Article

State Forest Management Organisations in Europe: A comparison using Principal Component Analysis and Cluster Analysis

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Abstract: State Forest Management Organizations (SFMOs) play a crucial role in the European forest sector, managing almost half the forests in the region. SFMOs are often managed for timber production only 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 is to analyse the current situation of SFMOs by clustering them according to indicators that reflect three pillars of the common understanding of sustainable forest management (SFM) concept. With the help of Principal Component Analysis (PCA), we grouped countries according to common characteristics of the forest sector at the national level. Results show three main clusters of SFMOs in Europe. The first cluster has rather small but commercially-oriented forestry unit together with other business activities and a strong focus on public services. The second sees itself as the protector of public interest, rather than commercially-oriented organisations. 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 an enduring feature of the economic landscape and will remain an influential force globally for some years to come [1]. A key role in managing state-owned resources is played by the so-called State-Owned Enterprises (SOEs). 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 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 United Nations Economic Commission for Europe (UNECE) showed that, in 2010, forests in Europe (excluding Russian Federation, Ukraine and Belarus – no need to explain why they are excluded) 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 an expansion of the traditional meaning of forest sustainability. Besides sustainable yield, the three dimensions of economic, ecological and social sustainability are expected to be on the forestry agenda [6]. These principles are embraced by EU Forest Strategy (2013) and are the guidelines for forest management in the EU. SFM, together with increased social demand and awareness about ecosystem services [7] provided by forests, forced State Forest Management Organizations (SFMOs)[1] to rethink their management goals.

Because of their public nature, SFMOs are expected to have a special responsibility in guaranteeing SFM. They should find a balance between social, economic and environmental aspects in their management models in order to satisfy the respective requirements and reach the SFM goals. The forest sector in the EU has a significant influence on all three pillars of sustainable development. 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 [8]. The sector has also a relevant role in the European economy and social development, and State-owned forests contribute to this role. Scholars (e.g., [9], [10], [11]) specifically highlight the role of forests

[1] 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. However, starting from the section 2.2 we tend to use the term "State forest management organization (SFMOs)" due to our sample (based on EUSTAFOR membership) that includes different legal forms of state ownership (see Table 4 in [20]), not just enterprises. SFMOs are defined as commercially-oriented state forest companies, enterprises and agencies that have sustainable forest management and sustainable wood production as major concerns [29].

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 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 [12].

Despite the large share of state forest in Europe, its relative economic importance and its high importance in providing a wide range of ecosystem services relevant for human wellbeing, there is a gap in the scientific literature about this topic. The majority of recent studies on state ownership are focused on developing countries or countries in transition: China [13], Vietnam [14], Central and Eastern European Region [15] and just a few on EU countries: Germany [16], United Kingdom [17], Czech Republic [18], Lithuania [19]. 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, not systematically collected or analyzed [20]. 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 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 is presented of obtained SFMOs clusters (section 4 and section 5). The final part of the paper gives the conclusions (section 6).

2. Background

2.1 State ownership

The state sector has always been important in many economies, including the most advanced ones. 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

115 political ideology of countries can influence a lot of maintaining of state ownership
116 ([21], [22], [23], [24])
117 Much of the extant literature tends to view SOEs as inefficient, bureaucratic
118 entities that are poorly managed without coherence in their strategy and resource
119 allocation decisions, and as a result they are less efficient in state than in private
120 hands ([25], [24], [21] and others). However, it is time to revise the role and
121 management systems of SOEs, especially due to the intense changes the state sector
122 went through in 1980-1990 [3]. These changes were mainly connected with a large
123 wave of privatization in Europe. SOEs were less productive than private enterprises,
124 additionally this was worsened by the difficulty in setting the objectives for SOEs
125 and evaluating their performance, as well as by a lack of commitment to good
126 administration [25]. Nevertheless, since the privatization wave, the direct role of the
127 state in the economy has not completely lost its relevance: there is still a number of
128 SOEs and the sector is remarkable for its size, economic impact, and the "strategic"
129 (e.g. energy, transport) sectors in which it operates [3]. At the same time, in many
130 market economies, SOEs have undergone enormous changes stimulated by pro-
131 market reforms. Globalization of the financial markets and increased international
132 trade also demanded that enterprises be more free and flexible than usually possible
133 in state ownership [3]. It is important to remember that "SOEs are expected to fulfill
134 special responsibilities and obligations for social and public policy purposes… (that)
135 may go beyond the generally accepted norm for commercial activities" and
136 disclosure of the "special obligations" should also increase transparency of SOEs
137 [26] (p.26). These changes have stimulated the rise of new ideas for SOEs
138 development.

139 *2.2 SFMOs in the EU*

140 The distribution of state forests and private forests in Europe varies a lot among
141 countries. For instance, in countries like Austria, France, Norway, Slovenia private
142 forests account for more than 75% of the total forest area in the country. Conversely,
143 Poland, Czech Republic, Croatia have only 15-30% of private forests [27]. Despite
144 these differences, SFMOs have traditionally played a major role in the forest sector
145 in European countries, justified by duties (tasks of forest authority and
146 management), large resource base and significant relationships with key
147 stakeholders [28]. Almost all SFMOs in Europe are represented under the umbrella of
148 EUSTAFOR [2]. EUSTAFOR currently has 30 members in 22 European countries.
149 Members represent the majority of the EU countries, Norway and Bosnia and
150 Herzegovina. EUSTAFOR's members account for one third of the EU forest area,

[2] The European State Forest Association (EUSTAFOR) is 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 [29] (https://www.eustafor.eu/).

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 [29].

The European forest sector went through intense changes in 1980-1990. These were generated by the collapse of the communist system in Eastern Europe and followed changes in the economy ([30], [15]). 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 is 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 [15]. With separate organization for forest management roughly speaking there are two directions for development: towards either commercial-oriented organization or delivering specific ecosystem services of public interest. Of course, many organisations integrate both in their development, and all of them, nowadays, are expected to pursue by means of management choices the three pillars of sustainability (economic, environmental and social).

Transition towards more competitive sustainable forest management is necessary for SFMOs. Forestry has a big 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, rising labor costs forced these organizations to undertake profound changes in their production processes. The main changes had a technological and organizational nature, like mechanization of harvesting operations, personnel reduction, outsourcing of some activities ([33], [31]). The success or failure of these organizations depends on many different factors such as market situation, 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. Instead, 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 [14]. This can be explained by the fact, that in some Eastern European countries, state forest authorities see themselves as the gatekeepers whose responsibility 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) [15]. New products emergence 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, provision of public goods and activities (e.g. recreation) through the concept of forest multifunctionality. Sustainability is a matter of balancing among 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, 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 on the forest sector at national and SFMO level. These data were processed with a Principal Components Analysis (PCA) [3] and a cluster analysis [4] respectively, as explained in the following subsections.

3.1. Principal Components Analysis (PCA)

3.1.1 Countries dataset description

The cross country dataset was built for 21 European countries, the SFMOs of which are members of EUSTAFOR: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Romania, Slovak Republic, Slovenia, Sweden, United Kingdom.

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[3] PCA is 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).[57].

[4] "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" [40] (p.385).

The analysis was based on 14 quantitative variables and a qualitative variable (see Table 1). Due to data heterogeneity in the international databases, we chose indicators based on data availability and how recently the data was produced. Since the variables Annual work unit (AWU), Main Function, and Fellings had some missing values, the R studio package *mice* was used for the estimation of these gaps.

Table 1. Summary statistics (own elaboration)

Variables	median	mean	std.dev	Description	Reference year	Source
AWU	5.00	4.97	2.82	Annual work units per 1 000 hectares	2010	Eurostat (online data codes: for_AWU and forest_area), FAO Forest Resources Assessment
PF_forests	60.00	52.95	26.66	Production function for all forest area (%)	2010	Global Forest Resources Assessment 2010 (FRA 2010)
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
ln_GDP	10.09	10.14	0.71	Log GDP per capita (current US$)	Average 2010 – 2011	World Development Indicators
AgVA	2.13	2.72	1.60	Agriculture, value added (% of GDP)	Average 2010 - 2011	World Development Indicators
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
State_for	49.40	48.07	21.14	State and public forest, ha or %	2010	Eurostat
Priv_for	50.60	51.93	21.14	Private forest, ha or %	2010	Eurostat
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
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

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Forest_protect	17.00	16.81	13.97	Forest within protected areas, % FRA2010	2010	Global Forest Resources Assessment 2010 (FRA 2010)
Removals_State	1.13	1.47	1.38	Removals (m^3) per ha of forest (State Ownership)	2010	Eurostat
Removals_State_w	1.43	1.67	1.53	Removals (m^3) per ha of forest for wood (State Ownership)	2010	Eurostat
Removals_Priv	1.67	1.89	1.31	Removals (m^3) per ha of forest (Private + Others)	2010	Eurostat
Removals_Priv_w	1.86	2.13	1.40	Removals (m^3) per ha of forest for wood (Private + Others)	2010	Eurostat
Forest_on_land	34.31	37.58	16.60	Forest area (% of land area)	Average 2010 - 2011	World Development Indicators
ln_Forest_Area	8.12	8.31	1.05	Log of Total forest area (000 hectares)	2010	Eurostat
Main Function (Qualitative Variable)	(1)			Primary designated functions of forest	2010	FAO, Global Forest Resources Assessment 2010

(1) *Production -15; Multiple Use – 4; Conservation of biodiversity – 1; None or unknown-1.*

Note: data accessed by source websites on March 2017

3.1.2. Countries data analysis[5] - 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 not 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 [35]. 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 Figure 3 and 4). The PCA allowed ranking of the contribution of each variable to the components (see Figure 2). 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. The observations were classified based on the principal components.

Figure 1. Correlation among quantitative variables

[5] All analysis were performed using RStudio, the software for statistical computing and graphics (www.rstudio.com).

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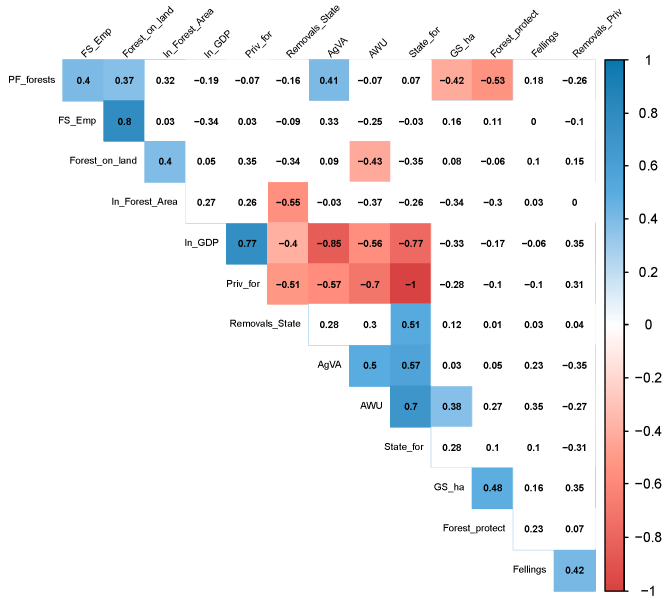

3.2. SFMOs analysis

3.2.1. Set of Indicators

The chosen indicators aimed to reflect the three pillars of SFM concept: economic, ecological and social aspects. The indicators are appropriate to the level of analysis of the actual organizational unit of forest management (i.e. single SFMO), where sustainable forestry management is taking place [36]. 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. [37]) and created new ad hoc ones.

Forest management indicators are essential for an organization that performs its activities within a forest ecosystem and they aim to retrieve data about 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 [38]. 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 level of transparency.

3.2.2. Data collection - SFMOs

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In this study, we focus on members of EUSTAFOR (see Table 2). 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, with a response rate of 50%) represent a broad diversity of SFMOs in Europe and can give a general, preliminary picture of the state forest sector in the EU.

Table 2. 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/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)	12538	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 is 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. 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). Data were collected December 2016 – March 2017.

3.2.3. SFMOs data analysis - Cluster analysis

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Cluster analysis was used for SFMOs. It was based on 29 variables (see Table 3). Since some variables had some missing values, the R studio package *mice* was used for the estimation of these gaps. We decided to use a hierarchical cluster analysis because there are variables but few observations. Since this method does not apply a rule of thumb for the sample size (while for the PCA the number of observations should be higher than the number of variables), it suits the study [39].

Table 3. List of indicators for cluster analysis and their basic statistical values (own elaboration)

Indicators	median	mean	SE.mean	CI.mean. 0.95	var	std.dev	coef.var
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	42350.9	205.8	1.2
Timber sell per ha of forest	168.8	161.7	32.3	69.3	15665.8	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
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
Protected forest, %	8.1	19.5	5.2	11.2	406.1	20.2	1.0

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Protected area, %	22.2	26.4	5.2	11.2	409.9	20.2	0.8
Labor productivity, Employees/1000 ha	3.5	3.5	0.7	1.6	8.1	2.8	0.8
Labor productivity, m3/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 is a single cluster and then the algorithm proceeds iteratively joining at each stage the two most similar clusters until a single cluster is obtained. To measure the dissimilarity among the observation we use the Ward method [39]. 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 draw conclusions about the similarity of two observations based on the location on the vertical axis where branches containing those two observations first are merged. As we move up the dendrogram, some objects are merged. These correspond to objects that are similar to each other. The earlier (lower in the dendrogram) the merging occurs, the more similar the clusters of observations are to each other [40]. The height of the merging is measured on the vertical axis and indicates how different the two SFMOs are. Thus, SFMOs that merge at the bottom of the diagram are very similar to each other and SFMOs that merge at the top of the diagram are very different.

In order to give robustness to the decision about the number of clusters in the dendrogram, we consider a gap statistic [41]. It is an algorithm that compares the change within-cluster dispersion (within intra-cluster variation for a given k clusters is the total within sum of square) with its expected value under the null hypothesis (no clustering). The higher the Gap statistic, the better the clustering. This analysis showed that the best clustering in our dataset is given by 6 units.

4. Results

4.1. Principal Components Analysis (PCA)

In this study, we used PCA to try to distinguish different groups of European countries in terms of similarities in the forest sector at national level with respect to the selected indicators. We obtained three principal components (see Figure 2). The figure shows which variables determine the location of observations on the four quadrants of the PCA graphs (Figure 3 and 4). Moreover, it allows interpretation of the first three principal components (PC).

Figure 2. Contribution of variables to the principal components: **(a)** Principal component 1; **(b)** Principal component 2; **(c)** Principal component 3.

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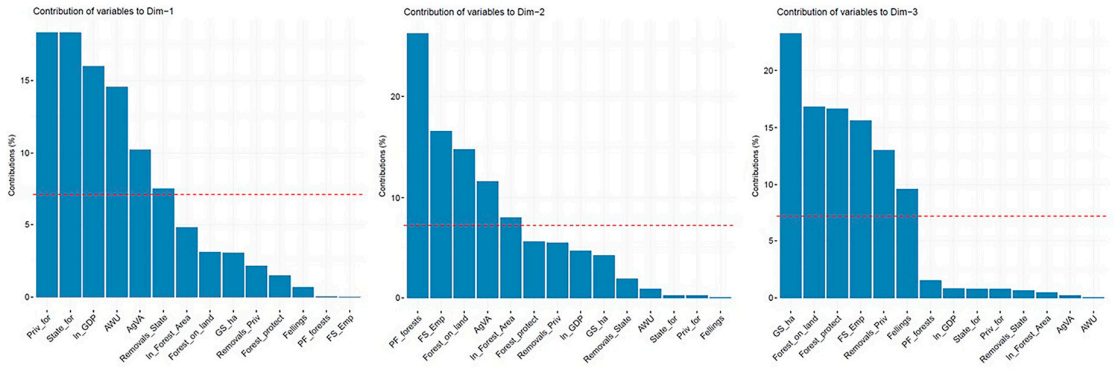

(a) (b) (c)

Principal Component 1(PC1): Socio-economic 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, Agricultural Value Added on total GDP (Figure 2 (a)).

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 larger number of AWUs. We can see these countries on the right-hand side of the graphs presented in Figure 3 and Figure 4. 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, contrarily to Ireland and Belgium. 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, percentage of forest on total land, Agricultural Value Added on total GDP (Figure 2 (b)).

For the component of Production value of the forest sector, the most productive countries are in the upper part of Figure 3: eastern and central European countries as well as Finland, Sweden, Norway, France. The variables "percentage of employment in forestry compared to all economic sectors" and "percentage of forest on total land" have a 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

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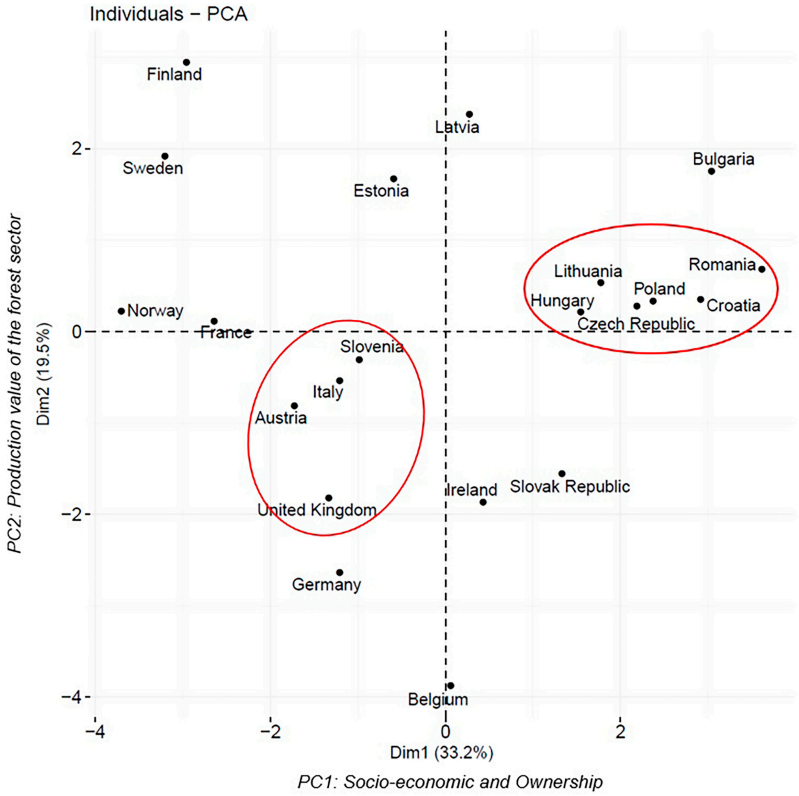
forest sector employment (0.6%). The variable of production function for all forest area has a positive correlation with other variables that comprise PC2, but the correlation shows weak relationship (R≈0.38) (see Figure 1). The patterns are therefore not that clear.

In Figure 3 we can distinguish two groups of countries that have quite similar characteristics. The first is represented by Lithuania, Romania, Poland, Hungary, Croatia and 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 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.

Figure 3. Countries score for the first and second PCs



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), Fellings as percentage of net annual increment (Figure 2 (c)).

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. The forest sectors of these countries have a high value for growing stock and high % of forest within protected areas; indeed, these

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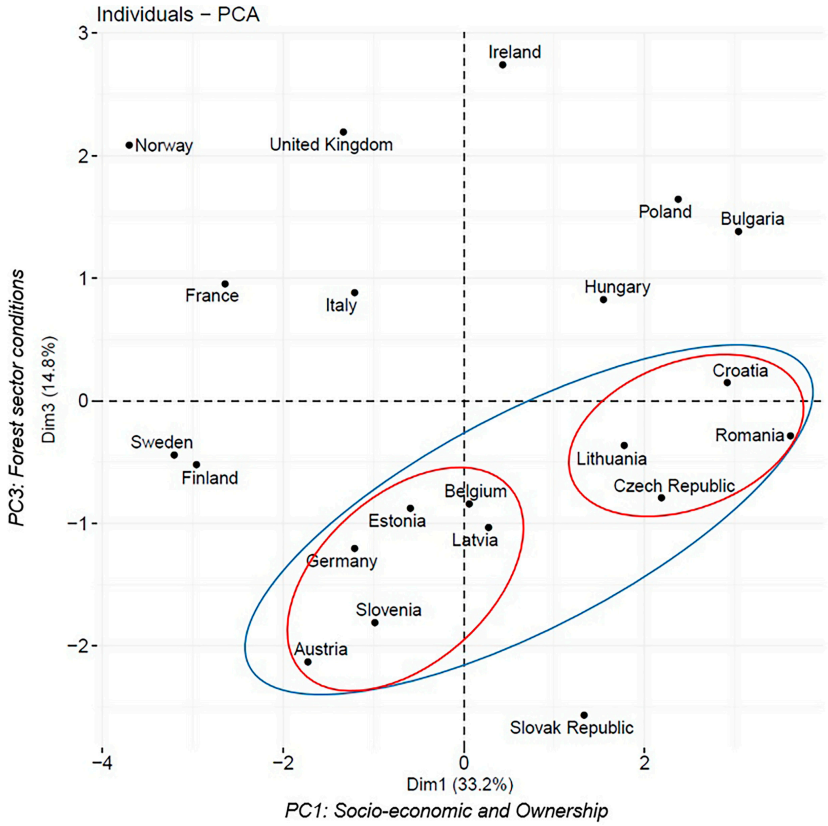
variables have moderate positive relationship (R=0.48). If we consider PC1 as well, this group can be split in two for the variable of forest ownership (see Figure 4) (group 1: Romania, Lithuania, Croatia and Czech Republic; group 2: Belgium, Estonia, Latvia, Germany, Slovenia and Austria).

Figure 4. Countries score for the first and third PCs

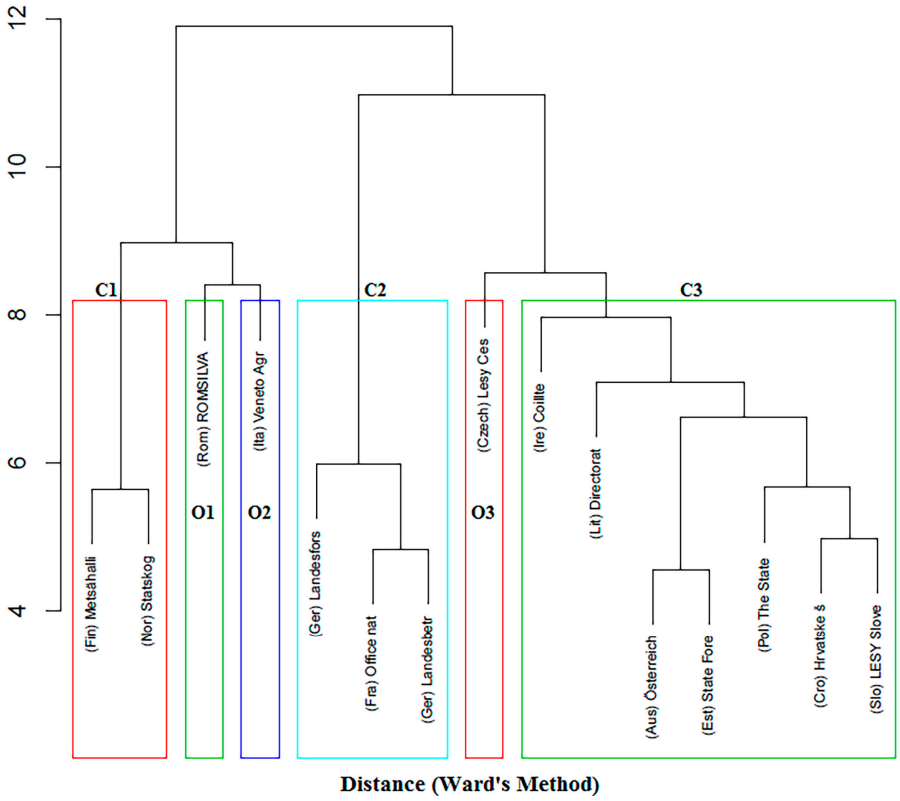


4.2. SFMOs clusters

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 5). Each cluster has some particular characteristics that distinguish it from others. We will describe three clusters first and then three outliers.

Cluster 1 (C1) is composed by two SFMOs: Statskog (Norway); Metsähallitus (Finland). Both SFMOs are representatives of Scandinavian countries. They therefore operate in similar natural conditions, which could explain their closeness in the cluster. However, there are also other similarities. Both own large areas (Metsähallitus owns 12538 thousand ha, Statskog-5900 thousand ha, average in the sample - 2615 thousand ha). But they are relatively small players in the forest economy of their countries. Their minor role in commercial forestry of the countries is confirmed by the fact that the proportion of production forest is relatively small (8% for Statskog and 28% for Metsähallitus in comparison to total area of SFMO).

Figure 5. Cluster analysis of SFMOs



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410 Additionally, to timber production, both use resources for the development of
411 new business activities (such as renewable energy, real estate, etc.) (see Table 4).
412 Institutionally, they place a strong emphasis on incorporating social and
413 environmental values into management systems and on the concept of forest
414 multifunctionality [42]. The social and environmental emphasis can be seen in the
415 organizational structure of corresponding SFMOs. Metsähallitus comprises the
416 Business Unit (Forestry, Laatumaa and 3 subsidiaries) and Parks & Wildlife Finland,
417 which attends to public administration duties. The number of visitors to Finland's
418 national parks continues to increase and their economic impact on local businesses
419 grew by nearly 13% in one year from 2014 to 2015 [42]. Statskog, together with
420 commercial activities such as property, energy and forestry, has activities devoted
421 specifically to outdoor life [43].

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426 **Table 4.** 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	

Cluster 2 (C2) is composed by three SFMOs: Landesbetrieb ForstBW (Germany); Office National Des Forêts (ONF) (France); Landesforst Mecklenburg-Vorpommern (Germany). All SFMOs have 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 6). The number of employees per 1000 ha in these SFMOs is much higher than in others (e.g. in ONF it is 6 employees per 1000 ha, in

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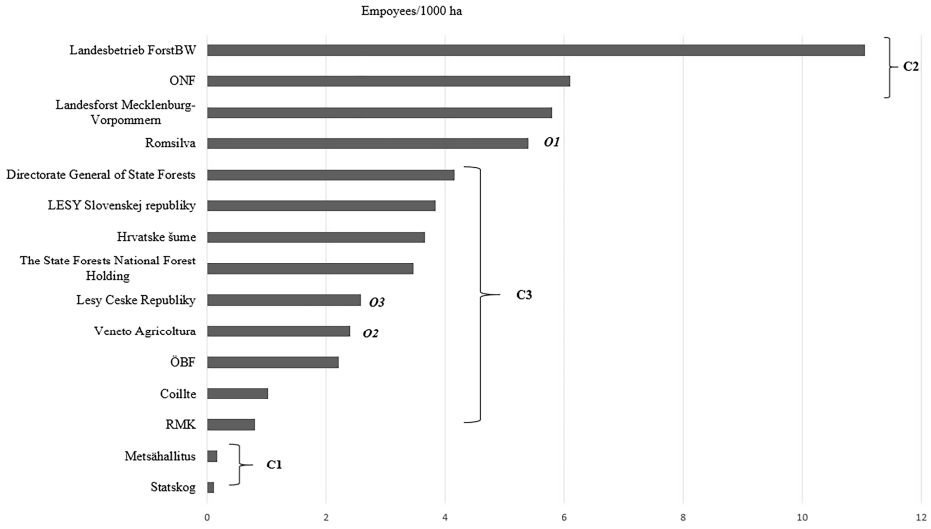
436 Landesbetrieb ForstBW – 11 employees per 1000 ha when an average in the sample
437 – 3.5 employees per 1000 ha).

438 **Figure 6.** Labor productivity in SFMOs (own elaboration)



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441 *Cluster 3 (C3)* is the biggest one and it includes several cases, i.e. 6 SFMOs from
442 6 countries: (LESY Slovenskej republiky (Slovakia); Croatian Forests (Hrvatske
443 šume) Ltd (Croatia); The State Forests National Forest Holding (Poland); State Forest
444 Management Centre (RMK) (Estonia); Austrian Federal Forests (ÖBF) (Austria);
445 Directorate General of State Forests (DGST) (Lithuania); Coillte (Ireland). LESY
446 Slovenskej republiky (Slovakia) and Hrvatske šume Ltd (Croatia) converge inside
447 C3 with a rather low height on the vertical axis, which shows their similarity. Indeed,
448 many of the indicators for these SFMOs are quite similar, such as profit per ha of
449 forest, forest management fee, and labor productivity. At the next step, the previous
450 two SFMOs are merged with Polish State Forests National Forest Holding. It
451 manages a bigger area than other SFMOs in C3 and it dominates in the forest sector
452 of its country (only around 16-18% of forest is privately owned) [44]. At the next
453 step, another convergence composed of Estonian RMK and Austrian ÖBF is
454 emerged. ÖBF is not a big player in its country but operates in highly competitive
455 markets with private forest owners (around 74%), and has been forced to adopt
456 institutional reforms in response. ÖBF is actively developing new business areas in
457 its portfolio (e.g. real estate, consulting, renewable energy) (see Table 4). Instead,
458 RMK is operating in a vastly expanding market, in which private forest owners are
459 also dominant (61%) but still maintain significant market shares [15]. The Directorate
460 General of State Forests (DGSF) (Lithuania) joined the cluster at the next step. The
461 focus of this SFMO is clearly timber production; however, the efficiency compared
462 to other SFMOs might be not at the highest level. Although they outsource quite a
463 lot of activities the indicator of labor productivity (see Figure 6) is the highest in the
464 C3 (around 4 employees per 1000 ha, average in C3 - 2.6 employees per 1000 ha). The
465 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 profit (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 4): from panels' production to infrastructure projects.

Outlier 1 (O1) –National Forest Administration Romsilva (Romania). This SFMO owns a big area and covers around 47% of total forest cover in the country. 73% of Romsiva`s area is a production forest and growing stock is the highest among 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 6).

Outlier 2 (O2) is Veneto Agricoltura (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 focused our attention only on the forestry part of the organization, specifically on the Cansiglio Forest. Compared to other SFMOs, it is the smallest enterprise. Profits that is gained from selling wood and concessions fee are reinvested in forest management.

Outlier 3 (O3) - Lesy České republiky, s.p. (LČR) (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

Cluster analysis and PCA

5.1. General considerations

In this research we decide to use cluster analysis, because we wanted to see what groups of SFMOs exist in respect to forest management 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 [28], specifically the benchmarking model. It is based on comparison of performance of selected State Forest Institutions (SFI) with the two reforming benchmarks, meaning profit-seeking (forest government) and facilitating SFI (forest governance). Model is based on eight criterions (Orientation toward market demand, Orientation toward none-market demand, Sustained forest stands, Cost efficiency, Profits from forests, Orientation toward new forest goods, Speaker for forestry, Mediator of all interests in forests). The model was inspiring in the identification of some of the indicators (e.g. profits from forest, new forest goods). However, we used cluster analysis as we aimed to group similar organizations rather than to benchmark them by each single indicator.

5.2. Cluster analysis and PCA

 doi:10.20944/preprints201710.0054.v1

Cluster 1 (Statskog (Norway); Metsähallitus (Finland)) can be named "SFMOs with diversified goals". This model of managing state property is balancing among the three pillars of sustainability. SFMOs operate in a highly competitive market in economies where forestry contributes significantly to GDP [15]. Therefore, both SFMOs have a strong focus on commercial forestry but within a limited area of organization and their comprehensive focus is on environmental concerns and delivery of public goods as main guidelines. The position of the countries according to PCA is consistent with the SFMOs clustering regarding PC1 and PC2, specifically with respect to indicators as AWU, % of private owned forests, Production function for forest area. Additionally, these countries have very high standards for statistics availability and transparency issues. It is confirmed by the study of Bastida, F. and Benito, B. (2007), in which both countries are located in the "Cluster B: top-performing" concerning issues of transparency, meaning they have modern accounting systems, not only in the private but also in the public sector [45]. These countries are among few that report on monitoring of outdoor recreation activities nationwide [46]. 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 that SFMOs of Cluster 1 are well advanced in integrating all the three pillars of the SFM, as forestry, its multifunctinality and transparency issues are well incorporated into economic, social and cultural components.

C2 (Landesbetrieb ForstBW (Germany); Office National Des Forêts (ONF) (France); Landesforst Mecklenburg-Vorpommern (Germany)) can be named "SFMOs - protectors of public interests". In both countries forest management is based on "close-to-nature" principles and SFMOs perform as protectors of forest. In Germany a large amount 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 [47]. The ONF in France is the only authority in charge of implementing the French forestry regime that implies that forests are liable to strict management planning based on the multifunctionality of the forest. French public opinion shares the 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 [48]. 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 required sizeable subsidies [48]. It is visible from the indicator of "profit/assets", it is very low in the C2 SFMOs, which means inefficient management of resources even if there is a big potential for the development of commercial forestry. The current federal government is therefore seeking to improve

549 the effectiveness of forestry administrations and reduce the bureaucracy [49] given
550 that 85% of the forestry regime's financing plan comes from central government in
551 the form of compensatory payments designed to cover the ONF's management costs
552 [48]. C2 characterizes by the higher number of employees per 1000 ha compared to
553 other SFMOs that might be explained by the fact that commercial functions and
554 delivery of public goods are not separated. We cannot state that separation of these
555 functions will improve conditions for state forestry. Experience has shown that
556 outcomes will vary depending on the unique circumstances defining the overall
557 institutional framework [15]. It is therefore up to the decision makers to decide
558 which goal they would like to reach: profit or service delivery. Comparing the results
559 of PCA and cluster analysis in C2, we can see that by PC1 France and Germany are
560 located quite close. The difference is in PC2 and PC3. The most determining variable
561 in PC2 is production function % for all forest area, which for France is 75%, for
562 Germany – 0% [50]. The data for Germany is not consistent with data obtained from
563 the questionnaire, where more than 90% is dedicated to production forests. In PC3
564 the most determining variable is growing stock. Both in the country analysis and
565 SFMOs, the difference in the variable is quite big in the favor of the analyzed
566 administrations in Germany.
567 C3 (LESY Slovenskej republiky (Slovakia); Croatian Forests (Hrvatske šume) Ltd
568 (Croatia); The State Forests National Forest Holding (Poland); State Forest
569 Management Centre (RMK) (Estonia); Austrian Federal Forests (ÖBF) (Austria);
570 Directorate General of State Forests (DGST) (Lithuania); Coillte (Ireland). LESY
571 Slovenskej republiky (Slovakia) and Hrvatske šume Ltd (Croatia)) can be identified
572 as the "profit-oriented". SFMOs of this cluster have adopted a commercial model of
573 forest management. It is interesting to note that this model is used in both forest rich
574 (e.g. Austria and Poland) and low forested country (e.g. Ireland). Thus, it seems that
575 the predominance of economic goals is not necessarily connected with the
576 importance of the forests in the national economy, as one might to have expected.
577 Interesting to note, that Irish Coillte is the commercialized state organization that
578 manages to retain a dominant share of the market, where private forest owners do
579 not feature significantly in the timber economy [15]. However, Coillte has the biggest
580 institutional challenge over the next 10 years as private owners begin to compete as
581 their forests reach maturity and they become competitors on the Irish market [15].
582 Together with Coillte, other SFMOs apart from Austrian ÖBF manage a significant
583 part of the forest area in their countries. It is therefore important to remember that
584 when commercialized state organizations operate in economies where the share of
585 private forest ownership is low or is expected to increase over time, they can pose a
586 threat to private producers because of their dominate position in the market, which
587 they are unlikely to yield [15]. C3 also contains SFMOs with different organizational
588 structure as for example Joint stock company owned by the State in Ireland, Austria
589 and State enterprise as a government department in Poland [20]. The State Forests
590 (Poland) is a hierarchical organization with policy-making and forest management
591 being integrated within one entity. Brukas (2010) characterizes this SFMO with a

command style administration, when ÖBF and Coillte have functions of commercially 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 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 Națională a Pădurilor Romsilva) 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 [51]. More than 90% of its income comes from timber sales. Beleţu (2011) confirms this in her study, stating that Romsilva corresponds to an ideal situation where the current outcome is positive because the operation is large enough to cover the financial costs and so Romsilva has promoted a policy of financial independence; the leverage effect will allow it to improve profits, without being affected by financial risk. However, in a comparison with other SFMOs in neighboring countries, consequently very close natural conditions, we can say that resources could be used more efficiently and bring more profit to the SFMO. Data collected from Romsilva shows that it is a production-oriented organization and 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 (Italy). It is hard to compare it to others due to its size. It is public services oriented organization. However, in the Cansiglio Forest there is historically well developed timber production that is maintained till now. And additionally, many projects are aimed to deliver public goods, mainly recreational activities [53]. We can therefore say that as a management model it is close to C1.

The Outlier 3 is LČR. It is high profitability might be explained by an economic reform of forestry in the Czech Republic after 1990 of 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 selling and purchase of timber for the price at the stump [18]. 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 very efficient use of resources.

The existence of diverse SFMO clusters shows us the possibility of different approaches to SFM with a focus on different 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 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 is spread over different databases ([50], [27], [54] 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. The same limitation was confirmed by a study commissioned by the European Centre of Enterprises with Public Participation and of Enterprises of General Economic Interest (CEEP), since specific data for the forest sector are not covered in any of the data sources [55]. The situation with SFMOs is even worse. Irish SFMO Coillte (2002) emphasizes the differences between countries and SFMOs in the legal framework, forest management objectives, system of accountancy etc., and therefore, the resulting difficulties in a comparison between organizations in terms of financial, social and environmental indicators [56]. 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 had been selected for the set 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 presented better, but even so it is difficult to make a comparison because of the difference among data provided. We can state 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 larger amounts of indicators for the analysis might have changed the results of obtained clusters, especially social ones, as their presence is very limited in the research. The findings from this study stress the importance to study 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.

6. Conclusions

The article lays the groundwork for a richer 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) give us a varied range of SFMOs. For example, there is typically one large SFMO per country (e.g. Metsähallitus in Finland manages more than 12 million ha), but there are exceptions (e.g. Lithuania has 42 State Enterprises with an average of 0.025 million ha). Some of SFMOs are heavily market oriented, such as Coillte (Ireland) and LČR (Czech Republic) and others with a strong emphasis on public goods service delivery, especially nature protection, such as SFMOs in Germany.

Through comparison of countries grouping by PCA and SFMOs clustering, we can note 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.

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

The main recent development tendencies of SFMOs are:

- Most SFMOs are owned by the state but function as a private unit;
- Increased importance of environmental services and social inclusiveness in the management of SFMOs, specifically in Nordic countries (i.e. Finland, Norway);
- SFMOs actively develop new business activities, among the most common are sources of renewable energy, real estate and recreation activities;
- Increased outsourced activities and consequent reduction of SFMO personnel;
- SFMOs are often responsible for the full cycle of forest operations from planting to logging and wood sale but they are not involved in wood processing;
- SFMOs generally decided to separate functions of supervision and management between different institutions (SFMO itself and other state authority).

Acknowledgments: We would like to thank EUSTAFOR and specifically its Executive Director Piotr Borkowski for the support and help in the preparation of the questionnaire and data collection. We are grateful to the SFMOs that have replied to our inquiry and provided valuable data for the research. We would also like to thank local experts, mainly in the scientific community, for sharing their knowledge and available data to provide missing information.

Author Contributions: Liubachyna, A., Secco, L. and Pettenella, D. jointly conceived and designed the idea of the article; Liubachyna, A. collected, analyzed and interpreted data, and wrote the paper; Bubbico, A. carried out the statistical analysis by using PCA and cluster analysis and contributed to data interpretation; Secco, L. helped to structure the contents and provided the overall critical revision of the article.

Conflicts of Interest: "The authors declare no conflict of interest."

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