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Management Goals and Performance: Clustering State Forest Management Organizations in Europe with Multivariate Statistics

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Abstract: State Forest Management Organizations (SFMOs) play a crucial role in the European forest sector, managing almost half of the forests in the region. SFMOs are often only managed for timber production, whereas, being publicly owned, they should play an important role in providing a vast range of public goods (e.g., soil protection, biodiversity conservation). Their management goals depend on the history and current conditions of the forest sector at a national level, as well as different challenges and the potential for development. Although there is a lack of knowledge about the current performance of SFMOs, there have been recent changes to their management goals and practices in response to the new demands expressed by society (e.g., transparency, social inclusion). The main purpose of this study was to analyze the current situation of SFMOs by grouping them with the help of a Cluster Analysis according to indicators that reflect the three pillars of the common understanding of the sustainable forest management (SFM) concept. Additionally, in light of the differences in the forest practices and management priorities in each country, we used Principal Component Analysis (PCA) to group countries according to common characteristics of the forest sector at the national level. The results showed three main clusters of SFMOs in Europe. The first cluster had a rather small but commercially-oriented forestry unit together with other business activities and a strong focus on public services. The second focused on public interest, rather than commercially-oriented organizations. The third is mainly profit-seeking. The existence of diverse SFMO clusters shows the possibility of different approaches for SFM with a focus on different goals (e.g., profit gaining, public service delivery).

Keywords: state ownership; forest management; forest enterprise; public enterprise; cluster analysis; European forestry

1. Introduction

State ownership appears to be a persistent characteristic of the economic forest landscape on a global scale [1]. A key role in managing state-owned resources is played by the so-called State-Owned Enterprises (SOEs). An SOE is a "firm that is (wholly or partially) owned and controlled by the state (government)" [2]. The state exercises ownership over SOEs in the interests of the public. The main purpose of state ownership should be to maximize value for society through an efficient use of resources [3]. For this reason, the governance of SOEs is attracting increasing attention from citizens. In the last few decades, public control was increased by the spread of the principles of transparency and disclosure. These principles are even more important for SOEs than for other companies since it is important to show how public resources are used and distributed. Rising public scrutiny provides

strong incentives for good governance. This kind of control can help SOEs to deal with the problems and criticisms usually associated with them [3]. Among the most common problems of SOEs are (i) inefficiency; (ii) poor monitoring of managers; (iii) lack of market discipline; (iv) corruption; and (v) political interference [4].

State forest ownership is strong in Europe. The statistics of the United Nations Economic Commission for Europe (UNECE) showed that, in 2010, forests in Europe (excluding Russian Federation, Ukraine, and Belarus, where almost 100% of forest is state-owned) were 61.6% privately owned and 38.4% state owned. In European forestry, sustainable forest management (SFM) has been a highly relevant topic since the 1990s. The principles defined in 1992 at the United Nations Conference on Environment and Development in Rio [5] led to a precise definition of SFM. Besides a sustainable yield, the three pillars of economic, ecological, and social sustainability are expected to be on the forestry agenda [6]. These principles are embraced by the European Union (EU) Forest Strategy (2013) and are core guidelines for forest management in the EU. Later, widely-accepted concepts such as ecosystem services [7] have forced State Forest Management Organizations (SFMOs) to rethink their management goals. SFMOs are defined as commercially-oriented state forest companies, enterprises, and agencies that have sustainable forest management and sustainable wood production as major concerns [8]. We tend to use the term "State forest management organization (SFMOs)" due to our sample based on The European State Forest Association (EUSTAFOR) membership that includes different legal forms of state ownership (see Table 4 in [9]), not just enterprises. However, as generally, in the literature on state ownership the term "State-owned enterprise (SOEs)" is used. Therefore, in the theoretical background, we keep this term due to the authenticity of data.

Because of their public nature, SFMOs are expected to have a special responsibility in guaranteeing SFM. They should find a balance between the different and sometimes competing priorities of the forest functions (social, economic, and environmental) in their management models in order to satisfy the respective requirements and reach the SFM goals. The forest sector in the EU generally has a significant influence on the aspects of SFM. It operates within vulnerable and valuable ecosystems, providing many necessary public goods such as biodiversity, cultural landscapes, good quality of water, air and soil, a stable climate, and resilience to fire and flooding [10]. The sector also has a relevant role in the European economy and social development, and State-owned forests contribute to this role. Scholars (e.g., [11–13]) specifically highlight the role of forests especially in rural development, mainly for their contribution to job opportunities and income in regions with high unemployment rates. Finally, European statistics show that forest-based industries represent about 7% of EU manufacturing Gross domestic product (GDP). In 2011, they had a combined production value of EUR 460 billion, with a total added value of EUR 135 billion on a turnover of EUR 485 billion [14].

Despite the large share of state forest in Europe, its relative economic importance, and its high importance for many other different values, there is a gap in the scientific literature on the behavior of the SFMOs/SOEs relative to SFM. The majority of recent studies on state ownership are focused on developing countries or countries in transition: China [15], Vietnam [16], Central and Eastern European Region [17], and just a few on EU countries: Germany [18], United Kingdom [19], Czech Republic [20], and Lithuania [21]. Yet, there is still very little information about state forest ownership in today's markets, its current situation, challenges, or opportunities. The existing information is scarce and not systematically collected or analyzed [9]. The objective of this paper is therefore to present a first attempt at a comparative overview of SFMOs in the EU forest sector context. Specifically, we try to cluster SFMOs and to see how they balance their management and business activities between the three main pillars of sustainable forest management: ecological, economic, and social.

The article is structured as follows: the theoretical background of the study focuses on state ownership and specifically on state-owned forests (Section 2). After describing the research methodology (Section 3), an analysis and discussion of obtained SFMOs clusters are presented (Sections 4 and 5). The final part of the paper outlines the conclusions (Section 6).

2. Background

2.1. State Ownership

The state sector has always been important in many economies, including the most advanced. Several socio-economic, political, and historical reasons explain why governments have established and maintain SOEs. One of the most common reasons for state ownership is natural monopoly. The state may be the appropriate monopolist in an economic sector where an interlocking supply network is required for the provision of goods or services. SOEs have also been established to carry out nationally strategic but risky or long-term investments where private sector investors were not available. Another common argument for SOEs is externalities. Private investors do not have the incentive to invest in industries, which benefit other industries without being paid for the service. SOEs can be created for the supply of goods or services, which the private sector is not incentivized to supply. For example, profit-seeking firms in industries that provide basic goods and services may refuse to serve less profitable customers, such as poor people, vulnerable consumers, or people living in remote areas. Lastly, the historical heritage and political ideology of countries can have a large influence on state ownership ([22–25]).

Much of the literature tends to view SOEs as inefficient, bureaucratic entities that are poorly managed without coherence in their strategy and resource allocation decisions, and as a result, they are less efficient in state than in private hands ([22,25,26] and others). However, it is time to revise the role and management systems of SOEs, especially due to the intense changes that the state sector went through in 1980–1990 [3]. These changes were mainly connected with a large wave of privatization in Europe. SOEs were found to be less productive than private enterprises, difficulties were detected in setting the objectives for SOEs and evaluating their performance, and there was a lack of commitment to good administration [26]. Nevertheless, since the privatization wave, the direct role of the state in the economy has not completely lost its relevance: there are still a number of SOEs and the sector is remarkable for its size, economic impact, and the "strategic" (e.g., energy, transport) sectors in which it operates [3]. At the same time, in many market economies, SOEs have undergone enormous changes stimulated by pro-market reforms. Globalization of the financial markets and increased international trade also demanded that enterprises should be more free and flexible than what is usually possible in state ownership [3]. It is important to remember that "SOEs are expected to fulfill special responsibilities and obligations for social and public policy purposes . . . (that) may go beyond the generally accepted norm for commercial activities" and disclosure of these "special obligations" should also increase the transparency of SOEs [27] (p. 26). The changes described above have stimulated the rise of new ideas for SOEs development.

2.2. SFMOs in the EU

The distribution of state forests and private forests in Europe varies a lot among countries. For instance, in countries like Austria, France, Norway, and Slovenia, private forests account for more than 75% of the total forest area in the country. Contrarily, Poland, Czech Republic, and Croatia only have 15–30% of private forests [28]. Despite these differences, SFMOs have traditionally played a major role in the forest sector in European countries, justified by duties (tasks of forest authority and management), a large resource base, and significant relationships with key stakeholders [29]. Almost all SFMOs in Europe are represented under the umbrella of EUSTAFOR, an organization that represents commercially-oriented state forest companies, enterprises, and agencies. The main goal of EUSTAFOR is to support and strengthen state forest management organizations in Europe, in order to provide sustainable forest management by helping them to maintain and enhance their economically viable, socially beneficial, culturally valuable, and ecologically responsible practices [8]. The organization currently has 30 members in 22 European countries representing the majority of the EU countries, as well as Norway and Bosnia and Herzegovina. EUSTAFOR's members account for one third of the EU forest area, including the management of 13 million ha of protected areas. Their combined annual

harvest amounts to approximately 123 million m^3 of round timber. Together, the members provide employment for more than 100,000 people [8].

The European forest sector went through intense changes in 1980–1990. These changes were generated by the collapse of the communist system in Eastern Europe and followed the changes in the national economies ([17,30]). In the former socialist countries, a free timber market was formed and new models of ownership have caused changes in the state forest sector [31]. One of the dominant ideas among forest institutions that decided to reform/reorganize was to separate policy, regulatory, enforcement, and management functions. In this case, a forest authority, as part of its enforcement functions, supervises how forests are managed, while actual management is undertaken by a separate and independent organization [17]. With separate organization for forest management there are, broadly, two directions for development: towards either a commercial-oriented organization or delivering specific ecosystem services of public interest. Of course, many organizations integrate both of these goals in their development, and all organizations, nowadays, are expected to pursue the three pillars of sustainability (economic, environmental, and social).

Transition towards more competitive SFM is necessary for SFMOs. Forestry has large economic potential and many organizations therefore prefer to go for commercial activities in their development. For this reason, it is not surprising that one of the most dominant forms of management of state forests is the creation of a separate state enterprise (SE). Many countries in Europe, like Estonia, Ireland, and Austria, have created SEs for commercial purposes [32]. Changes in the forest sector such as a decrease in timber prices and rising labor costs forced these organizations to undertake profound changes in their production processes. The main changes had a technological and organizational nature, like the mechanization of harvesting operations, personnel reduction, and outsourcing of some activities ([31,33]). The success or failure of these organizations depends on many different factors such as the market situation and political reforms in the country or specifically in the forest sector, etc. For example, state forest enterprises in Latvia and Estonia have significantly increased their turnover and profit after reorganization. Contrarily, the Polish state forest enterprise has been in a difficult financial situation and has been unable to achieve economic returns similar to other state forest organizations [16]. This can be explained by the fact that in some Eastern European countries, state forest authorities see themselves as the gatekeepers whose responsibility it is to ensure that intervention in forests is assessed from an ecological point of view [33]. In parallel to timber production, forestry, as a natural resource-based sector, allows new products and services to be developed for the support of sustainable development. It is important for an organization to define what these services and products are (or should be) in order to possibly reform its structure and to have clear objectives and targets. "Services" in the forest sector can be broadly defined to include services for the public good, as well as specific services to the forest industry (marketing assistance) or to private forest owners (extension services) [17]. The emergence of new products has a potential role for employment in rural areas when a promotion of ecosystem services improves the environmental aspects of sustainability. Forestry is therefore one of the sectors that can ensure sustainability and quality of life through a combination of timber harvesting and the provision of public goods and activities (e.g., recreation) through the concept of forest multi-functionality. Sustainability is a matter of balancing these functions.

2.3. The Forest Sector at the National Level

The extent and characteristics of state ownership can vary a lot depending on the country's history, its level of economic and institutional development, political system, macroeconomic situation, structural characteristics, comparative advantages, and access to various resources, as well as its integration with international trade and investment markets [34]. In the same way, we can expect that how each SFMO is organized and managed is influenced by the specific conditions of the forest sector in the country.

3. Methods

For the purposes of this study, both primary and secondary data were collected and analyzed. In particular, sets of data were collected in the forest sector at a national and SFMO level. These data were processed with Principal Components Analysis (PCA) (a statistical procedure used to analyze data by reducing the number of variables within the data to a limited number of linear combinations (linearly uncorrelated variables); each linear combination will correspond to a principal component (PC) [35]) and a cluster analysis ("clustering refers to a very broad set of techniques for finding subgroups, or clustering clusters, in a data set;when we cluster the observations of a data set, we seek to partition them into distinct groups so that the observations within each group are quite similar to each other, while observations in different groups are quite different from each other" [36] (p. 385)) respectively, as explained in the following subsections.

All analysis was performed using RStudio (Version 1.1.383, R Studio, Inc., Boston, MA, USA), the software for statistical computing and graphics (www.rstudio.com).

3.1. Principal Components Analysis (PCA)

3.1.1. Countries Dataset Description

The cross-country dataset was built for 21 European countries, i.e., those with an SFMO member of EUSTAFOR: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Romania, Slovak Republic, Slovenia, Sweden, and the United Kingdom.

The dataset consisted of 14 quantitative variables and a qualitative variable that characterized and allowed a comparison of the forest sector at the national level (see Table 1). Due to data heterogeneity in the international databases, we used variables based on data availability and how recently the data was produced. The variables in existing databases were shown in various formats. To allow for comparison, the data were recalculated to relative values (e.g., Growing stock (million m^3) per ha of forest, Removals (m^3) per ha of forest (State Ownership)). Since the variables Annual work unit (AWU) and Fellings had some missing values, the R studio package mice was used for the estimation of these gaps (The missing values represent 20% of observations for AWU and Fellings. The MICE algorithm implements a multiple imputation that uses Fully Conditional Specification (FCS), as described in [37]). Moreover, to create the variable Main Function, we assume that if a forest function is missing, its value is zero.

3.1.2. Countries Data Analysis—PCA

Collected data for countries was further processed with the help of PCA. The data analysis consisted of two steps: Analysis of correlation and PCA.

Analysis of correlation (see Figure 1) is essential to interpret non-causal relationships among variables, considering the sample of countries in the study. The correlations are very helpful when interpreting the clusters by using PCA.

The PCA was performed with the objective of reducing the number of variables that characterize observations by synthetizing them into new variables (principal components) with further interpretation [38]. The PCA allowed us to rank the contribution of each variable to the components (see Table 2). Table 2 shows which variables determine the location of observations on the four quadrants of the PCA graphs (Figures 2 and 3) and allows interpretation of the first three principal components (PC). The score of each observation for each component (from "−4" to "4" on the vertical and horizontal axis) showed the similarity among these observations see Figures 2 and 3 Considering the whole countries dataset, the variance explained by the first three principal components represented 70% of the variability of the full system and was considered sufficient to explain differences among observations.

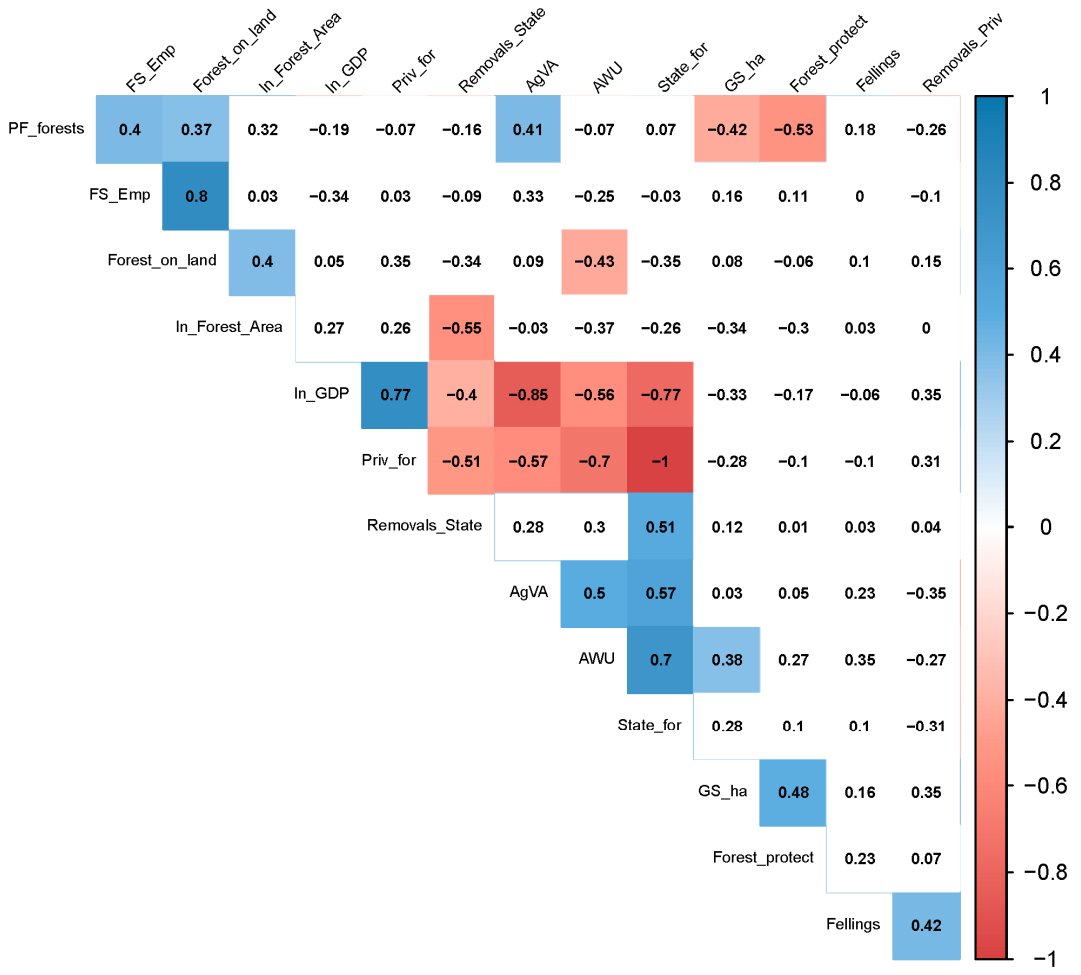

Figure 1. Correlation between quantitative variables (Blue color means there is a positive correlation; red means a negative correlation. The darker the color, the stronger the correlation. White square means there is no a significant correlation).

Table 1. Summary statistics.

Variables	Median	Mean	Std. Dev	Description	Reference Year	Source
AWU	5.00	4.97	2.82	Annual work units per 1000 hectares	2010	Eurostat (online data codes: for_AWU and forest_area), FAO Forest Resources Assessment [28,39]
PF_forests	60.00	52.95	26.66	Production function for all forest area (%)	2010	Global Forest Resources Assessment 2010 [39]
Fellings	62.16	63.54	17.65	Fellings as percent of net annual increment (%)	2010	FOREST EUROPE/UNECE/FAO enquiry on pan-European quantitative indicators [40]
ln_GDP	10.09	10.14	0.71	Log GDP per capita (current US$)	Average 2010–2011	World Development Indicators [41]
AgVA	2.13	2.72	1.60	Agriculture, value added (% of GDP)	Average 2010–2011	World Development Indicators [41]
FS_Emp	1.40	1.55	0.88	Forestry sector employment as a proportion of total labor force	2011	FAO, Contribution of the forest sector to national economies [42]
State_for	49.40	48.07	21.14	State and public forest, ha or %	2010	Eurostat [28]
Priv_for	50.60	51.93	21.14	Private forest, ha or %	2010	Eurostat [28]

Table 1. *Cont.*

Variables	Median	Mean	Std. Dev	Description	Reference Year	Source
GS_ha	19.76	20.00	7.33	Growing stock (million m^3) per ha of forest	2010	FOREST EUROPE/UNECE/FAO enquiry on pan-European quantitative indicators and EUROSTAT [40]
GS_ha_w	23.54	22.94	7.75	Growing stock per ha of forest for wood supply	2010	FOREST EUROPE/UNECE/FAO enquiry on pan-European quantitative indicators and EUROSTAT [28,40]
Forest_protect	17.00	16.81	13.97	Forest within protected areas, % FRA2010	2010	Global Forest Resources Assessment 2010 [39]
Removals_State	1.13	1.47	1.38	Removals (m^3) per ha of forest (State Ownership)	2010	Eurostat [28]
Removals_State_w	1.43	1.67	1.53	Removals (m^3) per ha of forest for wood (State Ownership)	2010	Eurostat [28]
Removals_Priv	1.67	1.89	1.31	Removals (m^3) per ha of forest (Private + Others)	2010	Eurostat [28]
Removals_Priv_w	1.86	2.13	1.40	Removals (m^3) per ha of forest for wood (Private + Others)	2010	Eurostat [28]
Forest_on_land	34.31	37.58	16.60	Forest area (% of land area)	Average 2010–2011	World Development Indicators [41]
ln_Forest_Area	8.12	8.31	1.05	Log of Total forest area (1000 hectares)	2010	Eurostat [28]
Main Function (Qualitative Variable)	(1)			Primary designated functions of forest	2010	Global Forest Resources Assessment 2010 [39]

Production—15; Multiple Use—4; Conservation of biodiversity—1; None or unknown-1. Note: data accessed + by source websites on March 2017.

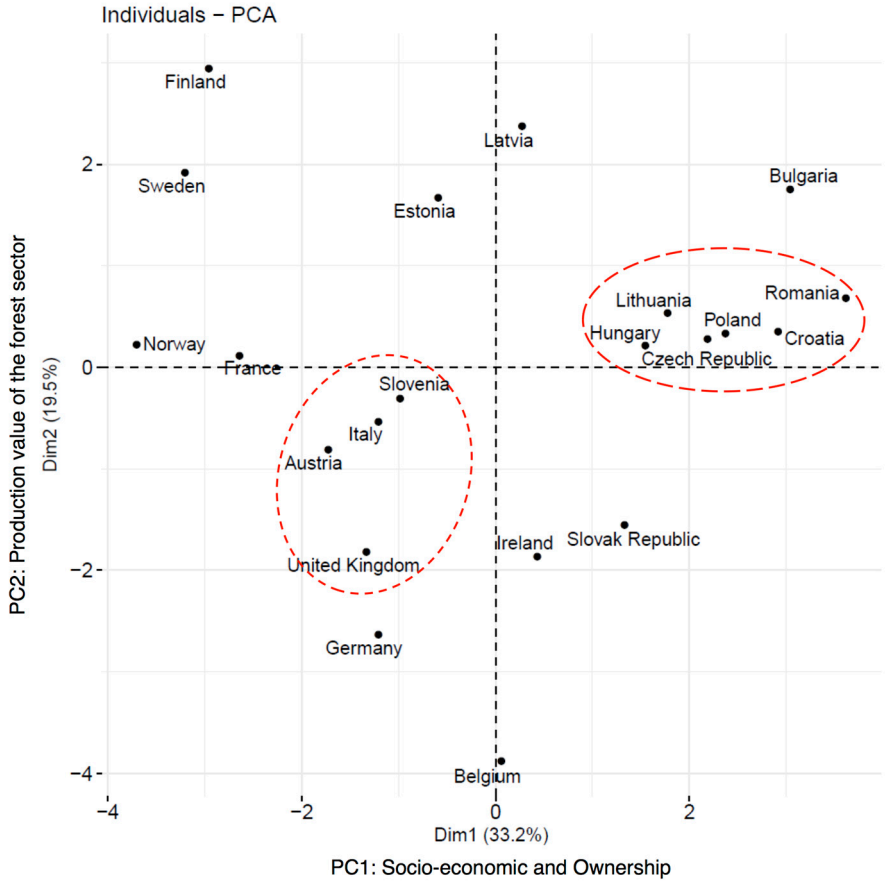

Figure 2. Countries score for the first and second PCs.

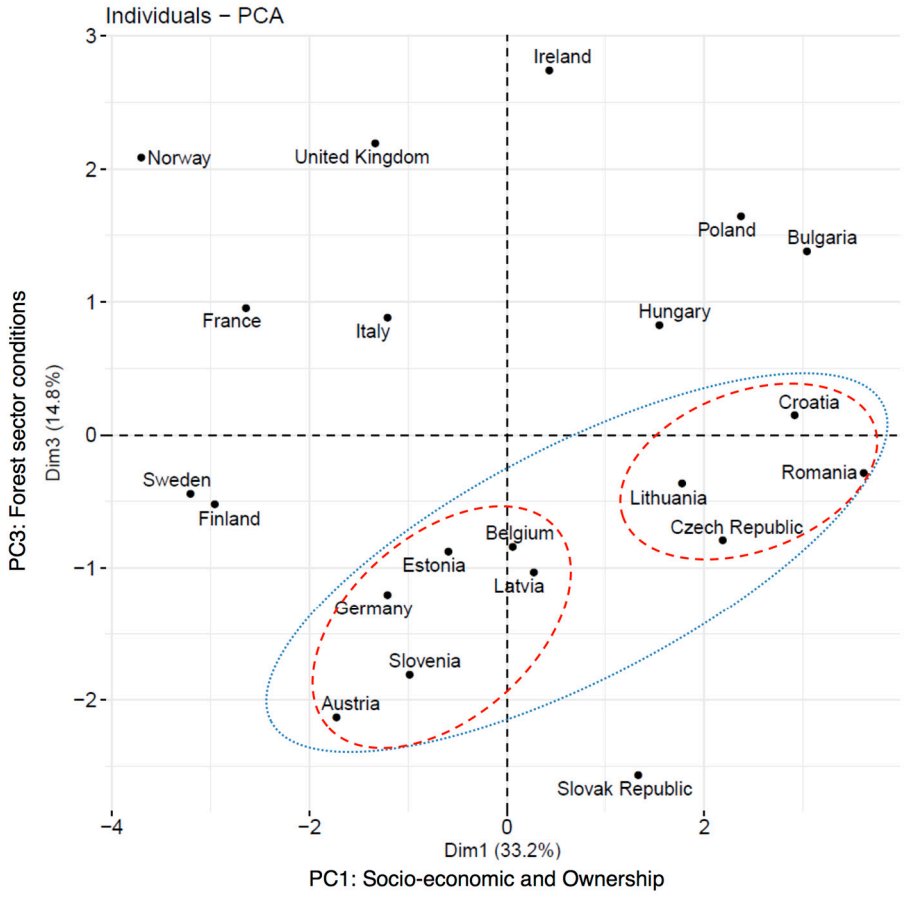

Figure 3. Countries score for the first and third PCs.

Table 2. Contribution of each variable to the first three principal components in % (own elaboration).

Variables	Principal Component 1 Socio-Economic Conditions and Ownership	Principal Component 2 Production Value of the Forest Sector	Principal Component 3 Forest Sector Conditions
AWU	14.54	0.87	0.01
PF_forests	0.00	26.20	1.50
Fellings	0.66	0.01	9.61
ln_GDP	15.98	4.62	0.80
AgVA	10.21	11.61	0.20
FS_Emp	0.00	16.56	15.60
State_for	18.28	0.21	0.75
Priv_for	18.28	0.21	0.75
GS_ha	3.03	4.18	23.22
Forest_protect	1.47	5.57	16.64
Removals_State	7.52	1.88	0.61
Removals_Priv	2.14	5.42	13.02
Forest_on_land	3.09	14.76	16.82
ln_Forest_Area	4.80	7.89	0.45

3.2. SFMOs Analysis

3.2.1. Set of Indicators

The chosen indicators aimed to reflect the three pillars of the SFM concept: economic, ecological, and social. The indicators are appropriate for the level of analysis of the actual organizational unit of forest management (i.e., single SFMO), where the forest management is taking place [43]. The selected indicators had to respect the following criteria: (i) be fact based; (ii) be based on available data for all SFMOs; (iii) be easily interpreted. In creating the final list of indicators, we both adapted indicators proposed by existing initiatives (e.g., [44]) and created new ad hoc indicators. One of the ad hoc indicators was, for example, "Labor productivity, Employees/1000 ha". With the help of this indicator, we aimed to assess whether the SFMO re-organized itself through reducing the number of employees and/or outsourcing some of the forest management activities. Another indicator was "Availability of reports in English (yes/no)". This indicator was created in light of the growing importance of the principles of transparency and disclosure of information by SFMOs. The opportunity to monitor the performance of organizations is crucial for the implementation of the principles of sustainability. In addition, the availability of information in English allows effective communication of information to all concerned parties.

Forest management indicators are essential for an organization that performs its activities within a forest ecosystem to retrieve and evaluate data about effects of forest management. Therefore, we placed indicators related to forest resources into a separate group. Guaranteeing adequate forest resources to provide social, economic, and environmental functions for future generations is essential for sustainable development. Knowledge on how and why a forest area changes over time is essential for managing forests sustainably because such changes may result in long-term losses [45]. Environmental protection indicators represent SFMOs' contribution to conservation and sustainable management of resources in the area. Indicators about financial aspects represent the financial viability of SFMOs. This component is one of the main targets for the organization and is compulsory for the achievement of other goals. Indicators about social responsibility and public relations aspects aim to represent a contribution to local livelihood and communities by SFMOs, as well as to indicate the level of transparency.

3.2.2. Data Collection—SFMOs

In this study, we focus on members of EUSTAFOR (see Table 3). The paper does not cover all members of Association, but only those who responded to our questionnaire. The responding organizations (15 SFMOs out of 30, i.e., 50% response rate) represent a broad diversity of SFMOs in Europe.

Table 3. Selected data concerning analyzed SFMOs (own elaboration).

SFMO (Country)	Area of Enterprise, 1000 ha	Forest Area, 1000 ha	Timber Sell, m^3/ha	Forest Management Fee, % from Turnover	% of State Forest to Total Forest Cover	Harvesting Level/Net Annual Increment (NAI), %
ÖBF (Austria)	850	510	3.6	12.6	13.1	22.8
Hrvatske šume (Croatia)	2019	2019	2.6	3.5	77.0	98.5
LSR (Czech Republic)	1284	1284	6.1	51.7	48.3	70.7
RMK (Estonia)	1209	904.7	4.6	11.7	40.8	82.0
Metsähallitus (Finland)	12,538	9100	1.7	34.8	37.9	50.3
ONF (France)	1700	1500	7.5	−15.5	9.4	66.7
Landesbetrieb ForstBW (Germany)	325.3	306.7	6.9	14.9	2.8	98.5
Landesforst Mecklenburg-Vorpommern (Germany)	190	180	5.2	12.6	1.6	66.7
Coillte (Ireland)	445	410	4.7	1.2	55.5	123.3
Veneto Agricoltura (Italy)	8	5.8	1.6	0.0	0.1	32.9
Directorate General of State Forests (Lithuania)	1040.7	974	4.7	17.9	45.1	56.9
Statskog (Norway)	5900	1007	0.8	14.6	9.8	50.3
The State Forests National Forest Holding (Poland)	7603.8	7292.8	5.4	15.8	78.1	82.0
Romsilva (Romania)	3215.8	3108.9	3.9	6.4	47.3	36.4
LESY Slovenskej republiky (Slovakia)	898.7	898.7	6.0	2.4	46.5	70.7

Data on the management of selected SFMOs were obtained from publicly accessible data, namely financial statements (balance sheets, income statements), annual reports, corporate responsibility (CR)/sustainability/integrated reports, official web-pages, etc., and through the questionnaire. The questionnaire was based on a chosen set of indicators, open questions (e.g., a question about the main non-wood-production-oriented activities in order to have an initial idea of the main diversification strategy and goals adopted by the SFMOs), and a voluntary comments section. The questionnaires were prefilled with available data from publicly accessible sources. The data enquiry was for the time period of 2013–2015. During the first phase, the EUSTAFOR central office sent the questionnaire to members covering 20 countries and 33 SFMOs through the internal mailing list, followed by two reminders. During the second phase, we contacted SFMOs that had not responded through their official emails with the help of local experts (mainly scientists). The data were collected between December 2016 and March 2017.

3.2.3. SFMOs Data Analysis—Cluster Analysis

A cluster analysis based on 29 variables, was used to analyze SFMOs (see Table 4). Since some variables had missing values, the R studio package mice was used for the estimation of these gaps. We decided to use hierarchical cluster analysis instead of PCA because there are more variables than observations [46].

Table 4. List of indicators for cluster analysis and their basic statistical values (own elaboration).

Indicators Category	Indicators	Median	Mean	Standard Error Mean	Confidence Intervals (0.95) Mean	Variance	Standard Deviation	Coefficient of Variation
Economic	Profit/assets	2.8	2.9	0.7	1.4	6.4	2.5	0.9
	Expenditure for services per ha of land	105.4	168.2	53.1	114.0	42,350.9	205.8	1.2
	Timber sell per ha of forest	168.8	161.7	32.3	69.3	15,665.8	125.2	0.8
	Timber sell per ha of total forest area, m^3/ha	3.8	3.7	0.5	1.1	4.2	2.0	0.6
	Profit per ha of total forest area	9.6	27.1	10.5	22.5	1647.5	40.6	1.5
	Profit/turnover	9.0	12.2	2.8	6.1	120.2	11.0	0.9
	Investment in forest management, euros per ha of total forest area	20.6	29.5	10.5	22.6	1669.4	40.9	1.4
	Distribution of reinvestment in forest management, %	12.3	14.6	3.2	6.9	157.5	12.5	0.9
	Money paid to the state budget (forest management fee), %	12.6	13.6	3.6	7.6	189.4	13.8	1.0
	Existence of risk strategy or risk policy (yes/no)	1.0	0.7	0.1	0.3	0.2	0.5	0.7
	Market share of the national supply of industrial round wood, % (range from 1 to 4)	2.0	2.5	0.3	0.7	1.7	1.3	0.5
Forest management	Hunting activities (yes/no)	1.0	0.8	0.1	0.2	0.2	0.4	0.5
	Ratio of state forest to total forest cover, %	40.8	34.2	6.8	14.6	698.5	26.4	0.8
	Growing stock per ha of production forest (m^3/ha)	256.8	244.3	23.3	50.0	8160.1	90.3	0.4
	Ratio of production forest to total area of SFMO, %	74.8	70.1	6.8	14.6	696.4	26.4	0.4
	Certified forest, %	100.0	94.5	3.9	8.3	224.4	15.0	0.2
	Ratio of SFMO roundwood removals to country roundwood removals, %	35.2	29.8	7.4	15.8	815.0	28.5	1.0
	Harvesting level/NAI, %	66.7	67.3	7.0	15.1	739.6	27.2	0.4
	Comparison of net annual increment of SFMO to country, %	0.0	−0.5	0.3	0.7	1.6	1.3	−2.4
	Forest damaged area, % (range from 1 to 4)	1.0	1.7	0.3	0.5	1.0	1.0	0.6
	Sawmills (yes/no)	0.0	0.1	0.1	0.2	0.1	0.4	2.6
Environmental protection	Protected forest, %	8.1	19.5	5.2	11.2	406.1	20.2	1.0
	Protected area, %	22.2	26.4	5.2	11.2	409.9	20.2	0.8
Social responsibility and public relations	Labor productivity, Employees/1000 ha	3.5	3.5	0.7	1.6	8.1	2.8	0.8
	Labor productivity, m^3/ha	3.9	3.6	0.5	1.1	3.9	2.0	0.5
	Gender ratio, %	18.8	23.1	2.4	5.1	84.9	9.2	0.4
	Tourism activities. (yes/no)	1.0	0.9	0.1	0.1	0.1	0.3	0.3
	Free access to non-wood forest products for population (yes/no)	1.0	0.9	0.1	0.1	0.1	0.3	0.3
	Availability of reports in English (yes/no)	1.0	0.5	0.1	0.3	0.3	0.5	1.0

Initially, each SFMO was a single cluster and then the algorithm proceeded iteratively joining at each stage the two most similar clusters until a single cluster was obtained. To measure the dissimilarity among the observation, we used the Ward method [46]. The Ward's minimum variance method allows the creation of a cluster at each step by including in it the SFMO that leads to the minimum increase in the intra-cluster variance after its merging in the cluster. The initial distance between SFMOs is defined by the squared Euclidean distance. We drew conclusions about the similarity of two observations based on the location on the vertical axis where branches containing those two observations are first merged. As we move up the dendrogram, some objects were merged as an effect of objects that were similar to each other. The earlier (lower in the dendrogram) the merging occurred, the more similar the clusters of observations were to each other [36]. The height of the merging was measured on the vertical axis, indicating how different the two SFMOs are. Thus, SFMOs that merged at the bottom of the diagram were very similar to each other, whereas SFMOs that merged at the top of the diagram were very different.

In order to give robustness to the decision about the number of clusters in the dendrogram, we considered a gap statistic [47]. This is an algorithm that compares the change in within-cluster dispersion (within intra-cluster variation for a given k cluster is the total within sum of square) with the expected value under the null hypothesis (no clustering). The higher the Gap statistic value, the better the clustering. This analysis showed that the best clustering in our dataset was given by six units.

4. Results

4.1. Principal Components Analysis (PCA)

In this study, we obtained three principal components (PC) (see Table 2) that distinguished different groups of European countries, which we can observe on the four quadrants of the PCA graphs (see Figures 2 and 3) in terms of similarities in the forest sector at a national level with respect to the selected indicators.

Principal Component 1(PC1): Socio-economic conditions and Ownership. The most influential variables are the economic ones related to the public forest sector: ownership of forests (private and public are the reciprocal of one another), GDP per capita, Annual Working Unit (AWU) in forestry, removals from State, and Agricultural Value Added on total GDP (see Table 2).

The Socio-economic and Ownership component is influential in eastern European countries with a lower GDP per capita, a presence of state ownership in the forest sector (more than 40%), and a higher number of AWUs. We can see these countries on the right-hand side of the graphs presented in Figures 2 and 3. Ireland and Belgium are positioned slightly to the right of center on the graphs as they have a high GDP per capita but also a high level of state forest ownership. Like Belgium and Ireland, Germany also has a high level of state forest land compared to other western European countries and a high GDP per capita, but it is on the left part of the graph for the first component since the AWU is lower than the average. Two other variables with an influence on PC1 (removals from State, Agricultural Value Added on total GDP) have a positive correlation with a variable of state forest (%), with values of 0.51 and 0.57, respectively (see Figure 1). They therefore pull eastern European countries with high values for these variables to the right of the graphs.

Principal Component 2(PC2): Production value of the forest sector. The most influential variables are the production function for all forest area, the percentage of employment in forestry compared to all economic sectors, the percentage of forest on total land, and Agricultural Value Added on total GDP (see Table 2).

For the component of Production value of the forest sector, countries with the most productive forest management systems are in the upper part of Figure 2; i.e., eastern and central European countries, as well as Finland, Sweden, Norway, and France. The variables "percentage of employment in forestry compared to all economic sectors" and "percentage of forest on total land" have a strong positive relationship (R = 0.8). Therefore, we can see on the left graph the range of countries from

Finland with a high level of forest land (73%) and high level of forest sector employment (2.8% with a mean of 1.55%), to Belgium at the bottom with a low level of forest land (22.5%) and low level of forest sector employment (0.6%). The variable of production function for all forest area has a positive correlation with other variables that comprise PC2, but the correlation shows a weak relationship ($R \approx 0.38$) (see Figure 1). The patterns are therefore not that clear.

In Figure 2, we can distinguish two groups of countries that have quite similar characteristics. The first is represented by Lithuania, Romania, Poland, Hungary, Croatia, and the Czech Republic. They have a high percentage of state forestland, quite high level of forest productivity, and low GDP per capita compared to other countries in the analysis. The second group is composed of Slovenia, Italy, Austria, and the United Kingdom. They have a low level of state forest ownership (circa 20–30%), average or lower than average productivity, and medium level of GDP per capita.

Principal Component 3(PC3): Forest sector conditions. The most influential variables are the growing stock, percentage of forest on total land, percentage of forest within protected areas and percentage of employment in forestry compared to all economic sectors, Removals of forest (Private + Others), and Fellings as a percentage of net annual increment (see Table 2).

The variables contributing most to PC3 are not well correlated. Nevertheless, we can distinguish one large group for this component that is spread along the vertical axis with values from 0.1 to −2.2 (see Figure 3, blue ellipse). The forest sectors of these countries have a high value for growing stock and high % of forest within protected areas; indeed, these variables have a moderate positive relationship ($R = 0.48$). If we also consider PC1, this group can be split into two for the variable of forest ownership (see Figure 3, red ellipses) (group 1: Romania, Lithuania, Croatia, and the Czech Republic; group 2: Belgium, Estonia, Latvia, Germany, Slovenia, and Austria).

4.2. SFMOs Clusters and Outliers

With the cluster analysis, we obtained three clusters (C1, C2, C3) of SFMOs in the EU and three outliers (O1, O2, O3) that are fused rather arbitrarily at much higher distances and do not fit into the analysis clusters (see Figure 4). Each cluster has some particular characteristics that distinguish it from the others. Therefore, first we will describe three clusters and try to see which indicators have influenced the formation of these clusters. Next, we look at three outliers as their absence from the group is explained not by data anomalies, but by different values of indicators. Although outliers do not represent a typical SFMO, it is worth looking into them in more depth as they can provide useful insights into typical management practices that influence performance, either positively or negatively.

Cluster 1 (C1) is composed of two Nordic countries SFMOs: Statskog (Namsos, Norway) and Metsähallitus (Vantaa, Finland). Both countries are dominated by boreal forest, the state owns large areas (Metsähallitus owns a total area of 12,538 thousand ha of which the total forest area is 9100 thousand ha while Statskog owns a total area of 5900 thousand ha of which the total forest area is 1007 thousand ha, average in the sample—total: 2615 thousand ha, forested: 1966 thousand ha), and the majority of their managed land area is not productive forest (only 8% of Statskog land is productive forest and 28% for Metsähallitus in comparison to total area of SFMO). Another similarity is that they are relatively small players in the forest economy of their countries.

In addition to timber production, both use resources for the development of new business activities (such as renewable energy, real estate, etc.) (see Table 5). Institutionally, they place a strong emphasis on incorporating social and environmental values into management systems and on the concept of forest multi-functionality [48]. The social and environmental emphasis can be seen in the organizational structure of corresponding SFMOs. Metsähallitus comprises the Business Unit (Forestry, Laatumaa, and three subsidiaries) and Parks & Wildlife Finland, which attends to public administration duties. The number of visitors to Finland's national parks continues to increase and their economic impact on local businesses grew by nearly 13% in one year from 2014 to 2015 [48]. Statskog, together with commercial activities such as property, energy, and forestry, has activities devoted specifically to outdoor life [49].

Table 5. Non-wood business activities of SFMOs (own elaboration).

SFMO (Country)	Nurseries	Renewable Energy	Real Estate/Land	Extraction of Natural Recourses	Recreation	Fishing	Game	Consulting	Other
ÖBF (Austria)		X	X	X	X	X	X	X	Wild Media (video and photo shooting)
Hrvatske šume(Croatia)	X	X		X	X		X	X	Horticulture
LSR (Czech Republic)	X			X		X	X		
RMK (Estonia)	X						X		The Põlula Fish Farm; Christmas trees sale
Metsähallitus (Finland)	X		X	X		X	X		
ONF (France)	X	X	X		X	X	X	X	Daycares for municipalities
Landesbetrieb ForstBW (Germany)	X	X	X			X	X		
Landesforst Mecklenburg-Vorpommern (Germany)	X		X		X		X	X	Ecopoints
Coillte (Ireland)	X	X	X		X			X	Panels production (MEDITE SMARTPLY)
Veneto Agricoltura (Italy)		X	X		X				
Directorate General of State Forests (Lithuania)	X						X		Timber transportation
Statskog (Norway)		X	X		X	X	X		
The State Forests National Forest Holding (Poland)	X			X	X	X			
ROMSILVA (Romania)	X		X	X		X	X		Breeding of pure-breds horses
LESY Slovenskej republiky (Slovakia)	X		X	X	X	X	X	X	

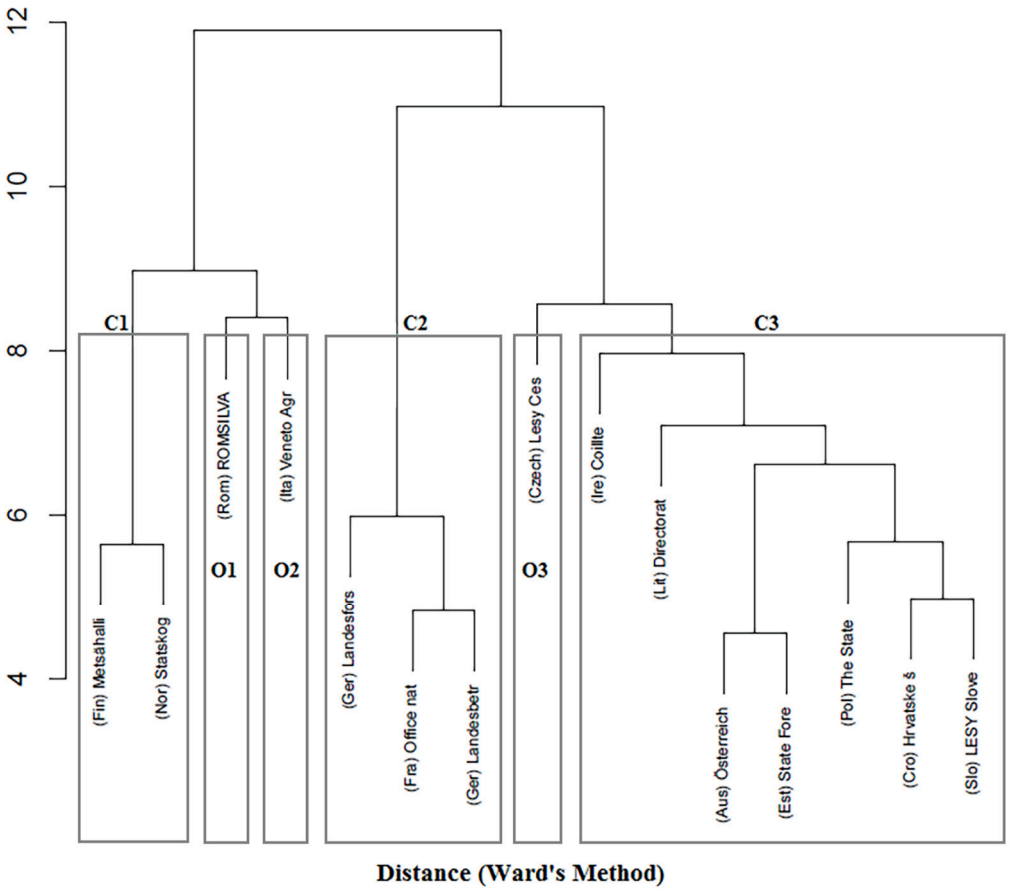

Figure 4. Cluster analysis of SFMOs.

Cluster 2 (C2) is composed of three SFMOs: Landesbetrieb ForstBW (Germany); Office National Des Forêts (ONF) (France); Landesforst Mecklenburg-Vorpommern (Germany). All SFMOs have a very high amount of production forest (in Germany more than 90%). At the same time, three of them have the lowest numbers by indicator "profit/assets" (ONF—(0.07), Landesbetrieb ForstBW—(−0.39), Landesforst Mecklenburg-Vorpommern—(0.34), in average in the sample—(2.89). In addition, the indicator of labor productivity (employees/1000 ha) in C2 is very different from other SFMOs (see Figure 5). The number of employees per 1000 ha in these SFMOs is much higher than in others (e.g., in ONF it is six employees per 1000 ha, in Landesbetrieb ForstBW—11 employees per 1000 ha when an average in the sample—3.5 employees per 1000 ha).

Cluster 3 (C3) is the biggest one and includes several cases, i.e., six SFMOs from six countries: LESY Slovenskej republiky (Banská Bystrica, Slovakia); Croatian Forests (Hrvatske šume) Ltd. (Zagreb, Croatia); The State Forests National Forest Holding (Raszyn, Poland); State Forest Management Centre (RMK) (Tallinn, Estonia); Austrian Federal Forests (ÖBF) (Vienna, Austria); Directorate General of State Forests (DGST) (Vilnius, Lithuania); Coillte (Dublin, Ireland). LESY Slovenskej republiky (Slovakia) and Hrvatske šume Ltd. (Croatia) converge inside C3 with a rather low height on the vertical axis, which shows their similarity. Indeed, many of the indicators for these SFMOs are quite similar, such as profit per ha of forest, forest management fee, and labor productivity. At the next step, the previous two SFMOs are merged with Polish State Forests National Forest Holding. It manages a bigger area than other SFMOs in C3 and it dominates in the forest sector of its country (only around 16–18% of forest is privately owned) [50]. In the next step, another convergence composed of Estonian RMK and Austrian ÖBF emerges. ÖBF is not a big player in its country but operates in highly competitive markets with private forest owners (around 74%), and has been forced to adopt institutional reforms in response. ÖBF is actively developing new business areas in its portfolio (e.g., real estate, consulting, renewable energy)

(see Table 5). Instead, RMK is operating in a vastly expanding market, in which private forest owners are also dominant (61%) but still maintain significant market shares [17]. The Directorate General of State Forests (DGSF) (Lithuania) joined the cluster during the next step. The focus of this SFMO is clearly timber production; however, the efficiency compared to other SFMOs might be not at the highest level. Although they outsource quite a lot of activities, the indicator of labor productivity (see Figure 5) is the highest in the C3 (around four employees per 1000 ha, average in C3—2.6 employees per 1000 ha). The last SFMO to join C3 is Coillte (Ireland). By any standard, Ireland is poorly endowed with forests, and forestry contributes only minimally to GDP. However, in the last century, the area of forests in Ireland has increased from 1% to around 10%. Coillte has basically held a virtual monopoly over timber production with one of the highest profits (75 euros per ha of total area of SFMO) within the sample, even though 42% of forests are privately owned. Apart from forestry, Coillte has a very diverse business portfolio (see Table 5): from panels' production to infrastructure projects.

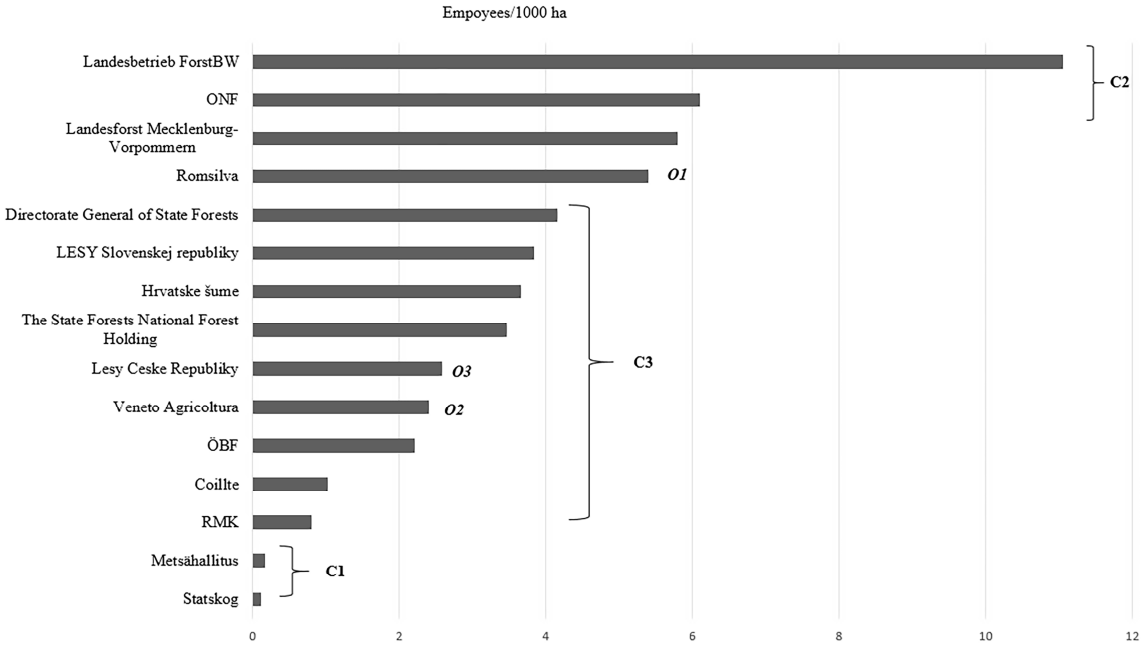

Figure 5. Labor productivity in SFMOs (own elaboration).

Outlier 1 (O1)—National Forest Administration Romsilva (Bucharest, Romania). This SFMO owns a big area and covers around 47% of total forest cover in the country. A total of 73% of Romsiva's area is a production forest and growing stock is the highest among the analyzed SFMOs—453 m^3/ha compared to a median of 257 m^3/ha. However, the indicator "Profit per ha of total forest area" for Romsilva is not that high in comparison with others. It is 8 euros/ha, when, for example, in the neighboring Czech Republic, it is more than 155 euros/ha. At the same time, labor productivity is half (5.4 employees/1000 ha in Romsilva, 2.6 employees/1000 ha in LSR) (see Figure 5).

Outlier 2 (O2) is Veneto Agricoltura (Rome, Italy). Veneto Agricoltura is a Regional Agency that supports the Regional Council in the areas of agriculture, agro-food, forestry, and fishery. In our study, we only focused our attention on the forestry part of the organization, specifically on the Cansiglio Forest. Compared to other SFMOs, it is the smallest enterprise. Profits gained from selling wood and concessions fee are reinvested in forest management.

Outlier 3 (O3)—Lesy České republiky, s.p. (LČR) (Hradec Králové, Czech Republic). It is the most profitable SFMO within the sample. Profit per ha of forest area in LČR is 155.8 euro/ha, whereas the sample mean is only 27 euro/ha.

5. Discussion

5.1. General Considerations

In this research, we chose to use a cluster analysis because we wanted to see what groups of SFMOs display similar SFM priorities. Only a few studies have been carried out on this topic. We found one model to study the SFMOs' performances proposed by Krott and Stevanov [29] on a benchmarking model for comparing the performance of two selected State Forest Institutions (SFI): profit-seeking and activating. The model was based on eight criteria (Orientation toward demand on existing private goods, Orientation toward public-good and merit-good demand, Ecological sustainable management, Production efficiency, Profits from forests, Orientation toward new forest goods, Speaker for forestry, Mediator of all interests in forests). The model helped in the identification of some of the indicators in this study (e.g., profits from forest, new forest goods). However, we used a cluster analysis as we sought to group similar organizations rather than to benchmark each of them by a single indicator.

5.2. Cluster Analysis and PCA

SFMOs with diversified goals—Cluster 1 (Statskog (Norway); Metsähallitus (Finland)). This model of managing state property aims to balance the three pillars of sustainability. SFMOs operate in a highly competitive market in economies where forestry contributes significantly to the GDP [17]. Therefore, both SFMOs have a strong focus on commercial forestry but within a limited area of organization and comprehensive focus is on environmental concerns and the delivery of public goods as main guidelines. These countries are positioned close together in Figure 2 of the PCA, specifically with respect to indicators such as AWU, % of private owned forests, and Production function for forest area. Additionally, these countries have very high standards for statistics availability and transparency. This finding is in agreement with the study of Bastida and Benito (2007), in which both countries were identified as top-performing for transparency, meaning they have modern accounting systems, not only in the private, but also in the public sector [51]. These countries are among few that report on the monitoring of outdoor recreation activities nationwide [52]. In fact, the SFMOs of these two countries were those who provided the highest number of indicators including social issues that were problematic to collect in other SFMOs (e.g., Metsähallitus (Finland) provided indicators such as "accidents during work for employees", "number of technical training hours/training days per employee, average", "number of tourist visits", and others; Statskog (Norway) provided "number of health and safety training hours per employee, average", "cultural heritage sites", and others). Thus, we can argue that these SFMOs are well advanced in integrating all the three pillars of the SFM into their management practice, as well as principles of transparency and information disclosure.

SFMOs—protectors of public interests—Cluster 2 (Landesbetrieb ForstBW (Germany); Office National Des Forêts (ONF) (France); Landesforst Mecklenburg-Vorpommern (Germany)). In both countries, forest management is based on "close-to-nature" principles and SFMOs perform as protectors of forest. We can argue that the environmental pillar of SFM is strong in these countries. In Germany, a significant proportion of forest areas (up to 70%) are designated as protected areas according to the different protection categories delineated in the forest law and nature protection law [53]. The ONF in France is the only authority in charge of implementing the French forestry regime that requires that forests are liable to strict management planning based on the multi-functionality of the forest. French public opinion shares this idea of the forestry regime and is not usually favorable to logging. For the population, the forest should remain a place to walk in natural surroundings, left in relative wilderness [54]. In the countries of C2, forestry is of minor importance and its contribution to the national income is quite modest compared to other economic sectors. Moreover, for the last several decades, this model of state forestry has been ineffective and has required sizeable subsidies [54], as indicated by the low performance in "profit/assets", which indicates the inefficient management of resources even if there is the potential for the development of commercial forestry. The current federal government is therefore seeking to improve the effectiveness of forestry administrations and

reduce the bureaucracy [55] given that 85% of the forestry regime's financing plan comes from the central government in the form of compensatory payments designed to cover the ONF's management costs [54]. These SFMOs are characterized by the higher number of employees per 1000 ha compared to other SFMOs, which might be explained by the fact that commercial functions and the delivery of public goods are not separated. The results of the PCA show that the differences between countries are in PC2 and PC3. The variables that most influence these differences are production function % for all forest area in PC2 (75% in France and 0% in Germany—[39]) and growing stock in PC3 (in favor of Germany). However, it is worth noting that the data for Germany for production function % for all forest area is not consistent with data obtained from the questionnaire, where more than 90% is dedicated to production forests.

Profit-oriented SFMOs—Cluster 3 (LESY Slovenskej republiky (Slovakia); Croatian Forests (Hrvatske šume) Ltd. (Croatia); The State Forests National Forest Holding (Poland); State Forest Management Centre (RMK) (Estonia); Austrian Federal Forests (ÖBF) (Austria); Directorate General of State Forests (DGST) (Lithuania); Coillte (Ireland). LESY Slovenskej republiky (Slovakia) and Hrvatske šume Ltd. (Croatia)). These SFMOs have adopted a commercial model of forest management, and therefore, the economic pillar of SFM prevails. It is interesting to note that this model is used in both forest rich (e.g., Austria and Poland) and low forested countries (e.g., Ireland). Thus, it seems that the predominance of economic goals is not necessarily connected with the importance of the forests in the national economy, as one might have expected. It is interesting to note that Irish Coillte is the commercialized state organization that manages to retain a dominant share of the market, where private forest owners do not feature significantly in the timber economy [17]. However, Coillte has the biggest institutional challenge over the next 10 years as private owners begin to compete as their forests reach maturity and they become competitors in the Irish market [17]. Together with Coillte, other SFMOs apart from Austrian ÖBF manage a significant part of the forest area in their countries. It is therefore important to remember that when commercialized state organizations operate in economies where the share of private forest ownership is low or is expected to increase over time, they can pose a threat to private producers because of their dominant position in the market, which they are unlikely to yield [17]. The C3 also contains SFMOs with different organizational structures, such as joint stock companies owned by the State in Ireland and Austria and a state enterprise as a government department in Poland [9]. The State Forests (Poland) is a hierarchical organization with policy-making and forest management being integrated within one entity. Brukas (2010) characterized this SFMO with a command style administration, while ÖBF and Coillte have functions of profit-oriented managers. The cluster analysis results for SFMOs do not seem to be very similar with groups that we can distinguish with the help of PCA for countries. C3 is relatively large and consists of SFMOs from countries with very different profiles. The differences are in geographical location, natural conditions, economic, and social development. We can therefore assume that the direction and management goals of SFMOs do not depend solely on the country characteristics or geographical region, but on their own priorities.

The Outlier 1—The National Forest Administration Romsilva (Regia Naţională a Pădurilor Romsilva), in Romania, is a state-owned enterprise with a commercial mandate that is responsible for the development of publicly owned forests, and the management of hunting and fishing grounds [56]. More than 90% of its income comes from timber sales. Beleţu (2011) stated that Romsilva is a large enough organization to cover the financial costs and thus be financially independent of the state; the leverage effect will allow it to improve profits, without being affected by financial risk [57]. However, in a comparison with other SFMOs in neighboring countries and assuming similar natural conditions, our findings indicate that resources could be used more efficiently and bring more profit to the SFMO. Data collected from Romsilva as a production-oriented organization has the resources for increasing its profitability. With its management priority, it is very close to C3.

The Outlier 2 is represented by Veneto Agricultura, specifically the Cansiglio Forest, in Italy. It is hard to compare it to others due to its size. It is a public services oriented organization. However, in the

Cansiglio Forest, there has historically been and currently is a well-developed timber production organization. Additionally, many projects are aimed at delivering public goods, mainly recreational activities [58]. Thus, their management model is close to C1.

The Outlier 3 is LČR, Czech Republic. Its high profitability might be explained by an economic reform of forestry in the country after 1990 when supervision in the state forests was separated from operating performance. LČR's business strategy is based on complex contracting out of forestry operations and on the sale and purchase of timber for the price at the stump [20]. At the same time, LČR is the largest manager of protected sites in the Czech Republic. It manages sites with a high conservation interest with due regard for the individual categories of land protection, and particularly the presence of protected species, valuable habitats, and other significant natural and cultural phenomena. LČR is very close to C3, in particular to Coillte (Ireland), as both of them are big players in the forest economy of their countries with a very efficient use of resources.

The existence of diverse SFMO clusters illustrates the possibility of different approaches to SFM with a focus on multiple management goals (e.g., profit gaining, environment protection, or a more balanced combination of different public services delivery).

5.3. Data Availability

There is a lack and inconsistency of data at both the national and SFMO level. Some magnitudes and trends can be inferred from existing studies of individual countries, but different definitions of state ownership and data scarcity make cross-country comparisons difficult. Data about forestry at a national level are spread over different databases ([28,41], etc.). However, there is still a lot of data missing and/or not updated, and data are very often aggregated by region, which does not allow for comparison within a region. These limitations were identified in a study commissioned by the European Centre of Enterprises with Public Participation and of Enterprises of General Economic Interest (CEEP), where it was concluded that specific data for the forest sector are not covered in any of the data sources [59]. The situation with SFMOs is even worse. The differences between countries and SFMOs in the legal framework, forest management objectives, system of accountancy, etc., result difficulties in a comparison between organizations in terms of financial, social, and environmental indicators . In addition, there is very little data in English available on-line. In most cases, SFMOs did not reply with data on social issues that are challenging forestry and should be at the core of the attention of SFM, such as "number of technical training hours per employee", "number of health and safety training hours per employee", "accidents during work for employees", etc. Consequently, many indicators that were selected in this study were eliminated due to insufficient data. It remained unclear whether the data were not available because the companies do not collect it or do not report it. Typical economic/financial data are better presented, but even so, it is difficult to make a comparison because of the differences among data provided. We can conclude that there is a gap in transparency and information disclosure by SFMOs on emerging key issues (such as social issues, while more is available on biodiversity for example). It is worth noting that greater numbers of indicators for the analysis might have modified the results of obtained clusters, especially social ones, as their presence is very limited in the research.

6. Conclusions

The article lays the groundwork for a deeper understanding of state-owned forests in Europe. Different characteristics of the forest sector in the EU countries (e.g., the area of state forests, their relative importance for government budgets, the scope of their responsibilities, and the social and environmental obligations assigned to them) result in different performances among SFMOs. For example, there is typically one large SFMO per country (e.g., Metsähallitus in Finland), but there are exceptions (e.g., Lithuania with 42 State Enterprises). Some of SFMOs are heavily market oriented with a strong economic pillar of SFM, such as Coillte (Ireland) and LČR (Czech Republic), and others

put a bigger emphasis on public goods service delivery (social pillar), especially nature protection (environmental pillar), such as SFMOs in Germany.

Through a comparison of countries grouped by PCA and SFMOs clustering, we can conclude that the way SFMOs are organized and managed is often predetermined by the specific conditions of the forest sector in the country. However, there are exceptions (e.g., Ireland, Austria) when the forest sector of a country does not always define the way a specific SFMO decides to manage its land. Of course, country characteristics lay down preconditions for the development of the sector, but it is up to the SFMO to choose a management direction and priorities.

In the cluster analysis, we identified three main groups of SFMOs. The main reason for this division is a different prioritization of SFM pillars, mainly in two ways: profit or ecosystem services delivery or a combination of these. Some of the SFMOs lean towards the economic pillar of SFM, whereas others tend to first of all satisfy the environmental and social aspect of SFM. It is important to note that regardless of the ultimate goal, all SFMOs follow the principles of SFM. Cluster analysis resulted in three groups of SFMOs and three outliers. The cluster C1 was composed of organizations with a strong emphasis on service delivery, but at the same time, with a rather small area compared to the total area of SFMOs and with a strongly profit-oriented forestry and diversified business portfolio (well balanced pillars of SFM). Cluster C2 presents service-oriented SFMOs without a profit gaining goal, mainly subsidized by the government (environmental pillar prevails). Cluster C3 represents SFMOs with a profit-oriented goal (economic pillar prevails). Outlier 1 (Romsilva) and Outlier 3 (LČR) are leaning towards Cluster 3. Outlier 2 (Veneto Agriculture) is similar to Cluster 1.

In summary, the most substantial general performance trends were: (i) most SFMOs are owned by the state but function as a private unit; (ii) increased importance of environmental services and social inclusiveness in the management of SFMOs, specifically in Nordic countries (i.e., Finland, Norway); (iii) SFMOs actively develop new business activities, among the most common are sources of renewable energy, real estate, and recreation activities; (iv) increased outsourced activities and consequent reduction of SFMO personnel.

The lack of a wider range of explanatory variables and more comprehensive data sets were the major obstacles to a broader analysis in this study. Despite these limitations, this work enriches the knowledge about the state-owned forest sector and its performance in Europe. In terms of a recommended way forward for SFMOs, we can argue that there is a need for optimization between social, economic, and ecological pillars in SFM by SFMOs. Finding a better balance between the competing demands on Europe's forests may require different management approaches/models. An SFMO management model in one country may be an important catalyst for reforms and changes in the other countries; however, a model is not directly transferable and has to be interpreted in the natural conditions, political, and socioeconomic context of the recipient country. The existence of one single, "best model" of organization is highly unlikely. However, the findings from this work stress the importance for future studies to have a closer look at particular case studies of different management models, their implications, possible obstacles, and positive outcomes with a wider set of indicators and their changes over time. It will bring researchers and policymakers to a better understanding of the management of SFMOs and factors that are influential for their success.

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