Longhitano *et al.*, 2012). Performances monitoring is one of the strategies that support and affect the farms resilience (Darnhofer *et al.*, 2010); in the absence of monitoring, sustainable economic, social and environmental management cannot be assumed. In the same direction, a recent study (2017) conducted by Poppe and Vrolijk, investigated existing methods for collecting farm sustainability data. The authors, through the publication FLINT project results, demonstrated the potential associated with the FADN database as an appropriate statistical tool to collect sustainability data. The authors stated that FADN database is adequately expresses the heterogeneity of the EU agricultural sector allowing different policies to be analysed. The results of FLINT project represent a significant challenge to expand the FADN database with the appropriate data to express the multi-disciplinary features of sustainability issues. A study by Buckley *et al.* (2017) argued in the same field and used national extensions of the EU farm accounting data network to obtain nationally representative nitrogen use efficiency indicators for dairy farms in Ireland and the Netherlands. Despite the considerable potential of the FADN database in providing answers to the new challenges emerging from the post-2020 CAP, a study conducted by Kelly *et al.* (2018) highlights the need to expand the scope of data collection through a broader assessment of sustainability at farm level and the need to include new information sets to address environmental issues. Indeed, the literature shows that there are many researches studies emphasising the appropriacy of FADN data for the sustainability and competitiveness analysis on farms: cases studies using data derived exclusively from FADN (Desjeux & Latruffe, 2010; Zhu *et al.*, 2011; Latruffe *et al.*, 2012; Lebacq *et al.*, 2013; Latruffe & Desjeux, 2016); studies using FADN data in association with national initiatives collecting additional data through the FADN (Pesti & Keszthelyi, 2009; Samson *et al.*, 2012; Dolman *et al.*, 2014; Ryan *et al.*, 2014; Dillon *et al.*, 2016); studies and researches using FADN data in combination with additional data from other sources than FADN, available nationally, at the EU or internationally (Letty *et al.*, 2012; Latruffe & Pie, 2014; Läpple *et al.*, 2015; Gillespie & Thorne, 2016).

2. Methodology

2.1. *Matherial and methods*

The applied methodology includes the multivariate analysis techniques, namely, Cluster and Factorial Analysis based on principal components. We use information and data from the FADN, the European database of the European Commission, to compare on two periods a classification of the strategic profiles identifying the farms of the Lazio Region, by following approach as suggested by Russo (2014), in this case simplified. According to our approach, development paths are attributed to individuals farms in the sample through the interpretation of factorial axes resulting from a factor analysis using the principal components method. The applied methodology allows to assess the sustainability and competitiveness of individual farms; their classification into groups of entities diversified by the degree of compliance with the principles of sustainable agriculture. The ability to measure and assess the sustainability of farms can be considered as the first step in the process of creating effective agricultural development support policies. In details, the data collected refer to the Lazio region (Italy) FADN sample, focus on two different years, 2011 and 2019. The analysed information and data are reported to the year 2019 because is the last one available, while we use the year 2011 because we believe that this year was the better year possible to analyse the CAP 2007-2013 implementation policies, namely, measures from the I and II Pillar of the CAP. On the other hand, starting from an in-depth analysis FADN data reported to the CAP 2007-2013, 2011 was the one year available without missing information and data on FADN thus an exhaustive dataset of appropriate data-information in representing the phenomenon as fully as possible. The decision to apply the empirical methodology to the analysis of Lazio's agricultural sector data is justified by the specific characteristics of the regional agricultural sector. In particular, the production and agricultural system in the Lazio region is characterised by structural and cyclical dynamics distinguished by a marked diversification of the activity oriented to multifunctional agriculture (Liberati & Di Fonzo, 2020). The existence of a multifunctional agriculture model has allowed to compare farms on two different periods, 2011 and 2019, in order to discuss the main implications on the farms of the last and current programming in terms of competitiveness and sustainability. Despite efforts to identify two periods as full as possible in the data availability and suitability, the findings of the analysis are not consistent in representing the phenomenon and this limits the possibilities to compare research results. FADN database has limitations due to the limited number of variables available and farms that are different for the 2011 and 2019, on the one hand, and, by the other, due to the high level of aggregation of data and information of the database. While the strategic profiles of the companies have been compared, considering the limitations of the analysis, the development trajectories attributed to the clusters, in the results section, exclusively refer to 2019.

Our approach allows us to interpret the findings as a representation of the status quo both before and after the start of implementation of the 2014-2020 RDP. In 2011, the sample contains 557 observations. The agricultural area considered in the analysis is equal to 17,731.48 hectares of TAA and 16,162.42 hectares of UAA. Average farm size is 31.9 hectares of TAA and 29 hectares of UAA. In 2019 the sample shows a greater number than in 2011 and it is represented by 584 farms, that absorb a total of 25,511.18 hectares of

TAA and 21,876.89 of UAA. Average farm size is 43.7 hectares of TAA and 37.5 ha of UAA[1].

In order to perform a factorial analysis with principal components methods necessary for the interpretation of the factorial axes, a database was developed to support the processing in order to systematize the collected data into SPAD dataset.

To simplify the interpretation and to compare the two periods covered, the farms are summarised in a small number of homogeneous groups defined using a cluster analysis (Jambu & Lebeaux, 1983; Russo & Sabbatini, 1998; 2002). Therefore, at the next stage, a mixed cluster analysis was performed based on the criteria of the optimal combinations that the software returned. Following this approach, the FADN variables collected from the survey have been sorted and processed to calculate the indexes (25) (reported in table 1) that are useful for the description of regional farms and used in the principal components analysis as active variables.

*Table 1 - Description of the indexes used in the Principal Components Analysis**

Indexes	*Indexes Description*
1. Arable crops area rate	Arable_crops area/UAA: it indicates the arable land area incidence compared to the utilized agricultural area.
2. Current cost rate	Current_Cost/GSP: it indicates the current cost incidence compared to the total gross salable production.
3. Europeansubsidies rate	Sub_EU/GSP: it indicates European subsdies incidence compared to the gross salable production.
4. Family labor rate	FWU/AWU: it indicates the unpaid labor incidence compared tothe farm's total labor force.
5. Forest area rate	Forest_area/TAA: it indicates the forest area incidence compared to the total agricultural area.
6. Gross agricultural labour productivity	GSP/AWU: it indicates the unitary productivity compared to farm revenues.
7. Gross agricultural land productivity	GSP/UAA: it indicates the unitary productivity of the utilized agricultural area.
8. Irrigation systems rate	Irrigation_systems/UAA: it indicates the irrigation systems incidence compared to the utilized agricultural area.
9. Land capitalization	Land and buildings/AWU: it explains the intensity degree of landed capital use compared to the labor total units.

1. The difference in data than census depends on the universe of reference of the two surveys, quite different. In fact, the FADN field of observation does not consider smaller farms as it applies minimum size thresholds.

Table 1 - Continued

Indexes	*Indexes Description*
10. Land intensity	Land and buildings/UAA: it indicates the soil intensity degree of the landed productive factor and of the capital invested on it.
11. Land intensification degree	ALU/AWU: it indicates the availability of agricultural area for work unit.
12. Land mechanization degree	kW_Machine/UAA: it indicates farm mechanization degree compared to the utilized agricultural area.
13. Meadows and pastures area	Meadows_pastures_area/UAA: it explains the land used incidence for the cultivation of grass or other herbaceous forage plants compared to the utilized agricultural area.
14. Net land productivity	VA/UAA: it expresses the net productivity of the utilized agricultural area.
15. Net land profitability	Net_Income/UAA: it explains the net profitability of family work.
16. Nitrogen rate	Nitrogen_per_hectare/UAA: it indicates the amount of nitrogen used compared to the utilised agricultural area.
17. Phosphorus rate	Phosphorus_per_hectare/UAA: it indicates the amount of phosphorus used compared to the utilised agricultural area.
18. GSPdirect sales rate	GSP_direct sales/GSP: it indicates the gross salable production incidence relating to direct sales compared to total gross salable production.
19. GSP processing rate	GSP_processing/GSP: it indicates the gross salable production incidence relating to processing compared to the total gross salable production.
20. GSPquality rate	GSP_quality/GSP: it indicates the gross salable production incidence relating to quality compared to the total gross salable production.
21. Potassium rate	Potassium_per_hectare/UAA: it indicates the amount of potassium used compared to the utilised agricultural area.
22. Tree area rate	Tree_area/UAA: it expresses the incidence relating to area destined for tree crops compared to the utilized agricultural area.
23. UAArate	UAA/TAA: it indicates the utilized agricultural area incidence compared to the total agricultural area.
24. ALUrate	ALU/UAA: it indicates the livestock unit incidence compared to the utilized agricultural area.
25. Water usage	Total_water_volume/UAA: it explains the water volume used compared to the utilized agricultural area.

* PLV: Gross Salable Production; UBA: Adult Livestock Unit; TAA: Total Agricultural Area; UAA: Utilized Agricultural Area; FWU: Family Working Units; AWU: Annual Working Units; VA: Value Added.

The axes resulting from factorial analysis are defined through positive or negative correlation with the variables used. The interpretation of the axis-variable associations, according to the system theory of the farm, allows the factor to be used as a conceptual category that explicates the agricultural sector. In order to generate a coherent interpretative framework, the factorial axes sort the factors according to their ability to reflect the variance in the data or their ability to interpret it. As a consequence, the conceptual scheme does not fully represent the phenomenon, but the choice of the combination, even if not exhaustive, is the best possible illustration. The first factorial axes resulting from the principal components analysis can be interpreted as follows:

1. Factorial_axis (1): Competitiveness. Based on the semantic contrast between public support on the one hand and profitability/productivity of the land, on the other. The axis represents the dichotomy between income and profit as an entrepreneur objective to be optimized. The competitiveness is defined as the ability of the farm to provide adequate input returns through market access.
2. Factorial_axis (2): Functional diversification. The axis shows the paradox between opposite semantics, represented on the one hand, by the productivity of the land and, on the other, by the presence of certified quality production (local and organic products) and of food processing and direct sales. In terms of production, the contradictions are associated with the production of arable crop and the presence of permanent crops. The result is a dichotomy between a productivity approach and multifunctionality, where the last is interpreted as the multiplicity of functions performed by farms, as against specialisation in the agricultural function.
3. Factorial_Axis (3): Environmental pressure. The axis includes the dichotomy between the use of agricultural land for crops and the use for forests and pastures. The emerging duality opposes the preservation and exploitation of the land resource and shows the different degree of stress that agricultural activity places on the natural environment and land.

3. Results

The applied multivariate analysis technique (clustering) found five different clusters of farms in Lazio region, in both periods considered. The representation of the strategic profiles that grouped the farms, variables and structural indexes are described below and presented in Tables 2 and 3 for 2011 and in Tables 4 and 5 for 2019.

Table 2 - Main collected variables distribution infarms profiles (average value, 2011)

	TAA	UAA	ALU	GSP	Net income	UAA irrigated	AWU	VA	Sub.EU
Sample mean	31,88	29,07	32,54	108.992	41.507,63	8,29	2,04	70.677,14	9.416,47
Homologated farms family	11,50	10,20	2,57	57.031,67	29.542,28	3,26	1,45	44.654,37	2.116,69
Resilience	23,29	7,00	8,14	28.558,43	3.937,86	1	1,29	20.233,43	108
Livestock farms	67,38	63,48	74,56	62.298,58	30.786,92	0,69	1,40	44.125,50	8.040,65
Large capitalized farms	35,37	32,36	38,54	132.716,22	47.527,73	11,30	2,32	83.366,47	12.512,92
Services farms	1,37	0,95	0,53	111.584,11	38.255,21	2,37	2,32	68.076,47	531,21

Table 3 - Main indexes distribution in farms profiles (average value, 2011)

	UAA rate	ALU rate	% Family work	Sub EU rate	Land mechaniz.	GSP proces. rate	GSP qual. rate	GSP dir. sal. rate	Irrigation system rate	Land net profitability
Sample mean	0,98	2,08	0,81	0,02	21,57	0,08	0,03	0,05	0,48	4.449,40
Homologated farms family	1	0,19	0,90	0	17,19	0,26	0,10	0,10	0,37	2.872,22
Resilience	0	1,71	0,71	0	46,86	0,14	0	0	0,43	2.564,43
Livestock farms	1	5,40	0,92	0	6,92	008	0	0,04	0,04	882,19
Large capitalized farms	1	2,08	0,78	0,02	16,78	0,03	0,02	0,04	0,50	3.747,55
Services farms	0,95	5,11	0,63	0	168,68	0	0	0,05	2	37.295,58

Table 4 - Main collected variables distribution in farms profiles (average value, 2019)

	TAA	UAA	ALU	GSP	Net income	UAA Irrigated	AWU	VA	Sub UE
Sample mean	43,74	37,52	43,57	133.937,33	57.640,16	5,78	1,97	90.337,52	11.915,13
Homologated farms family	17,66	15,58	2,39	93.343,5	40.303,54	4,11	1,92	68.303,73	4.097,60
Resilience	57,28	17,71	35,14	107.442	34.486,28	0,71	2,21	67.704,28	3.467,85
Livestock farms	123,28	105,09	61,19	176.577,82	67.696,32	7,63	1,84	11.116,10	29.132,54
Large capitalized farms	32,31	29,14	55,32	131.758,85	58.185,60	5,98	1,92	86.430,95	11.088,61
Services farms	5,90	5,14	60,09	250.050,33	130.797,71	8,47	3,28	209.959,52	926,04

Table 5 - Main indexes distribution in farms profiles (average value, 2019)

	UAA rate	ALU rate	% Family work	Sub EU rate	Land mechaniz	GSP proces rate	GSP qual. rate	GSP dir.sal. rate	Irrigation system rate	Land net profitability
Sample mean	0,97	6,28	0,81	0,02	12,49	0,07	0,06	0,12	0,21	3.163,38
Homologated farms family	1	0,67	0,82	0	13,69	0,24	0,15	0,18	0,28	2.035,19
Resilience	0	2,71	0,64	0	8,07	0,14	0,07	0,50	0,07	1.985,35
Livestock farms	1	0,77	0,73	0,13	3,20	0,01	0,01	0,01	0,03	726,88
Large capitalized farms	1	2,51	0,87	0	11,75	0,03	0,05	0,10	0,21	2.433,19
Services farms	0,90	126,38	0,52	0,05	61,67	0,05	0,10	0,29	0,61	33.358

Cluster (1)_Homologated family farms. This cluster describes the medium to large size farms, where most of the work is provided by the farmer and his family (between 80 and 90% on average). The farms intensively exploit the agricultural area (between 85 and 90% of the UAA). There isn't a significant diversification of agricultural activities and no significant use of quality labels. The relevant presence of vegetable gardens suggests the importance of the residential function and agricultural consumption. The property of land and buildings, machinery and livestock is lower than the regional average. This results in profitability indexes below the regional average and a high incidence of European subsidies on the farm balance sheet. This cluster is placed on development paths linked to economies of scale and cultivation.

Cluster (2)_Large capitalized farms. Farms grouped in this cluster are distinguished by the large availability of land capital, mechanical and livestock, that allows to achieve a high value of GSP even with a relatively limited use of labour. As a result, the labour productivity indexes are particularly high (over 130,000 Euros). The intense exploitation of the soil is also confirmed by the high incidence of UAA on the TAA. The large size and the type of production in arable crops allow these farms to benefit European subsidies, that have an important impact on the farm's balance sheet. The development trajectory of the cluster appears linked to the exploitation of economies of scale resulting from access to large amounts of capital. Farm's investments make it possible to offer the labour factor and the farmer high remuneration. The relevant estimated number of the cluster makes it particularly important for policy assessment purposes. The development paths are linked to economies of scale and cultivation.

Cluster (3)_Resilience. This cluster includes farms smaller than the average, characterized by low income and labour related almost entirely to the farmer and his family. The economic size is clearly below average, with a farming practised that sees prevailing arable crops and presumably self-consumption animal husbandry. Given the small areas, EU payments do not reach an average of 3,500 euros, even if they significantly affect the balance sheet. Farm survival appears to be linked to the residential and use function, as well as the possibility of integrating with additional income (including retirement). The distinctive feature of the cluster is identified in a strategic choices lack and an indefinite development path.

Cluster (4)_Livestock farms. The discriminating element of this cluster is the presence of grazing areas, that absorb a modest percentage of the TAA. The farms have a large surface area (over 60 ha) and a substantial livestock capital (between 60 and 75 ALU). However, they are characterized as medium-sized farms, with a ALU/Ha ratio between 5 and 7.

Cluster (5)_Services farms. They are distinguished by the importance of the component services in the farm balance sheet. Faced with a modest GSP, these farms develop high value added and substantial income by non-agricultural activities. The development paths are related to land productivity and services.

Figures 1 and 2, respectively, for 2011 and for 2019, report the percentage composition of the grouping for the reference sample.

Figure 1 - Percentage frequencies distribution in the strategics farms profiles (2011)

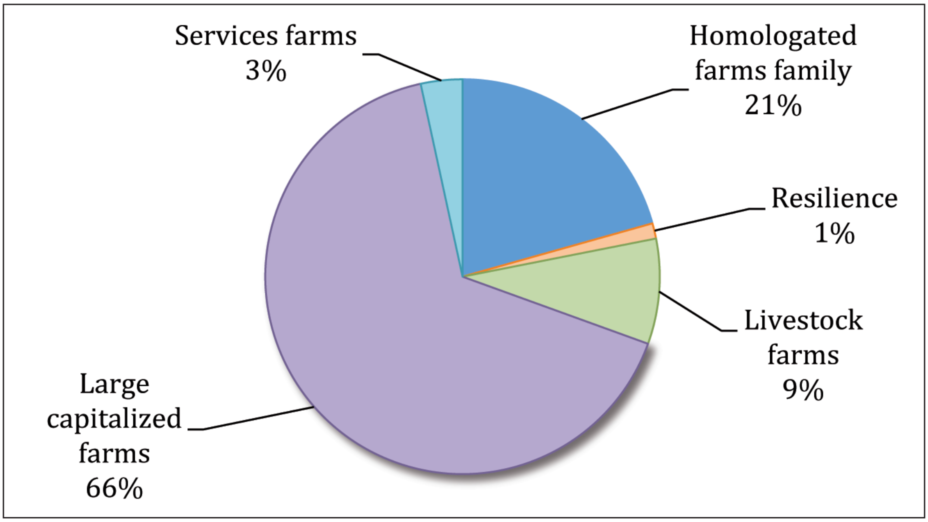
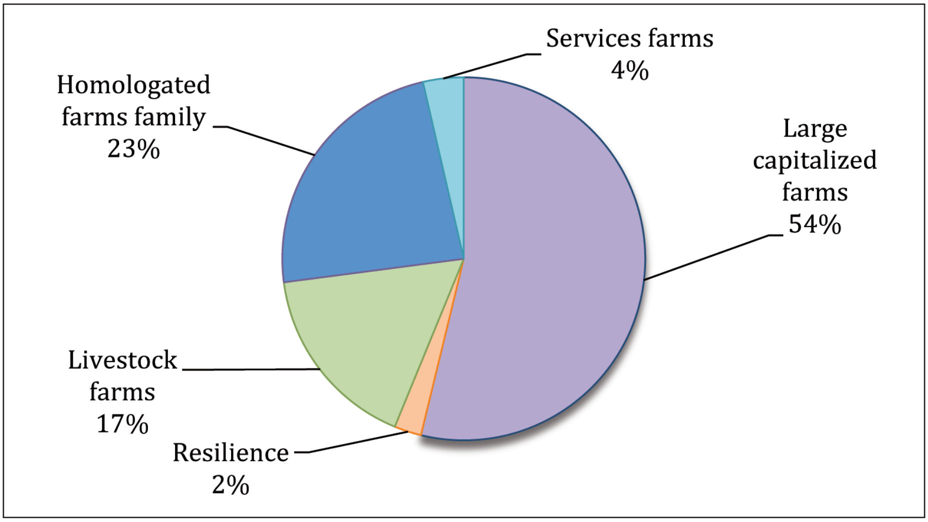


Figure 2 - Percentage frequencies distribution in the strategics farms profiles (2019)



The results, in particular, the five different cluster identified in Lazio region also conclude that Lazio agriculture and their respective farms have moderate sustainability where the subsidies from CAP have a positive impact on. Moreover, agricultural activity in the Lazio region presents a moderate contribution in environmental terms. The main conclusion highlights the need to better adjust agricultural policies among the European Member States in order to better promote the sustainability of agriculture in Europe.

4. Conclusions

This paper illustrates a multivariate analysis (clustering) on the data collected from a representative sample of farms from the FADN survey in the Lazio region, in order to describe the possible development paths that drive the choices of the farms towards a production model that is increasingly competitive as well as sustainable. The farms covered by the analysis were identified through a model of classification into categories based on explanatory indexes of structural characteristics and sustainable behaviour. The results obtained in the periods considered (2011-2019) select five profiles of farms, each one united by elements of competitiveness and sustainability in a homogeneous set of data composed of structural, economic and environmental variables.

The finding of this study aims to merely present a description of a agricultural system of Lazio region, that although not characterised by profound mutations, the changes in the groups' structural composition require some reflection. In fact, between 2011 and 2019, the reduction of capital farms (–12%) reflects in 2019 a path of development of farms aimed at increasing the use of sustainable production methods, such as livestock farming. The simultaneous presence of diversification of activities (with particular incidence of forests and pastures) and the related public subsidies reflects forms of environmental monitoring.

The moderate increase in the number of family farms and resilient shows the dependence of the farm competitiveness on the presence of European payments. This result is supposedly due to delays in the use of RDP 2014-2020 funds that are not still used by producers or farms that have partially benefited from them. Nowadays, the EU and national objectives are to use new transition rules to accelerate the implementation of the expenditure programmes. The increasing trend in service farms, however slight, represents an amplification of farm functions, which reflects a multifunctional agricultural development path. Our paper, despite methodological limitations discussed, aims to contribute to the literature that argues the contributions of FADN in the assessment of CAP policy and its supporting measures. In this direction, the proposal put forward by the European Commission is oriented towards greater simplification efficiency and sustainability. The thematic objectives of the 2014-2020 period have been summarised in 5 policy objectives of cohesion policy 2021-2027, to ensure a greater flexibility also in the transfer of resources within a priority. These include "A Greener Europe" to promoting energy efficiency measures; promoting renewable energies; promote adaptation to climate change, risk prevention and disaster resilience; promote sustainable water management; promote the transition to a circular economy. In the view of these considerations, the Commission's CAP reform proposal is strong integrated with the Green Deal programme. The need to measure and monitor sustainability led the Commission will propose legislation to convert its Farm Accountancy Data Network (FADN) into the Farm Sustainability Data Network with a view to also collect data on the Farm to Fork targets and other sustainability indicators. In this framework, FADN represents a valuable statistic tool in the Common Monitoring and Evaluation Framework (CMEF) for assessing the functioning of the Common Agricultural Policy (CAP) and improving its efficiency to measure the performance of the whole CAP (both Pillar I – direct payments to farmers and market measures – and Pillar II – rural development measures).

On the issue discussed, future research could branch out in different directions. Faced with one of the main limitations of the current study, it would be appropriate to analyse the farms profiles, defining them in more detail for better external consistency of the results. This could be achieved, for example, by selecting more explanatory variables of sustainability, which by definition (multidimensional character) is a complex concept. Finally, the results of our study could be applied in other regions, geographic areas or on a national level, or have a more integrated view on the issue.

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