



Forest subsidy distribution in five European countries



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ARTICLE INFO

Keywords:

European agricultural fund for rural development (EAFRD)
Policy
Incentives
Multifunctional forests
Small-scale forest owners
Bioeconomy

ABSTRACT

Forest subsidies are widely used to achieve policy objectives aimed at maintaining and supporting the provision of the various ecosystem services provided by forests. In the European Union, an important instrument is the European Agricultural Fund for Rural Development (EAFRD) within the EU's Common Agricultural Policy (CAP), but countries also have national subsidy systems. In both cases, individual countries determine which objectives they want to achieve with the subsidy schemes and which measures are supported. In this comparative study, we investigate which forest-related measures are subsidized across Europe and which forest owners, representing a very heterogeneous group, are involved in the activities of the subsidy systems.

We collected data on subsidies paid out for forest-related measures from Austria, Finland, Germany, Slovenia and Sweden from the EAFRD funding period 2014–2020 for a comparison of the funded activities. Further, we analysed how subsidies were distributed among private forest owners with forest holdings of different sizes by performing G-tests to compare the observed with the expected subsidies received by forest owners in the different size categories.

The results show that through the flexibility given by the CAP for countries to adjust their subsidy programmes to the specific national needs, EAFRD funds and equivalent national subsidies are indeed used for a wide range of activities instead of only a few following one common European goal. Reflecting the different needs and various forest functions, the subsidized activities range from the more ecology-oriented "investment to increase resistance and the ecological value of forests" to the more management-oriented "purchase of new machinery and new equipment for forestry operations".

In all five countries, small-scale forest owners with holdings smaller than 200 ha are the largest owner group and manage a large share of the forest area in private hands (from 47% in Austria to 97% in Slovenia). However, especially owners of the smallest holdings (< 20 ha) rarely use the funding scheme of the EAFRD framework and thus receive a disproportionately low share of subsidies. There might be several reasons for this. Small-scale forest owners are generally less involved regarding policy issues (including subsidy schemes) than owners of larger forest holdings and may not be aware of all funding opportunities. In addition, the considerable effort to apply, including project preparation, administration and documentation may be perceived as a barrier.

It became clear that the current subsidy systems of the countries focus on different forest policy objectives. Our study further revealed that the documentation of subsidy distribution is partly unclear and inconsistent across countries hampering European comparisons. However, understanding current subsidy distribution is urgently

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needed for increasing the effectiveness of subsidy systems to achieve European policy goals of vital multifunctional forests.

1. Introduction

Covering about one third of the European land mass, forests play an important economic, social and ecological role in most European countries (FOREST EUROPE, 2020). They provide a wide range of ecosystem services such as biodiversity, soil and water protection, protection against natural hazards and provision of wood and non-wood products (FAO, 2015; FOREST EUROPE, 2020). Therefore, forests have to meet various and sometimes conflicting requirements of different stakeholders, e.g. wood and paper industry, forest owners, nature conservationists, and the general public. This can be particularly challenging in times of global climate change and the biodiversity crisis (Díaz et al., 2019; Steffen et al., 2015). The future of forests could be shaped by several trends and drivers: including economic, societal, technological, ecological or governance trends (Wolfslehner et al., 2020). In general, the importance of forests and the forest-based sector is increasing and one driver combining parts of these trends is the increase of the global demand for renewable resources as many countries aim to shift towards a bioeconomy (Churkina et al., 2020; von der Leyen, 2019).

Subsidy schemes are a widely used tool to steer future developments in the forest sector. They can influence forest management decisions towards the implementation of desired policies (FOREST EUROPE, 2020). Therefore, it strongly matters how subsidies are distributed. In Europe, financial subsidies from European or national funds, followed by tax reliefs are the most common financial instruments to support private forest owners (FOREST EUROPE, 2020). The “Regulation (EU) No 1305/2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)” was adopted to achieve the goals set out in the new EU forest strategy which is “covering the whole forest cycle and promoting the many services that forests provide” (European Commission, 2019; European Union, 2013). This regulation provides the framework for the rural development policy, which is the 2nd pillar of the Common Agricultural Policy (CAP). The EAFRD budget for the 2014–2020 programming period was about €100 billion. Since the CAP encourages flexibility in drafting national CAP strategic plans and the final distribution of subsidies towards different activities and recipients is regulated within each country, there are large differences among national subsidy systems. Such subsidy systems do not necessarily fully support the EU forest strategy (European Commission, 2017b, 2021) and are often a mixture of funding from European, national and/or regional sources.

Subsidies can influence production and management through intertwined mechanisms (Kumbhakar and Lien, 2010; Quiroga et al., 2019; Zhu and Lansink, 2010) but mainly work by two means. On the one hand by the activities that are funded and on the other hand by controlling who receives funding. National and European level policies cover a wide range of partly contradicting objectives, for example regarding biodiversity and energy policy (Winkel and Sotirov, 2016). This makes the choice of which activities to subsidize challenging and requires a careful reconciliation among national and European actors for as long as environmental policies are incompletely integrated (Baulenas and Sotirov, 2020). The EAFRD is used to achieve a number of objectives, including rural development, ecosystem conservation, resource efficiency and a more balanced income distribution. According to a report from the European Commission, the two main measures explicitly assigned to forests account for 4.6% (measure “8. Investments in forest area development and improvement of the viability of forests”) and 0.3% (measure “15. Forest-environmental and climate services and forest conservation”) of total EAFRD contribution (European Commission, 2017b). However, an extensive comparison of the forest related

expenditures and if they reach the anticipated goals is missing in the report because its authors faced several challenges such as the lack of implementation data. Previous studies have examined forest subsidies in the context of wood mobilisation (Lawrence, 2018), cost-sharing programmes (Song et al., 2014) and forest owners’ affinity for subsidies (Quiroga et al., 2019). Nevertheless, there is little research on subsidies from rural development programmes for forestry (Jarský et al., 2014; Jarský and Pulkrab, 2013) and there is still a lack of studies comparing the differences in European countries regarding the use of subsidies and the participation of different forest owner groups.

One group of recipients of financial incentives are private forest owners. Among those, the by far largest group are small-scale forest owners who substantially contribute to the production of traditional forest products (e.g. timber, pulp and paper, bioenergy) as well as raw products for a wider application (e.g. in the chemical industry) (Schmidthüsen and Hirsch, 2010). Moreover, their forests provide a wide range of other ecosystem services without monetary compensation. Policy expectations on forest owners are changing and the possibly conflicting demands and expectations from the wood market and the broader public to adjust forest management are increasing (Lawrence et al., 2020). Further, forest owners’ management practices and goals for forest ownership strongly differ between countries (Feliciano et al., 2017) and their decisions are driven by the interplay of individualistic factors and structural drivers, such as the market, social norms and policies (Deuffic et al., 2018). In addition to changes in external conditions, the ownership structure is in transition, with increasing numbers of owners but decreasing holding sizes and a growing number of more absent private owners (Weiss et al., 2019), making small-scale forest owners an increasingly heterogeneous group. More absent owners of small forests often do not have a formal education in forestry (Krajter Ostočić et al., 2017) and the anticipated resulting decreased interest in timber production counteracts the interest in wood mobilisation e.g. for reaching bioeconomy targets (Lawrence, 2018; Silver et al., 2015). These issues could be intensified by current challenges affecting forests, such as climate change and consequently an increase in extreme events, which are expected to result in a decline of various ecosystem services and therefore to have an impact on forest owners (Hanewinkel et al., 2013; Juerges et al., 2021; Snell et al., 2018). A growing concern is further that too extensively managed forests are not sufficiently adapted to climate change because absent forest owners may miss critical interventions leading to more yet avoidable damages caused by disturbances (Pröbstl-Haider et al., 2017). Incentives for encouraging the management of privately owned forests and thus for wood mobilisation have a long history and had a mixed success (Schaffner et al., 2014; Wilkes-Allemann et al., 2021). When subsidies are equally available (without major barriers e.g. administration) for all forest owners they should efficiently guide use and management of forests according to targets set by forest policy. Yet, with a focus on agriculture it was even shown that subsidies were more efficient on larger farms than on smaller ones (Staniszewski and Borychowski, 2020). As the flow of subsidies is often not well understood (European Commission, 2017b) it is difficult to determine why programmes are successful or not. To keep private forest owners engaged particularly in active forest management and to meet forest policy expectations, well-adjusted subsidy schemes – reaching the intended recipients and consequently goals – are therefore important.

Due to the heterogeneity of subsidy systems, diverse ownership structures and complex regulations, comparing subsidies across European countries is challenging. This consequently hampers the evaluation of subsidy systems and if they actually reach the anticipated goals. By analysing and comparing the forest-related subsidy systems of five

European countries, we aim at enhancing the understanding of such systems and thus at supporting the process of their evaluation and possible adaptation/optimization, which is especially important as the new CAP is under development. Our intention is to find similarities and differences between the countries regarding the two direct steering mechanisms in forest subsidy distribution: which activities and who is funded. Therefore, we aim to answer the following questions: (1) What forest-related measures have been funded in the five countries during the 2014–2020 funding period? (2) Are forest holdings of different sizes equally supported and what are the reasons for possible imbalances?

We hypothesize that the countries have a different focus on the subsidized activities which could originate from different national policy objectives, histories of the forest sector, ownership structures and even from varying recent experiences with climate change induced disturbances. Making the flow of subsidies towards different forest owner groups visible, further allows us to draw conclusions if subsidy systems are efficient in reaching those groups in need of support. This could be reflected in the share of subsidies small-scale forest owners receive, taking their (increasingly) important role in the forest sector and its development into account.

2. Material & methods

2.1. Studied countries

In this comparative study, we included five European countries: Austria, Finland, Germany, Slovenia and Sweden ([Table 1](#)). These countries have very different traditions, legislations and goals in forestry influencing national subsidy distribution, and thus represent diverse cases ([Seawright and Gerring, 2008](#)). Further, the five countries are distributed from Northern to Central/Southern Europe, featuring a broad range of different forest types (from boreal and alpine conifer forest, mixed deciduous forest to Mediterranean forests).

In the European Union the Gross value added (GVA) of forestry and logging industry amounts to 0.18% of EU's Gross domestic product (GDP), ranging from 0.06% in Germany to 1.75% in Finland within the included countries ([Table 1](#)). Austria, Germany, Slovenia and Sweden receive forest related funding through the EAFRD, while Finland kept all funding at national level. Yet, this requires close coordination with and reporting to the European Commission and the funding scheme is seen as an equivalent to EAFRD-based funding in other countries ([European Commission, 2017a, 2017b](#)). This alternative but in general similarly organized system is thus directly comparable and can offer further insights.

2.2. EAFRD and its application in the countries

To ensure comparability between countries, we focused on EAFRD

funding or as in the case of Finland equivalent national funding. Additional national or regional funding schemes were excluded (also in Finland), to not compromise comparability due to data availability. We analysed subsidies regarding forests paid out during the 2014–2020 EAFRD funding period. However, it is important to note that the exact period varies from country to country depending on data availability and covers only parts of the total EAFRD funding period, thus providing a snapshot and not the complete picture, because last payments from this period might be transferred until 2024.

The EAFRD includes 20 measures from which countries can choose when designing their Rural Development Programme (RDP). Each EAFRD measure is divided into sub-measures, and within these sub-measures countries define specific funded 'activities', which do not have to be activities per se, but may also be passive landscape preservation efforts (e.g. conservation of wetlands in Sweden). Each EAFRD sub-measure may include more than one national activity. The two main measures regarding forests are measure "8. Investments in forest area development and improvement of the viability of forests" which includes six sub-measures and measure "15. Forest-environmental and climate services and forest conservation" which includes two sub-measures ([European Commission, n.d., 2017b; European Union, 2013](#)). However, other measures also contain forest-related sub-measures ([Table 2](#)). All Finnish national activities are officially assigned to equivalent EAFRD measures and can thus be directly compared ([European Commission, 2015](#)).

The total subsidies paid out in the reported periods were €67.6 million in Austria (2014–2019), €165.7 million in Finland (2016–2018), €207.9 million in Germany (2014–2019), €29.9 million in Slovenia (2014–2020), €8.1 million (1 EUR = 10.45 SEK) in Sweden (2014–2018). Even though the difference in magnitude of subsidies can be captured well and allows a general comparison, it is important to keep in mind the different funding periods and that subsidy schemes of some countries partly include co-financed subsidies (e.g. in Germany, see details below). To facilitate the comparison of the paid subsidies, we standardized the values across countries by dividing the subsidies by the time period and the countries' total forest area ([Table 1](#)). It is important to note that this does not in any kind represent values that were received (or could be expected) by applicants per ha, because the countries' total forest area and not subsidized area was used (subsidized area is not reported in all countries or all measures). The implementation of EAFRD (in combination with national/regional programmes) and the distribution of subsidies are differently organized in the five countries.

2.2.1. Austria

The Austrian Federal Ministry of Agriculture, Regions and Tourism (BMLRT) organizes the subsidy distribution on the national level. Some federal states have additional subsidy systems, reserving funds for regional activities to handle special situations which could be

Table 1

General description of the five countries regarding forests and the forestry sector. Data on GDP (Gross domestic product) and GVA (Gross value added) was retrieved from Eurostat for 2019 ([Eurostat, 2022a, 2022b](#)). Data on subsidies was derived from national sources (see [section 2.2.](#)).

Forest area	Austria	Finland	Germany	Slovenia	Sweden
Total area country (in Mio ha)	8.39	33.84	35.74	2.03	45.03
Total forest area (in Mio ha)	4.02	22.8	11.42	1.18	28
Share of forest area in country (in %)	47%	73%	33%	62%	68%
GDP and GVA					
GDP in 2019 (in Mio €)	397,519	239,852	3,473,350	48,397	476,870
GVA of Forestry in 2019 (in Mio €)	870	4187	2188	293	3533
GVA of Forestry as a % of GDP (in %)	0.22%	1.75%	0.06%	0.61%	0.74%
Subsidies					
Paid subsidies, reported for the 2014–2020 EAFRD funding period (in Mio €)	67.65	165.67	207.92	29.87	8.05
Included period	2014–2019	2016–2018	2014–2019	2014–2020	2014–2018
Subsidies per year per ha of forest (in €) ⁽¹⁾	3.66	2.49	5.89	11.91	0.06
<i>paid subsidies period_{months}*total forest area of country</i>					

¹ values do not represent actually received subsidies per ha, as only the countries' total forest area and not subsidized area could be used.

Table 2

Measures and sub-measures from the European Agricultural Fund for Rural Development (EAFRD), that were represented in at least one country in the available and accessible data. The numbers in the country-columns indicate the number of 'national activities' ultimately implemented that focus on forests. A complete list of all national activities can be found in Table A1 in the supplementary material.

Measures and sub-measures	Code	EAFRD				National
		Austria	Germany	Slovenia	Sweden	
1. Knowledge transfer and information						
vocational training and skills acquisition actions	1.1	1		1		
2. Advisory services, farm management and relief services						
to help benefiting from the use of advisory services	2.1	1				
4. Investments in physical assets						
investments in infrastructure related to development, modernisation or adaptation of agriculture and forestry	4.3	1		1		1
7. Basic services and village renewal in rural areas						
studies/investments for the maintenance, restoration and upgrading of the cultural and natural heritage of villages, rural landscapes and high nature value sites including related socioeconomic aspects and environmental awareness actions	7.6	2				
8. Investments in forest area development and improvement of the viability of forests						
afforestation/creation of woodland	8.1	1	1			
prevention of damage to forests from forest fires and natural disasters and catastrophic events	8.3		1			1
restoration of damage to forests from forest fires and natural disasters and catastrophic events	8.4	1	1	3		
investments improving the resilience and environmental value of forest ecosystems	8.5	3	1		5	4
investments in forestry technologies and in processing, mobilising and marketing of forest products	8.6	2	1	2		
12. Natura 2000 and Water Framework Directive payments						
compensation payment for Natura 2000 forest areas	12.2		1			
15. Forest-environmental and climate services and forest conservation						
payment for forest-environmental and climate commitments	15.1	1	1			1
the conservation and promotion of forest genetic resources	15.2	1				
16. Cooperation						
joint action undertaken to mitigate or adapt to climate change and joint approaches to environmental projects and ongoing environmental practices	16.5	1		1		
SUM		15	7	8	5	7

insufficiently reflected in national or European policies (e.g. snow damage). These subsidies will not be further covered here to ensure comparability between countries. The Austrian forest subsidy system, which is now sustained through the EAFRD, developed from the national Rural Development Programme (RDP). The priority is to strengthen regional communities in economic, ecological and social terms. Historically, this support of rural communities aimed at compensating the general income difference between rural and urban areas.

2.2.2. Finland

In Finland, there is no funding through the EARFD in the forest sector. Subsidies are realised through national funds under the budget of the Ministry of Agriculture and Forestry and administrated by the Forest Centre. Subsidies of the 2014–2020 period are based on the Sustainable Forestry Financing Act (Kemera). Still, notification of and confirmation by European Commission is essential. The negotiations for the next funding period under the CAP are still ongoing and the outcome will show how the Finnish system will be continued (Viitala et al., 2018, 2022). Either it will stay more or less the same, some funding under a certain threshold might not require a notification (based on the *de minimis* condition) or Finland will also switch to funding through the European Commission leading to a more coherent system for all countries. The main goal of Finnish subsidies is to maintain the vigour, growth and health of forests. Forest owners shall be encouraged to continue forest management and therefore subsidies are orientated towards maintaining production.

2.2.3. Germany

In Germany, forest subsidies are granted by three different sources: through the joint task “Improving agricultural structures and coastal protection” (GAK) as the main national funding scheme, through federal states and through the EAFRD scheme (Ermisch et al., 2016). Combinations of funding are common and include either co-financing of GAK and EAFRD, co-financing of states and EAFRD or a combination of all three sources. The federal states are responsible for the distribution and administration of funding as well as the negotiation of target measures and funding amounts under EAFRD (13 distinct RDPs). This system provokes a high variability between the states and prevents a complete analytical breakdown into the parts funded by each of the entities. The GAK and funding through federal states aim at supporting forest multifunctionality as well as improving production, working and marketing conditions, while funding through the EAFRD completes the portfolio with measures to increase forest resilience and nature conservation.

2.2.4. Slovenia

The Slovenian Ministry of Agriculture, Forestry, and Food coordinates the main strategic orientations for the implementation of the CAP. Within the Ministry the Agency for Agricultural Markets and Rural Development is responsible for implementing the allocation of funds in agriculture, forestry, fisheries, the food industry and rural development. The subsidy system focuses on three main areas that reflect identified national priorities: (1) improving biodiversity, water and soil protection, (2) competitiveness of the agricultural sector, and (3) social inclusion and rural development.

2.2.5. Sweden

The Swedish Board of Agriculture is responsible for the distribution of the RDP budget allocated to forests. Forest owners can receive subsidies for environmental measures in the forests – also in connection to disasters – to preserve and develop biological diversity and cultural values. Policy regulates that there are no subsidies allowed for measures aiming at increasing production. The goal of the RDP in Sweden is to develop agriculture and rural areas, and the subsidies within the program shall contribute to prioritized goals in environment and climate, competitive agriculture, reindeer herding and forestry, and also to create new job opportunities in rural areas (The European Agricultural

Fund for Rural Development, 2015).

2.3. Data sources and availability

Data regarding the ownership structure, i.e. number and size of forest holdings (in size classes), and data on distributed subsidies was gathered from different entities in the countries as often the information was not available at one central data source.

2.3.1. Austria

Information on the ownership-structure was derived from the Austrian “farm structure survey” from STATISTIK AUSTRIA for 2016 (Statistik Austria, 2016). Data on the disbursement of subsidies for the forestry sector of the current EAFRD funding period (2014–2020) was provided by the BMLRT. The dataset included 7814 applications and payments from the beginning of 2014 until the 6th of May 2019. For 2771 of these applications the size of the applicant’s forest holding was known from data of the farm structure survey from 2016.

2.3.2. Finland

In Finland, information on forest ownership was derived from the Finnish forest owner survey from the year 2020. Data was accessed over the Luke Statistics database: “Forest property entities by the form of ownership” and “Forest property entities by year, form of ownership, size class, hectares and number or forest land area”. Data on subsidy distribution to private forest owners was provided by the Forest Centre. It is to be noted that in practice, small forest holdings (area below 5 ha) are excluded from data, as the minimum size of area to be subsidized is around 1.5 ha, which means that small forest holdings very rarely are able to fulfil this criteria and thus receive subsidies.

2.3.3. Germany

The German National Forest Inventory delivers information of the forest area by ownership size class (BMEL, 2021b). Exact information on the number of forest owners or holdings (overall and within size classes) is not available in Germany, yet a representative study of the Thünen Institute provides a reliable estimate of 1.82 Mio. forest owners for 2017 (Feil et al., 2018). Data on paid out subsidies is reported by the Federal Ministry of Food and Agriculture (BMEL) under “public funding” through EAFRD (BMEL, 2020), which includes co-financed funds (BMEL, 2019). However, the distribution of subsidies across different size classes is not available on a national level. Data was therefore requested from federal ministries and the data set provided by Schleswig-Holstein for the years 2017 to 2019 was used for the analysis as it was the only dataset that met the study’s requirements.

2.3.4. Slovenia

Information on the number of forest holdings as well as forest area per size class was retrieved from the 2019 Annual Report of the Slovenian Forest Service (Guček et al., 2020). The Agency for Agricultural Markets and Rural Development prepared and provided data on the subsidies paid out on 14th August 2020. Data on how many subsidies were paid per forest holding size is only available for the measure “Purchase of new machinery and new equipment for forestry operations” (EAFRD sub-measure 8.6).

2.3.5. Sweden

In Sweden, information about forest ownership is provided by the database of the Swedish Forest Agency and is based on cadastre data of all land holdings. Data on subsidies was provided by the Swedish Board of Agriculture. Data on subsidy distribution to different size classes is not available, because only size of the subsidized area is noted and not forest holding size. What still can be extracted from this is that when an area above 20 ha was subsidized, the holdings’ size must have been over 20 ha. When the subsidized area is below 20 ha, the size of the holding could be anything. As sometimes one application includes more than one

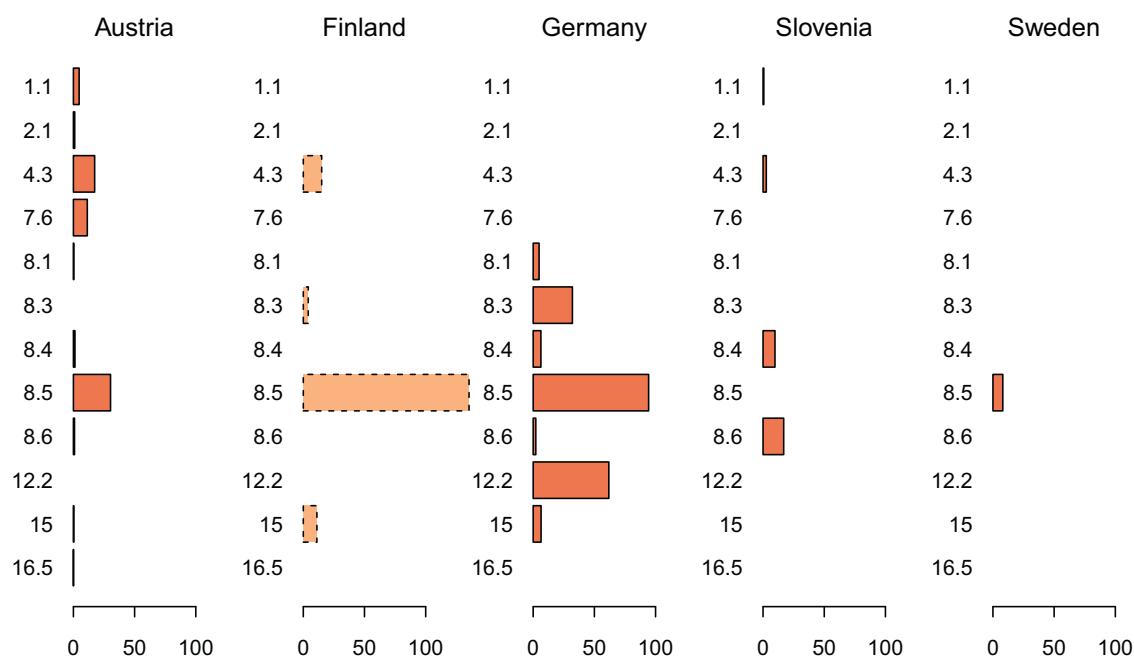


Fig. 1. Subsidies paid out (in Mio EUR) under each sub-measure in each country during the 2014–2020 EAFRD funding period (exact periods may vary by country due to data availability). See Table 2 for the names of the sub-measures and Table A1 for the exact amount of subsidies paid. For Austria, Germany, Slovenia and Sweden, subsidies (co-)financed by EAFRD are shown (dark orange boxes). For Finland, the national subsidies assigned to the respective EAFRD sub-measures are shown (light orange boxes, dashed outline). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

subsidized measure, where it is not possible to split the shares between measures, only those applications for one measure were further included. These cases correspond to 83.6% of all approved cases.

2.4. Choice of common ownership categories

Finding a general definition for small-scale forest owners in Europe remains challenging due to different ownership structures in the countries. Upper thresholds in the five countries range from 5 ha in Slovenia (Kumer and Štrumbelj, 2017; Pezdevšek Malovrh, 2010) to 5000 ha in Sweden (Swedish Forest Agency database), where the distinction is rather into private and non-private owners. Hirsch et al. (2007) assigned forest holdings from 11 European countries to size categories showing *inter alia* that 96% of all forest owners had holdings under 20 ha and 99% had holding under 100 ha, with the latter managing around 60% of the private forest land.

To compare ownership structures and subsidy distribution across countries, we divided “number of forest holdings”, “forest area” and “paid subsidies” into three size categories: < 20 ha, 20–200 ha and > 200 ha. We followed Feil et al. (2018) who used 20 ha as a threshold for “small private forests” and 200 ha for “small/medium private forests”, with 200 ha also being used as a threshold in Austria (BMLFUW, 2015). We refer to forest owners with holdings in the first two categories, i.e. with holdings under 200 ha, as small-scale forest owners. The thresholds chosen are in the centre of the countries’ range and thus prevent leaning towards an extreme end allowing a general comparison, which could not be reached when using country specific thresholds. Further, these categories worked as a common standardized subdivision of the data among all countries, which typically report ownership structure and subsidy distribution in different size ranges (Živojinović et al., 2015). For example, Austria and Slovenia do not report distinguished categories above 200 ha and Sweden reports forest area in a 6–20 ha category, what prevents the use of 10 and 500 ha thresholds used in the State of Europe’s Forests 2020 report (FOREST EUROPE, 2020). For ensuring transparency, the not aggregated national data is provided in the

supplementary material (Table A3).

2.5. Data analyses

To detect possible imbalances in the distribution of subsidies between forest holdings with different sizes we tested whether the subsidies paid out per size class are proportional to their respective share of forest area by performing a G-test of goodness-of-fit for each country. The G-test thus determines whether the observed outcome (subsidies paid) is consistent with the expected outcome (share of forest area) for each size category. This analysis was done for Austria, Finland and Slovenia, as in Germany and Sweden, data availability did not allow the application of a G-test and thus a direct comparison of the share of forest area and subsidies paid out. Since forest subsidies in Germany are regulated at the level of the federal states, no complete national dataset is available, but only data from one federal state (Schleswig-Holstein), which can therefore not be considered representative for the whole of Germany. For subsidies paid out in Sweden only the size of the subsidized area but not the size of the forest holding which received the subsidies is known. This means that the < 20 ha category actually includes forest holdings of all sizes which received subsidies for areas smaller than 20 ha. As the largest subsidized area had a size of 102 ha, there is no category > 200 ha in Sweden, but the 20–200 ha category consequently includes all holdings with forests larger than 20 ha. All statistical analyses were performed using R version 4.0.3 (R Core Team, 2020).

3. Results

In our comparative study we found that the five countries exhibit substantial variability in their subsidy systems. This variability is reflected not only in the total amount of subsidies paid out, which – when standardized over each country’s total forest area – ranged from 0.06 € per ha in Sweden to 11.91 € per ha in Slovenia (Table 1), but also in the heterogeneity of forest-related measures subsidized (Table 2, Fig. 1) and

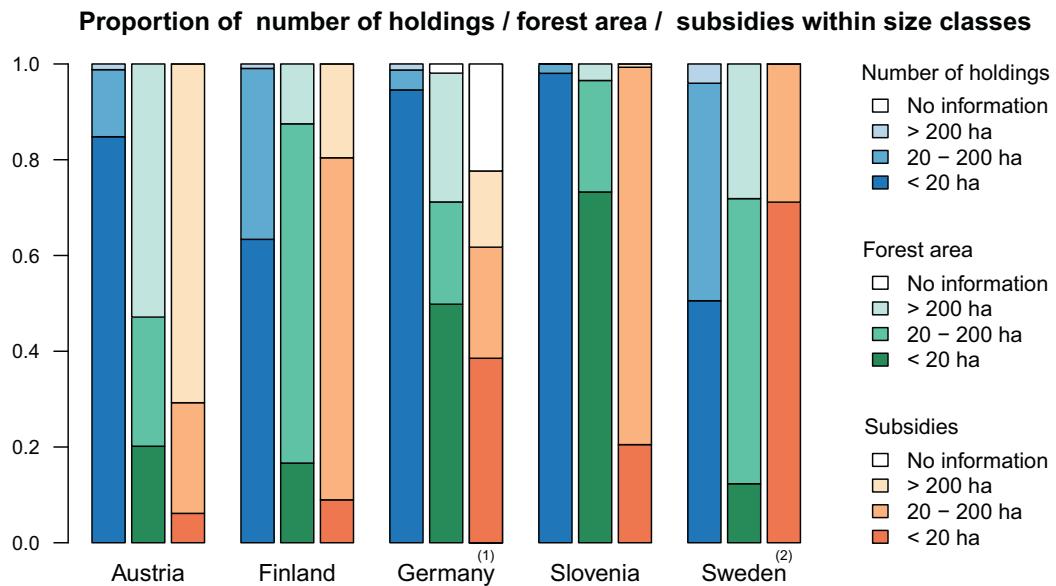


Fig. 2. Proportion of number of forest holdings and in the case of Germany forest owners (blue, left), forest area (green, centre) and forest-related subsidies (orange, right) within each size category. For exact values see Table A2 in the supplementary material. Note that (1) distribution of subsidies in Germany is only available for one federal state (Schleswig-Holstein) and (2) distribution of subsidies in Sweden are according to the size of subsidized area and not the size of the forest holding. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 3

Results from the G-test for Austria, Finland and Slovenia. For Germany and Sweden it is not possible to perform a G-test because of the lack of suitable data. (–) = amount of subsidies actually paid out is smaller than amount of expected subsidies (based on the proportion of forest area managed by each size category). (+) = amount of subsidies actually paid out is larger than expected.

	Size category (in ha)		
	< 20	20–200	> 200
Austria (G = 3'378'506, p < 0.001)			
Proportion of forest area	20.2%	27.0%	52.9%
Expected Subsidies	€ 3'496'722	€ 4'679'534	€ 9'171'926
Observed Subsidies (paid)	€ 1'065'442	€ 4'009'088 (–)	€ 12'273'652
	(–)		(+)
Finland (G = 12'738'764, p < 0.001)			
Proportion of forest area	16.6%	70.9%	12.5%
Expected Subsidies	€ 27'568'070	€ 117'386'697	€ 20'704'492
Observed Subsidies (paid)	€ 14'855'995	€ 118'348'197	€ 32'455'067
	(–)	(+)	(+)
Slovenia (G = 5'486'091, p < 0.001)			
Proportion of forest area	73.3%	23.3%	3.4%
Expected Subsidies	€ 2'917'304	€ 927'160	€ 137'340
Observed Subsidies (paid)	€ 816'164 (–)	€ 3'138'387 (+)	€ 27'254 (–)

the recipients of subsidies.

3.1. Subsidized measures

Out of the 20 measures defined within the EAFRD framework, we identified eight measures that included subsidies paid out for forest-related activities in at least one of the five countries (Table 2, Table A1, Fig. 1). The total number of forest-related activities at the national level ranges from five in Sweden to 15 in Austria. Most of these activities are found under the measure “8. Investments in forest area development and improvement of the viability of forests”, which is specifically designated to forests (Table 2, Table A1, Fig. 1). In Sweden, for example, all five activities are grouped under the EAFRD sub-

measure “8.5 Investments improving the resilience and environmental value of forest ecosystems” and include e.g. “Conservation burning” and “Thinning to bring out broadleaved or deciduous forests”. However, other measures and sub-measures also included forest-related activities in some countries. In Austria and Slovenia, for example, support for forestry machinery or infrastructure was partly also granted under the sub-measure “4.3 Investments in infrastructure related to development, modernisation or adaptation of agriculture and forestry”. National activities have further been subsidized under measure “15. Forest-environmental and climate services and forest conservation”, e.g. in Austria and Germany. Measure 15 is – as measure 8 – specifically dedicated to forests but the total sum of subsidies paid is much smaller. Five of the seven Finnish activities were assigned to EAFRD sub-measure “8.5 Investments improving the resilience and environmental value of forest ecosystems”.

Within each country the subsidies paid out are not evenly distributed across sub-measures (Fig. 1). The most heavily subsidized national activities are “Investment to increase resistance and the ecological value of forests – Public value and protection against natural hazards” (under sub-measure 8.5) in Austria, “Tending of seedling and young stands” (assigned to 8.5) in Finland, “Investments improving the resilience and environmental value of forest ecosystems” (under 8.5) in Germany, “Purchase of new machinery and new equipment for forestry operations” (under 8.6) in Slovenia and “Nature and cultural heritage” (under 8.5) in Sweden.

3.2. Ownership structure and distribution of subsidies per size class of forest holdings

In all five countries, the majority of privately owned forest holdings are smaller than 20 ha (Fig. 2). The proportion ranges from around 63% in Finland and Sweden to 98% in Slovenia. Only a small proportion of forest holdings are larger than 200 ha: from 0.03% in Slovenia to 4% in Sweden. Nevertheless, their share of forest area can be disproportionately large (Fig. 2), with the difference being the largest in Austria, where 1.2% of forest holdings account for almost half of the forest area (52.9%). The share of forest area of holdings smaller than 200 ha ranges from 47.1% in Austria to 96.6% in Slovenia.

The comparison of the share of subsidies of each size class in relation

to the forest area of each size class shows that in general small forest holdings with < 20 ha of forest receive a relatively small share (Fig. 2). In Austria, Finland and Slovenia, where the available data allows the most direct comparison, the G-test showed that owners with holdings < 20 ha actually received a disproportionately small share of the subsidies paid out (Table 3).

4. Discussion

This comparative study highlights the differences in the subsidy systems of the five European countries Austria, Finland, Germany, Slovenia and Sweden. Country specific forest policies result in a large variation in subsidized forest measures and subsidy systems. Small-scale forest owners (< 200 ha) manage the majority of private forest land, yet especially those who own forest holdings smaller than 20 ha receive a disproportionately small share of subsidies. For Austria, Finland and Slovenia this could be statistically confirmed but the data from Germany and Sweden, where data availability or structure hampered thorough statistical analyses, indicate similar results. Here we provide a first step towards understanding the reasons for these differences and imbalances in subsidy distribution across the five countries.

4.1. Subsidized measures

In line with the EU's objective of achieving a sustainable bio-economy, many of the subsidies reported aim at ecological goals (e.g. "8.5 Investments improving the resilience and environmental value of forest ecosystems") or management-oriented goals (e.g. "8.6 Investments in forestry technologies and in processing, mobilising and marketing of forest products"). This appreciates the complex forest ecosystem and the processes within, fostering a sustainable multifunctional forest management, where various ecosystem services and functions are being targeted (Schmithüsen, 2007). It became clear that countries adapt the subsidy programmes to their specific needs rather than the EU forest policy targets, resulting in different numbers and orientation of subsidies.

While some countries set one main objective for the subsidies, e.g. the focus on nature conservation in Sweden, other countries tend to distribute subsidies where they see a need, e.g. in Austria with activities such as "Interoperate measures regarding forestry and protection against natural hazards" under the EAFRD measure "7. Basic services and village renewal in rural areas". However, this is often still implemented with top-down control and with little involvement of potential beneficiaries. These different approaches can be explained on the one hand by the history of forest management (Brukas and Weber, 2009) and the respective funding system. In Austria the national Rural Development Programme, which has been established since the 1940s (Butschek, 2012) and worked at the regional level to balance income distribution between urban and rural areas, was later replaced by EU funding. Therefore, it was important to ensure continuity for the acceptance of the system in the communities, which could further explain the high number of subsidized activities in Austria. On the other hand, the importance of the forestry sector might also play a role. Sweden is the world's third largest exporter of pulp, paper and sawn timber (Lidestav et al., 2015). Hence, the country's focus of subsidies on nature conservation, such as compensation for income loss due to set-aside land or tending natural and cultural heritage/milieus, can be interpreted as a way to achieve the forest policy objective of balancing environmental goals with production goals. However, the comparison between Sweden and Finland, where the more management-oriented activity "Tending of seedling and young stands" received the most funding, shows that the two Northern European countries have quite different approaches. Despite the differing activities funded and their impact on e.g. timber production practices, the national inventories still show a high similarity in the overall forest structure and timber production (Korhonen et al., 2021; SLU, 2021).

The possibility to adjust the distribution of subsidies with a certain flexibility might become more important, especially in view of accelerated climate change and its consequences for forests (Lindner et al., 2010; Seidl et al., 2011), which require quick responses and decisions based on knowledge on regional/national conditions. This trend could already be observed in the current funding period. In Slovenia, the most subsidized activity in this funding period was "Purchase of new machinery and new equipment for forestry operations" (under sub-measure 8.6). This activity was planned for motivating forest owners to manage their forests to a larger extend and to consequently counteract the underuse of forests and the increasing damages, because – despite highly productive forests – only 50% of the annual increment was harvested in the years before 2012 (Skudnik et al., 2021). From 2014 to 2018, Slovenia eventually experienced several extreme weather events (including wind and ice storms) followed by bark beetles outbreaks, which required sanitary loggings to process disproportionately large amounts of damaged timber (De Groot et al., 2021; Ogris, 2020). The already planned funds for new machinery and equipment were then used to enable these loggings. For the subsequent restoration of the forests, support for the purchase of tree seedlings and of material for protection against browsing was necessary and released under "8.4 Restoration of damage to forests from forest fires and natural disasters and catastrophic events". Between 2012 and 2018 annual logging actually increased to 92% of the gross annual increment but effectively this was mainly due to sanitary loggings (Skudnik et al., 2021). In Germany, the extreme weather events of recent years have led to increased funds. Through the national GAK more funding was made available for coping with the consequences of storms, heat waves and droughts, requiring e.g. final cuttings, forest regeneration and transformation after damages (BMEL, 2021a). The efforts of mitigating climate induced damages is also reflected in massively increasing subsidies under sub-measure "8.3 Prevention of damage to forests from forest fires and natural disasters and catastrophic events" which increased from €0.5 million in 2014 and 2015 combined to €10.9 million in 2019 alone (BMEL, 2020). A strong focus on the future resilience of forests to climate change is likely to be reflected in the distribution of subsidies in more countries in the coming EAFRD funding period.

Besides financial support analysed in the present study, the role of non-monetary support for small-scale forest owners should not be underestimated. Some incentives are not received directly by forest owners, but by regional support groups or training facilities supporting them, for example through the supply of seedling material or the provision of advice, trainings and workshops (Wilkes-Allemann et al., 2021). As there are more and more absent small-scale forest owners, who have little experience in forest management, they might be better reached through e.g. forest owner associations offering direct support (Aurenhammer et al., 2018; Hogl et al., 2005; Lawrence et al., 2020; Sarvašová et al., 2015; Weiss et al., 2019). In Austria and Slovenia already some funding went into EAFRD sub-measure "1.1 Vocational training and skills acquisition actions". Due to the potential impacts of changing climate and increasing expectations for forest ecosystem services and functions, training of forest owners is likely to become more important in this respect (Carlton et al., 2014). Adapted management strategies together with new machinery, digital tools, etc. will be necessary in the future and it is important to transfer this knowledge to those who need it. Nevertheless, it is important to not rely on a top-down approach, where knowledge is transferred one-way, but an approach where the active engagement of forest owners is encouraged e.g. in peer-to-peer groups (Hamunen et al., 2015; Pelai et al., 2021; Wilkes-Allemann et al., 2021). In this way, their needs are heard and acceptance of the potentially new practises increases, strengthening the role of private forest owners.

4.2. Distribution of subsidies per size class of forest holdings

To better understand how private forest owners are affected by the

distribution of subsidies and what consequences this might have for the development towards a bioeconomy, it is necessary to know who benefits from these payments. Our study shows an imbalance of subsidies distributed, in favour of owners with larger forest holdings compared to small-scale forest owners. In particular, the shares of subsidies for small-scale forest owners with forest holdings smaller than 20 ha are disproportionately low compared to the share of forest area they manage (Fig. 2). In Finland, it has been found that the likelihood of undertaking stand improvements and receiving public subsidies increases with the size of the forest holding (Ovaskainen et al., 2017).

In general, the reasons why small-scale owners receive a relatively small share of subsidies are not always easy to assess and may be manifold. Small-scale forest owners might not be aware that subsidy systems exist (Hibbard et al., 2003; Lawrence et al., 2020; Sun et al., 2009) or they are not interested in participating. Especially more absent forest owners, who do not have a long forest management tradition, might not know of or fully understand the opportunities offered by various programs. This lack of knowledge might be due to the fact that they do not use traditional forest information channels and – as absentees – often do not participate in regional informal exchanges. This group of forest owners might also be less involved in forest management either way and therefore – even if they know about subsidy programs – are simply not interested in engaging with their forest (Kumer and Pezdevšek Malovrh, 2019). This is consistent with findings of Quiroga et al. (2019), who show that forest owners with a higher presence in forest activities (i.e. more time dedication) were more likely to agree with a subsidy policy than those who spent less time on forest activities or those who are not directly dedicated to their forest. The latter might show a stronger interest in a system aimed at the provision of public goods that are not efficiently provided by markets, as they are often more interested in environmental than monetary benefits (Juutinen et al., 2021; Lawrence, 2018; Mostegl et al., 2019).

Another obstacle could be the application process. Forest owners who are not part of forest owner associations could be discouraged by the bureaucracy needed to apply for subsidies. Especially, as a certain quality assurance is required for funding through European schemes. Since subsidies are often linked to the size of the forest holding / the forest area while the effort for applying is the same for owners of small and of large forest holdings, the cost-benefit ratio is worse for small-scale forest owners. Even if the bureaucratic burden is generally not too high, it may seem disproportionate for smaller investments by small-scale forest owners and therefore “not worth it”. In Slovenia, even a minimum of 5 ha of forest area is set as a limiting requirement for applicants in the Regulation on the Implementation of Investment Measures (Republic of Slovenia, 2017). This threshold was set despite the fact that about one third of Slovenian forests consist of forest holdings smaller than 5 ha (Table A3; Guček et al., 2020; Šcap et al., 2021). Here, the large imbalance can further be partly explained by an application evaluation criterion, where the size of the forest holding is one of the criteria for assessing the economic aspect of investments, which reduces the chances of small-scale forest owners later during the process. In general, there are efforts to simplify the application process in several countries, e.g. in Finland, but they still need to be refined. In Sweden, most of the funds are distributed through major initiatives and campaigns by forest associations, which could help to reach private forest owners. Providing active support throughout the application process to forest owners by local forest owner associations, regional authorities or authorized agencies already helps to overcome the hurdle of applying. However, this may still miss more absent forest owners, for whom new ways of communication and motivation may be needed to achieve active engagement with their forests, which could actually be facilitated by incentives.

4.3. Importance of subsidy transparency and data availability

During data collection for this study from the responsible authorities,

it became apparent how different and sometimes unclear the documentation of subsidy distribution is handled within the selected EU countries. A full evaluation and comparison of the five countries was even hindered by the data availability and parts of the analyses were only possible for three of the five countries. This outcome is concerning as the EAFRD was the most important subsidy system for forests covering 90% of the forest subsidies in the previous funding period 2007–2013 at European scale (Hänninen et al., 2017). In addition to subsidies within the EAFRD, most countries also support forest owners through national or even regional programmes (Hänninen et al., 2017), where data is extremely difficult to access and not processed in a consistent manner. In Germany, for example, it was not possible to fully separate some co-financed activities from EAFRD and GAK. Also payments after a respective funding period and delayed data availability mean that analyses of the full funding period can only be achieved long after the period has ended. All these small inconsistencies hinder direct comparability and thus the chance for countries to learn from each other (e.g. about the successful involvement of all forest owner groups in subsidy schemes). For quality assurance and to evaluate the impact of subsidies, there is the need for a standardized data collection and reporting in countries receiving EAFRD funds on forest owners applying for and receiving subsidies. This enables a transparent tracking of the flow and distribution of subsidies across different measures and forest owner groups, and helps to understand how well subsidies support the primary objectives of the subsidy system.

4.4. Conclusions

Current forest subsidy systems have many objectives and countries use them for different nationally determined purposes. The EU funding through EAFRD is an important source of funding for forest subsidies, but they might not necessarily support the EU forest policy targets directly. In general, subsidies are received by forest owners with larger holdings. This indicates that smaller forest holdings are not equally benefiting from subsidies and are potentially not guided and motivated to work in the direction of forest policy goals. As the next EU funding period is about to start and the CAP is being developed, there is room for developments at the European level but also at the national level. A better comparable design of the forest subsidy scheme in the EU could also support the implementation of the new EU forest strategy for 2030, which recognises the multifunctional role of forests in timber production, in achieving biodiversity and climate targets, and in maintaining lively rural areas.

CRediT authorship contribution statement

Elena Haeler: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. **Andreas Bolte:** Writing – review & editing. **Rafael Buchacher:** Investigation, Writing – review & editing. **Harri Hänninen:** Investigation, Writing – review & editing. **Robert Jandl:** Writing – review & editing. **Artti Juutinen:** Writing – review & editing. **Katharina Kuhlmeijer:** Investigation, Writing – review & editing. **Mikko Kurtila:** Investigation, Writing – review & editing. **Gun Lidestad:** Investigation, Writing – review & editing. **Raisa Mäkipää:** Writing – review & editing. **Lydia Rosenkranz:** Writing – review & editing. **Matevž Triplat:** Investigation, Writing – review & editing. **Ursā Vilhar:** Investigation, Writing – review & editing. **Kerstin Westin:** Investigation, Writing – review & editing. **Silvio Schueler:** Conceptualization, Methodology, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

This study was supported by the project ValoFor under the of ERA-NET ForestValue by the Federal Ministry for Sustainability and Tourism, Austria; the Ministry of Agriculture and Forestry Finland, the Coordinator Academy of Finland, the Innovation Funding Agency Business Finland, the Finland Ministry of the Environment; the Federal Ministry of Food and Agriculture, Germany, the German Agency for Renewable Resources, the German Federal Office for Agriculture and Food; the Ministry of Education, Science and Sport, Slovenia, the Agency for Agricultural Markets and Rural Development, Slovenia; the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, the Swedish Energy Agency, the Swedish Governmental Agency for Innovation Systems and the European Union's Horizon 2020 research and innovation programme (grant agreement N° 773324).

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.fopol.2022.102882>.

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