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The Impact of Salvage Logging on the Supply of Roundwood Assortments from Austrian Forests – a Statistical Analysis

Einfluss des Schadholzanfalls auf das Angebot von Rohholzsortimenten aus dem Österreichischen Wald – eine statistische Analyse

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Keywords: timber assortments, final cuts, thinnings, Timber Felling Reports, storm damage, bark beetle damage, snow-break, disturbances

Schlüsselbegriffe: Rohholz Sortimente, Endnutzung, Durchforstung, Holzeinschlagsmeldungen, Sturmschäden, Borkenkäferschäden, Schneedruck, Störungen

Abstract

This study analyses whether and how the amount of total timber from salvage logging has an impact on the shares of assortments of domestic timber supply as well as on the relationship between thinnings and final cuts in Austria. The main data source for this study are the annual „Timber Felling Reports" of the (currently labeled) „Federal Ministry Agriculture and Forests, Climate and Environment Protection, Regions and Water Management". Correlation analysis and analysis of variance (ANOVA) are the main statistical methods used, based on the time-series data 2006-2023. The results show, that the annual fluctuations of total timber from salvage logging are much more volatile than those of the assortments, the shares of which harvests are only moderately affected by the amount of salvage logging. For coniferous as well as non-coniferous wood, the share of sawlogs is not significantly decreasing and the

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shares of pulpwood and wood for energy are not significantly increasing when storm damage is increasing; rather it is the other way around. When the damage caused by other reasons than storm (*e.g.* bark beetles, snow-break) is increasing, then there generally is a decrease in the share of sawlogs. For coniferous wood the impact of damage other than storm is mainly and (partly) significantly positive on the supply of wood for energy, while for non-coniferous wood the main and (partly) significantly positive impact is on pulpwood supply. The supply of timber from salvage logging is above the average in final cuts (larger dimensions) and below average in thinnings (smaller dimensions). The correlation analyses show that increasing calamities affect final cuts more than thinnings, therefore the supply of sawlogs in general tends to increase slightly. Although the underlying data on timber harvests allow detailed analyses due to the differentiation by ownership categories, assortments, coniferous and non-coniferous timber as well as reasons for the damage (*e.g.* storms, bark beetles), the interpretation of the results is limited, because the data situation does not allow the inclusion of assortment qualities and assortment prices. In addition, the length of the time-series (2006-2023) is quite short. Several suggestions for potential follow-up research activities are presented.

Zusammenfassung

In dieser Studie wird untersucht, ob und wie sich die Menge an Schadholz auf die Sortimentsanteile des heimischen Holzangebots sowie auf das Verhältnis zwischen Vor- und Endnutzung in Österreich auswirkt. Hauptdatenquelle für diese Studie sind die jährlichen „Holzeinschlagsmeldungen“ des (aktuell benannt) „Bundesministerium Land- und Forstwirtschaft, Klima- und Umweltschutz, Regionen und Wasserwirtschaft“. Korrelationsanalyse und Varianzanalyse (ANOVA) sind die wichtigsten statistischen Methoden, die auf Zeitreihendaten 2006–2023 basieren. Die Ergebnisse zeigen, dass die jährlichen Schwankungen des Schadholzanfalls wesentlich volatiler sind als jene der Sortimentsangebote, deren Anteile am Einschlag nur mäßig von der Menge an Schadholz beeinflusst werden. Sowohl bei Nadel- als auch bei Laubholz nimmt der Anteil des Sägerundholzes nicht signifikant ab und der Anteil des Faserholzes sowie des Energieholzes nicht signifikant zu, wenn Sturmschäden zunehmen, eher umgekehrt. Wenn allerdings der Schadholzanfall aus anderen Ursachen als Sturm (z. B. Borkenkäfer, Schneebruch) zunimmt, geht der Anteil des Sägerundholzes tendenziell zurück. Bei Nadelholz wirken sich Schäden aus anderen Ursachen als Sturm hauptsächlich und (teilweise) signifikant positiv auf das Angebot an Energieholz aus, während bei Laubholz die wichtigsten und (teilweise) signifikant positiven Auswirkungen auf das Angebot an Faserholz zu verzeichnen sind. Der Anteil von Schadholz liegt beim Endnutzungseinschlag über dem Durchschnitt (größere Dimensionen), beim Vornutzungseinschlag (geringere Dimensionen) unter dem Durchschnitt. Die Korrelationsanalysen zeigen, dass sich zunehmende Kalamitäten stärker auf die Endnutzung als auf die Vornutzung auswirken, so dass das Angebot

an Sägerundholz tendenziell leicht zunimmt. Obwohl die Holzeinschlagsdaten aufgrund der Differenzierung nach Eigentumsarten, Sortimenten, Nadel- und Laubholz sowie Schadensursachen (z. B. Stürme, Borkenkäfer) eine detaillierte Analyse erlauben, muss die Interpretation der Ergebnisse eingeschränkt bleiben, da die Datenlage keine Einbeziehung von Sortimentsqualitäten und Sortimentspreisen zulässt. Zudem ist die Länge der Zeitreihe (2006–2023) recht kurz. Es werden mehrere Vorschläge für mögliche weiterführende Forschungsaktivitäten unterbreitet.

List of Abbreviations

ANOVA	Analysis of Variance (Varianzanalyse)
BFW	Bundesforschungszentrum Wald
BML	Bundesministerium für Landwirtschaft, Regionen und Wasserwirtschaft
BMLFKURW	Bundesministerium für Land- und Forstwirtschaft, Klima- und Umweltschutz, Regionen und Wasserwirtschaft
BMLFUW	Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasser
BMLRT	Bundesministerium für Landwirtschaft, Regionen und Tourismus
BMNT	Bundesministerium für Nachhaltigkeit und Tourismus
FAWS	Forests available for wood supply (Ertragswald)
FE	Forest enterprises > 200 ha (Betriebe)
FF	Federal Forests (Österreichische Bundesforste)
SFH	Small forest holdings < 200 ha (Kleinwald)
TFRs	Timber Felling Reports (Holzeinschlagsmeldungen)

1 Introduction

Forests in Austria are subject to an increasing frequency and magnitude of natural disturbances (Schelhaas *et al.* 2003) which in general have a significant negative impact on the entire forest-based sector as well as wider socio-economic implications (Gardiner *et al.* 2013; Donis *et al.* 2020). The current composition of Austria's secondary forests exacerbate effects of larger-scale impacts of climate change and already necessitate to induce adaptive forest management measures (Ledermann *et al.* 2022).

After calamities, which can be broadly distinguished into abiotic damage such as storm and wind breaks and biotic damage such as bark beetle infestations, forest owners usually induce post-disturbance salvage or sanitary logging measures by removing fallen, damaged or infested trees to reduce economic losses (Čakša *et al.* 2020) and also to comply with forest legislation to prevent further spreading of infections (BMLFUW 2003).

In the period 2006 to 2023 39% of the Austrian timber harvests consisted of salvage logging due to biotic as well as abiotic reasons (BMLFUW 2001-2017; BMNT 2018-2019; BMLRT 2020-2022, BML 2023-2024). Figure 1 shows that total harvests and their slight increase since 2000 have largely been driven by the amount of timber from salvage logging (average annual increase of salvage logging 150.000 cum under bark). Regular harvests – defined here as the difference between total harvests and salvage logging of damaged timber – have been stagnating (average annual decrease 20.000 cum u.b.), which is partly a reaction to compensate for potential timber over-supply and partly to keep harvests within or below a sustainable level. According to the Austrian Forest Inventory 2016-2021 larger forest enterprises already have harvested slightly above net-annual-increment (BFW 2025). In other words, the amount of damage-caused harvests plays an important role regarding the domestic supply of timber in Austria.

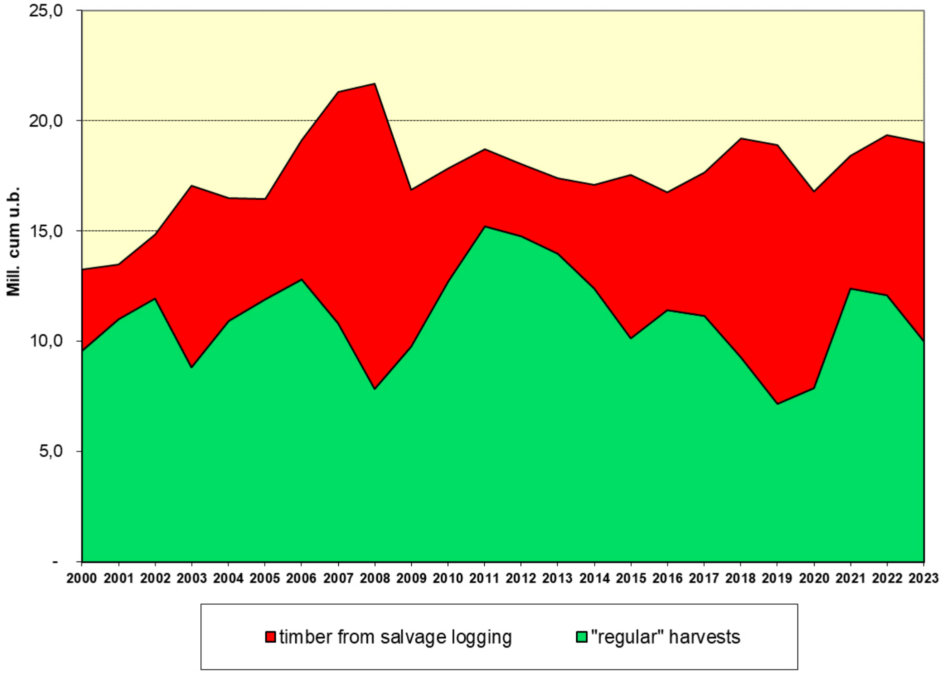

Figure 1: „Regular“ and Timber Harvests from Salvage Logging in Austria 2000-2023 (Sources: BMLFUW 2001-2017, BMNT 2018-2019, BMLRT 2020-2022, BML 2023-2024, own calculations).

Abbildung 1: „Reguläre“ und Schadholzeinschläge in Österreich (Quellen: BMLFUW 2001–2017, BMNT 2018–2019, BMLRT 2020-2022, BML 2023–2024, eigene Berechnungen).

Further differentiation of data regarding timber supply from salvage logging (2006-2023) shows that timber from damage caused by windthrows and windbreaks as the main abiotic cause have contributed 42% to the total amount of salvage logging, while bark beetles as the main biotic cause contributed 37% (figure 2).

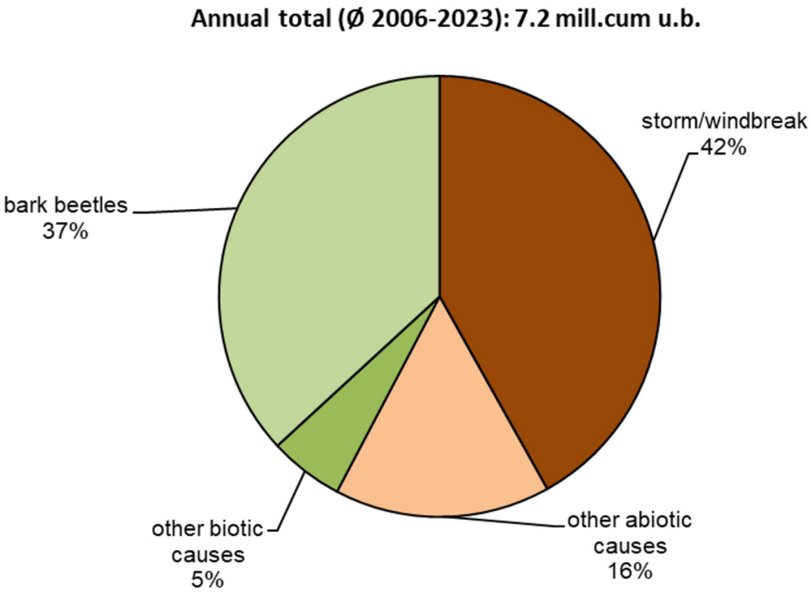

Figure 2: Annual timber supply from salvage logging by major causes. Averages 2006-2023 (Sources: BMLFUW 2001-2017, BMNT 2018-2019, BMLRT 2020-2022, BML 2023-2024, own calculations).

Abbildung 2: Jährliche Schadholzeinschläge nach Ursachen. Durchschnitte 2006-2023 (Quellen: BMLFUW 2001–2017, BMNT 2018–2019, BMLRT 2020–2022, BML 2023–2024, eigene Berechnungen).

A bulk of literature exists about reasons for ecological as well as climatic impacts (e.g. carbon balance) of calamities (*e.g.* Albrecht *et al.* 2010, Gardiner *et al.* 2013, Seidl *et al.* 2014, Thürig *et al.* 2013), including (silvicultural) management options (*e.g.* Mason & Valinger 2013, Zimmermann *et al.* 2018). Other authors focused on the question of risk management, planning support (*e.g.* Härtl *et al.* 2013, Holthausen 2004, Holthausen *et al.* 2004) and risk perception (*e.g.* Andersson & Gong 2010) in relation to forest damage. Some authors have investigated the possibilities of forest damage insurances (*e.g.* Sacchelli *et al.* 2018, Sauter *et al.* 2016). Baur *et al.* (2003) as well as Hanewinkel and Peyron (2013) have addressed the economic impact of storms for forest owners either regarding loss of income (loss in wood quality) and/or of the value of the forest estate.

Several authors have used econometrics to estimate the negative impact (elasticities) of a short- or medium/long-term oversupply of timber through calamities on timber prices (Bergen *et al.* 2002, Mantau 1987, Prestermon & Holmes 2000 and 2004, Schwarzbauer, 2006), which can also be a main reason for the income loss of forest owners. Schwarzbauer and Rauch (2013) added the aspect of a future procurement risk for the forest-based industry due to a medium to long-term reduction of growing stock and increment. The results of the research project „CareforParis" also show that in the so-called „disturbance scenario" with an assumed increase of damage caused timber growing stock and increment will decrease quite dramatically in the long run (Weiss *et al.* 2020, Ledermann *et al.* 2022).

No study so far exists that deals with the impact of timber supply from salvage logging on the supply of timber assortments, in particular on a potential change in the share of these assortments within total harvests on top of a potential increase of these harvests. Only the deterioration of wood quality is sometimes mentioned (Thürig *et al.* 2013, Hanewinkel & Peyron 2013). Härtl *et al.* (2013) use grading options in relation to calamities and price fluctuations as assumptions for their YAFO model, but they are an input, not an output.

This study aims to analyse whether and how the amount of timber from salvage logging has an impact on the shares of assortments of total (domestic) timber supply as well as on the impact of salvage logging on the relationship between thinnings and final cuts in Austria.

The following research questions and hypotheses are addressed:

1. Does the amount of timber from salvage logging have an impact on the conversion of timber into the assortments of sawlogs, pulpwood and wood for energy? Does this impact differ by ownership categories and wood species group (coniferous vs. non-coniferous)?

   Hypothesis 1: An increase in the total amount of timber from salvage logging leads to lower wood quality and therefore to a higher use of wood for energy as well as a lower material use (sawlogs, pulpwood).

2. Do causes of calamities (especially storm vs. other than storm) have an impact on the conversion of timber into intermediate product assortments?

   Hypothesis 2: Storms tend to affect more larger trees, snow-break and bark beetles tend to affect more smaller trees. Therefore, an increase in windthrows and windbreaks will create larger timber dimensions and – despite possible lower wood quality – increase the supply of sawlogs rather than wood for energy and pulpwood. An increase in timber supply by other reasons than storms will create smaller timber dimensions and rather increase the supply of wood for energy and pulpwood.

3. Does the amount of timber from salvage logging have an impact on the shares of thinnings and final-cuts in total harvests (as well as vice versa) and does this impact differ by ownership category and wood species group?

   Hypothesis 3: Because in terms of timber supply quantity older stands are generally more affected by forest damage than younger stands, an increase in the amount of damage caused timber leads to a shift towards more final-cuts and less thinnings.

2 Methods and Data

Methods

Correlation analysis and analysis of variance (ANOVA) are the main statistical methods used, based on the time-series data 2006-2023 (18 observations). Both focus on the relationship between the shares of total timber from salvage logging in total harvests on the one hand and the shares of assortments as well as thinnings and final-cuts on the other hand. In order to avoid spurious correlation, shares of timber supply from salvage logging as well as assortments with regard to harvests rather than absolute numbers were used in the analyses. In case of parallel or opposing trends of time-series data spurious correlations may appear, which are simply based on trends and not on causal relationships. By using shares rather than absolute numbers the impact of trends as a main reason for spurious correlation can be reduced or even eliminated (see Granger & Newbold 1974). To illustrate the calculation of shares, three examples: Total supply from salvage logging was set in relation to total harvests (all forests, total of coniferous and non-coniferous); coniferous sawlog harvests in SFH were set in relation to total coniferous harvests in SFH, non-coniferous wood for energy harvests in FE were set in relation to total non-coniferous harvests in FE; all other shares in analogy.

ANOVA (t-test with independent samples) was mainly used as a validity-check for the correlation results. The independent variable, the share of total timber from salvage logging (time series from 2006-2023), was recoded into two (ordinal) groups: low = below and equal to, high = above the respective median of the timber from salvage logging share. Both groups include 9 observations. t-tests were used to check whether the means of the dependent variables (share of assortments, share of thinnings and final-cuts) differ significantly between the two groups of low and high share of timber from salvage logging. In addition to the statistical analyses expert interviews with practitioners and specialists in timber markets for the three ownership categories (Friedl 2021 [SFH], Holzer 2021 [FF], Montecuccoli 2021 [FE]), were conducted to further validate and check the plausibility of the results derived from the statistical analysis, but also to get a better background understanding.

Data

The main data source for this study are the annual „Timber Felling Reports" (TFRs; „Holzeinschlagsmeldungen" in German) of the Austrian Federal Ministry of Agriculture, Regions and Tourism (BMLRT, BMLFUW or BMNT, BMLRT, BMLFRW, BML in earlier years and Federal Ministry Agriculture and Forestry, Climate and Environmental Protection, Regions and Watermanagement" [BMLFKURW) since 2025). Due to a structural break in the data regarding wood for energy, only annual data since 2006 are used in this study for consistency reasons (BMLFUW 2001-2017, BMNT 2018-2019, BMLRT 2020-2022, BML 2023-2024). Before 2006 only one category of wood for energy was reported (fuelwood stacked - „Scheitholz") in the annual TFRs, which did not include wood chips directly from forests („Waldhackgut"). Only since 2006 both categories are reported separately, although a part of the wood chips have most likely been included in the category fuelwood stacked already before 2006 (see Braun & Schwarzbauer 2018). Due to this inconsistency/structural break only the data since 2006 were used here. All data used for the analysis are presented as supplementary material in tables S1-S4.

TFR data for all harvesting components allow a differentiation by the three ownership categories (small forest holdings < 200 ha [SFH; „Kleinwald"; 57% of total forest area available for wood supply (FAWS – „Ertragswald"), 59% of growing stock]; forest enterprises > 200 ha [FE; „Betriebe"; 30% of FAWS, 28% of growing stock]; Federal Forests [FF; Österreichische Bundesforste; 13% of FAWS and 13% of growing stock]; numbers according to the Austrian Forest Inventory 2016-2021, BFW 2025) as well as a differentiation by coniferous and non-coniferous timber and a differentiation by assortments (sawlogs, pulpwood and wood for energy; wood for energy is further distinguished between fuelwood stacked [„Scheitholz"] and wood chips from forests [„Waldhackgut"]). The TFRs further distinguish final-cuts and thinnings. In addition, timber supply from salvage logging can be further disaggregated by the reasons for the damage (see figure 2). For the ANOVA-analysis timber supply by salvage logging was grouped into two groups of reasons for the damage: „only storm" and „other than storm" (bark beetles as well as other biotic and abiotic causes). Although non-coniferous timber makes up only about 16% of total timber harvests in Austria (Ø 2006-2023; BMLFUW 2001-2017, BMNT 2017-2018, BMLRT 2019-2022, BML 2023-2024) it is important to distinguish coniferous and non-coniferous species in our analysis for several reasons:

- Coniferous and non-coniferous timber are subject to a different demand structure. About 80% of coniferous timber is used for materials (sawnwood, pulp, panels), only about 20% for energy; on the other hand, only about 32% of non-coniferous timber is used for materials, about 68% for energy (BML 2023-2024).

- Coniferous and non-coniferous timber have different technical properties, which is eg. important for the use of timber in construction, in which – according to the current scientific status - coniferous wood cannot yet fully be substituted by non-coniferous wood (see *e.g.* Espinoza & Buehlmann 2018, Schier *et al.* 2018).

- Between the forest inventory periods 1992-1996 and 2016-2021 the share of coniferous species in the total stocked forest area available for wood supply has decreased by 5%-points, the share of non-coniferous species has increased by 5%-points accordingly (BFW 2025). Due to climate change this trend is likely to continue and may create challenges for the forest-based industries (in particular sawmills), which are currently mainly processing coniferous timber (Weiss *et al.* 2020).

The research questions were analysed by using the deepest possible differentiation (by ownership categories, by species groups, by assortments, by final-cuts and thinnings as well as by reasons for the damage).

3 Results

3.1 Relationships between shares of timber from salvage logging and of assortments in harvests

Figure 3 depicts the annual shares of total timber from salvage logging and the shares of the three assortments (sawlogs, pulpwood round & split and wood for energy) in total timber harvests. It can be seen that the annual fluctuations of timber from salvage logging are much more volatile than those of the assortments. This is a first indication that the shares of the assortments may be only slightly affected by salvage logging.

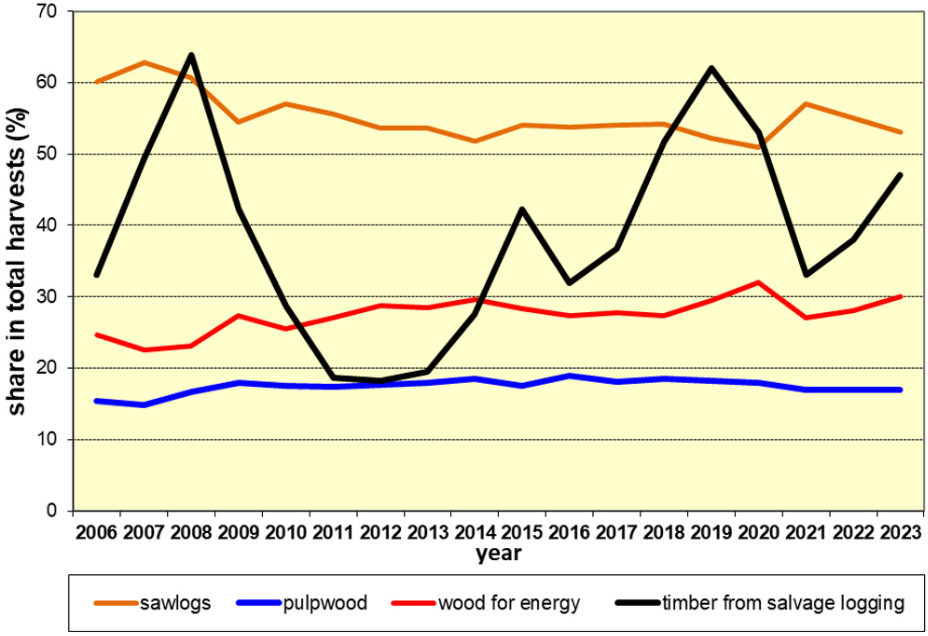

Figure 3: Share of total timber from salvage logging and shares of the assortments sawlogs and pulpwood (round & split) as well as wood for energy (incl. chips produced in the forest) in total harvests (total of coniferous and non-coniferous and all ownership categories) (Sources: BMLFUW 2001-2017, BMNT 2018-2019, BMLRT 2020-2022, BML 2023-2024, own calculations).

Abbildung 3: Anteil von Schadholz und Anteile der Sortimente Sägerundholz, Faserholz und

Energieholz (inkl. Waldhackgut) am Gesamteinschlag (Summe von Nadel- und Laubnutzung, Summe über alle Eigentumsarten) (Quellen: BMLFUW 2001–2017, BMNT 2018–2019, BMLRT 2020–2022, BML 2023–2024, eigene Berechnungen).

Figure 4 shows the scatterplots of the shares of total timber from salvage logging and the shares of the assortments in total harvests, each including a best fit straight line and the correlation coefficient. Overall (all ownership categories and total of coniferous and non-coniferous timber), there is no statistically significant correlation between the shares of total timber from salvage logging and the shares of assortments. However – even though not statistically significant – the graph shows that the share of sawlogs tends to increase with an increasing share of timber from salvage logging while the shares of pulpwood and wood for energy tend to decrease. This indicates a contradiction to hypothesis 1 and will be further analysed on a more detailed level.

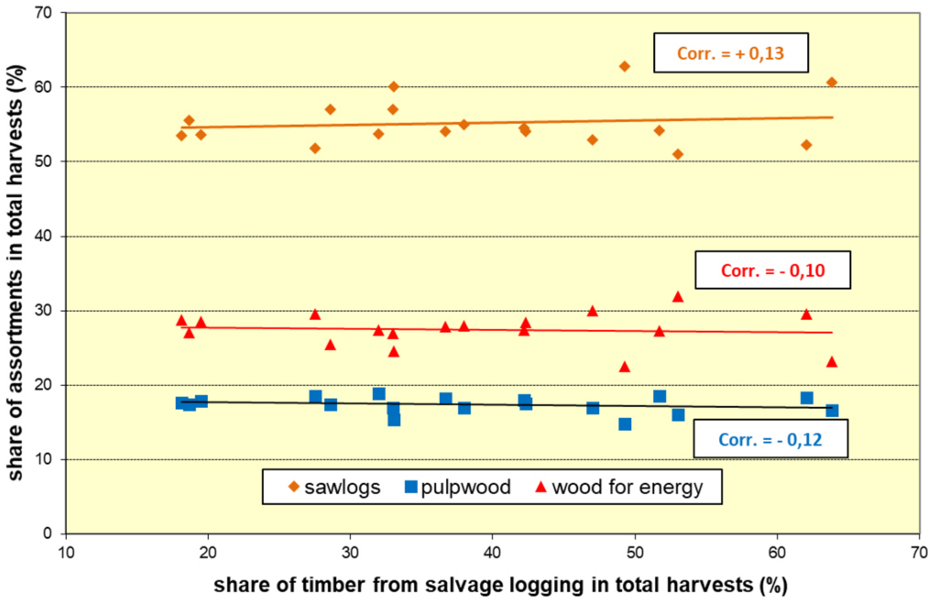

Figure 4: Correlations between the shares of total timber from salvage logging and the shares of the assortments sawlogs, pulpwood (round and split), wood for energy; total of coniferous and non-coniferous; all ownership categories (Sources: BMLFUW 2001-2017, BMNT 2018-2019, BMLRT 2020-2022, BML, 2023-2024, own calculations) (annual data: 2006-2023).

Abbildung 4: Korrelationen zwischen den Anteilen von Schadholz und den Anteilen der Sortimente Sägerundholz, Faserholz, Energieholz am Gesamteinschlag (Summe aus Nadel- und Laubholz, alle Eigentumsarten (Quellen: BMLFUW 2001–2017, BMNT 2018–2019, BMLRT 2020–2022, BML 2023–2024, eigene Berechnungen) (jährliche Daten: 2006–2023).

Table 1 shows the correlations between the share of total timber from salvage logging and the share of assortments in harvests, differentiated by ownership categories as well as by coniferous/non-coniferous wood and by reasons of damage (only storm/other than storm).

Table 1: Correlations between shares of total timber from salvage logging and assortments in harvests by species, reasons of damage and ownership categories (annual data: 2006-2023) (significant results in **bold***).*

Tabelle 1: Korrelationen zwischen den Anteilen von Schadholz und Sortimenten nach Nadel- und Laubholz, Schadfaktoren und Eigentumsarten (jährliche Daten: 2006–2023) (signifikante Ergebnisse **fett**).

		share of total timber from salvage logging: correlation with the share of … (correlation coefficients)				
ownership category	Species/ cause of calamity	sawlogs	pulpwood (round & split)	wood for energy (total)	wood for energy (stacked)	wood for energy (chips)
∑ all forests	coniferous	-0,05	-0,30	0,19	0,21	0,07
	of which: only storm	0,26	-0,43	-0,20	0,10	-0,22
	of which: other than storm	**-0,49***	0,11	**0,65****	0,22	0,46
	non-coniferous	0,09	**0,58***	**-0,52***	**-0,50***	0,29
	of which: only storm	**0,62****	0,11	-0,40	0,29	-0,45
	of which: other than storm	**-0,47***	**0,61****	-0,26	**-0,88****	**0,78****
SFH < 200 ha	coniferous	-0,34	-0,34	0,41	0,13	0,30
	of which: only storm	0,08	-0,14	-0,06	0,21	-0,17
	of which: other than storm	**-0,64****	-0,37	**0,73****	-0,05	**0,69****
	non-coniferous	-0,30	**0,65****	**-0,51***	**-0,70****	**0,54***
	of which: only storm	0,33	0,31	**-0,64****	0,08	-0,29
	of which: other than storm	**-0,52***	**0,57***	-0,22	**-0,84****	**0,78****
FE > 200 ha	coniferous	0,23	-0,43	0,07	0,24	-0,10
	of which: only storm	0,45	**-0,57***	-0,17	-0,03	-0,24
	of which: other than storm	-0,40	0,23	**0,49***	**0,56***	0,26
	non-coniferous	0,06	**0,68****	**-0,61****	**-0,58***	0,16
	of which: only storm	0,41	0,33	**-0,53***	0,05	-0,46
	of which: other than storm	-0,35	**0,58***	-0,27	**-0,83****	**0,68****
FF	coniferous	0,31	-0,29	-0,26	0,22	-0,29
	of which: only storm	0,37	-0,42	-0,28	-0,04	-0,19
	of which: other than storm	-0,06	0,15	0,02	0,36	-0,15
	non-coniferous	**0,52***	-0,28	-0,38	0,31	**-0,50***
	of which: only storm	**0,62****	-0,36	-0,40	0,39	**-0,60****
	of which: other than storm	-0,33	0,30	0,06	-0,30	0,31

Level of significance: ** p<=,01; * p<=,05

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML (2023-2024), own calculations

Despite some differences regarding the significance of correlation coefficients there are quite consistent - partly surprising – patterns regarding the relationships between the share of total timber from salvage logging and the share of assortments. Differences are not primarily between ownership categories but mainly between coniferous and non-coniferous wood as well as between the reasons for damage (storm vs. reasons other than storm). For all forests there are no statistically significant correlations for coniferous wood between the share of total damage caused timber and the share of the respective assortments. When further broken down into ownership categories and the reasons for damage, there is a clear difference between „only storm" and „other than storm". The share of damage caused coniferous timber other than by storm (smaller dimensions) in most cases correlates significantly negative with the supply share of sawlogs and significantly positive with the supply share of wood for energy.

For non-coniferous wood the share of total damage caused timber correlates statistically positive with pulpwood supply and negative with wood for energy supply (exception FF; here the correlation is negative for both, pulpwood and wood for energy, but not significantly). This situation can partly be explained by the fact that the costs for producing wood for energy in the forest is higher than for producing pulpwood. In addition, a decrease in non-coniferous wood for energy can also be caused simply by the fact that more coniferous wood for energy is available. With the exception of the FF a significant decrease of the share of non-coniferous wood for energy corresponds with a significant increase of the share of coniferous wood for energy caused by other reasons than storm. A high amount of coniferous wood for energy, which mainly can be contributed to low quality and cannot be avoided, reduces the willingness of forest owners to produce non-coniferous wood for energy; pulpwood round and split is more attractive (Friedl 2021). There is a clear difference on bucking when the damage is broken down by damage reasons. An increase in the share of storm damage also increases the supply share of non-coniferous sawlogs and decreases the share of non-coniferous wood for energy (partly significantly), an increase in the share of damage caused by other reasons than storms decreases the share of non-coniferous sawlogs (significantly only for all forests and SFH < 200 ha), increases the supply share of non-coniferous pulpwood (FF not significant); no significant relationship with the share of non-coniferous wood for energy. There is also an opposing impact on the two components of non-coniferous wood for energy: other than by storm damaged wood correlates significantly negative with the supply share of wood for energy (stacked), while significantly positive with the supply share of wood for energy chips from the forest (FF not significant).

For both, coniferous as well as non-coniferous wood, the share of sawlogs is not significantly decreasing and the share of pulpwood and wood for energy is not significantly increasing when storm damage is increasing; rather it is the other way around (but rarely significantly). Due to the higher contribution margin of sawlogs compared to pulpwood and wood for energy, forest owners generally tend to produce as much sawlogs as possible (Friedl 2021, Montecuccoli 2021) and deliver sawlogs earlier than pulpwood and wood for energy (Holzer 2021). When salvage logging in FE exceeds 20% of total harvests, forest owners tend to reduce thinnings in order to meet the allowable cut („Hiebsatz"); this mainly results in a reduction of pulpwood production (Montecuccoli 2021). A further reason for a lower production of pulpwood in times of salvage logging – especially when damages are caused by storm – is the increase of higher sawnwood production of sawmills, which leads to a higher production of sawmill residues and subsequently a lower demand for pulpwood round and split (Friedl 2021, Holzer 2021, Montecuccoli 2021). When the damage caused by other reasons than by storm is increasing, then there generally is a decrease in the share of sawlogs. For coniferous wood the impact of damage from other than by storm is mainly and (partly) significantly positive on the supply of wood for energy, while for non-coniferous wood the main and (partly) significantly positive impact is on pulpwood supply (exception FF). One of the main reasons for the latter may be the fact that non-coniferous pulpwood is more important than coniferous pulpwood for the kraft process in the pulp-industry.

To validate the results of the correlation analysis an analysis of variance (ANOVA) was carried out in addition (see chapter 2). Table 2 shows that different means of the shares of assortments generally are consistent with the correlation coefficients in table 1: a higher mean in the „high" (share of total timber from salvage logging) category in table 2 in most cases corresponds with a positive correlation coefficient, a lower mean in the „high" category with a negative correlation coefficient in table 1 and vice versa (the level of significance is not always the same in both tables). In general, the means of assortment shares between the two categories („low"/"high") do not differ very much in size, in most cases not even significant, which is not really a surprise (see figure 3). „High" and „low" shares of coniferous timber from salvage logging do not significantly affect the shares of sawlogs, pulpwood and wood for energy in all ownership categories, even when the shares of timber from salvage logging is further broken down into the „storm" and other than „storm" categories. However, the means of coniferous sawlogs in the „high" category are slightly and insignificantly higher than in the „low" category for FE > 200 ha and FF.

More statistically significant differences exist for the means of non-coniferous timber, which is consistent with the correlation results (table 1). Across ownership categories the means of shares for pulpwood are generally slightly higher in the „high" category and lower in the „low" category, while it is the other way round for wood for energy. This again confirms the correlation results (table 1) that for non-coniferous timber an increase in timber from salvage logging has a positive impact on the supply of pulpwood and a negative impact on the supply of wood for energy. Only when broken down into the reasons for damage a moderate (statistically insignificant) impact on the supply of sawlogs can be detected. A high non-coniferous share of timber from storm caused salvage logging tends to increase whereas a low share tends to decrease the share of non-coniferous sawlogs. A high share of timber from non-storm caused salvage logging tends to increase, a low share tends to decrease the share of non-coniferous pulpwood.

Table 2: ANOVA (t-Test): Means of the shares of assortments (dependent) by share of total timber from salvage logging (low = below and equal median; high = above median of damage caused timber share) (annual data: 2006-2023) (significant results in **bold***).*

Tabelle 2: Varianzanalyse (t-Test): Mittelwerte der Anteile von Sortimenten (abhängige Variable) nach Schadholzanteil (low = kleiner/gleich Median; high = größer als Median des jeweiligen Schadholzanteils (jährliche Daten: 2006-2023) (signifikante Ergebnisse **fett**).

			Mean share of ...		
ownership category	species	share of total timber from salvage logging	sawlogs	pulpwood (round & split)	wood for energy
∑ all forests	coniferous	low	0,64	0,17	0,19
		high	0,64	0,16	0,20
	of which: only storm	low	0,64	0,17	0,19
		high	0,63	0,17	0,20
	of which: other than storm	low	0,65	0,17	0,19
		high	0,63	0,17	0,21
	non-coniferous	low	0,11	0,20	0,69
		high	0,11	0,22	0,67
	of which: only storm	low	0,11	0,21	0,69
		high	0,12	0,22	0,68
	of which: other than storm	low	0,12	**0,20****	0,69
		high	0,10	**0,23****	0,67
SFH < 200 ha	coniferous	low	0,61	0,13	0,26
		high	0,60	0,12	0,28
	of which: only storm	low	0,60	0,13	0,26
		high	0,60	0,13	0,28
	of which: other than storm	low	0,62	0,13	**0,25***
		high	0,60	0,12	**0,28***
	non-coniferous	low	0,11	**0,07****	0,83
		high	0,09	**0,10****	0,81
	of which: only storm	low	0,10	0,08	0,83
		High	0,11	0,09	0,81
	of which: other than storm	Low	0,11	**0,07****	0,83
		high	0,09	**0,10****	0,81
FE > 200 ha	coniferous	low	0,68	0,23	0,09
		high	0,69	0,21	0,10
	of which: only storm	low	0,68	0,23	0,09
		high	0,69	0,22	0,10
	of which: other than storm	low	0,69	0,22	0,09
		high	0,68	0,22	0,10
	non-coniferous	low	0,14	**0,35***	**0,51***
		high	0,14	**0,38***	**0,48***
	of which: only storm	low	0,14	0,36	0,51
		high	0,14	0,37	0,49
	of which: other than storm	low	**0,15***	**0,34****	0,51
		high	**0,13***	**0,39****	0,49

FF	coniferous	low	0,63	0,24	0,13
		high	0,65	0,22	0,12
	of which: only storm	low	0,63	0,24	0,13
		high	0,65	0,23	0,12
	of which: other than storm	low	0,65	0,23	0,13
		high	0,64	0,24	0,13
	non-coniferous	low	0,10	0,52	0,39
		high	0,12	0,52	0,37
	of which: only storm	low	0,09	0,53	0,39
		high	0,13	0,50	0,37
	of which: other than storm	low	0,14	0,48	0,38
		high	0,09	0,54	0,37

Level of significance: ** p<=,01; * p<=,05

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML (2023-2024), own calculations

3.2 Relationships between the share of total timber from salvage logging and the share of final cuts as well as thinnings

One explanation that the increasing share of timber from salvage logging is not decreasing, but in most cases (non-significantly) increasing the supply share of sawlogs and decreasing the supply share of pulpwood and/or wood for energy lies in the fact that the supply of timber from salvage logging is above the average in final cuts and below average in thinnings. Therefore, the share of sawlogs (in particular for coniferous timber) and pulpwood (in particular for non-coniferous timber) can positively correlate with the share of timber from salvage logging. These relationships can also be validated by various assortment tables and bucking analyses (see *e.g.* Sterba & Grieß, 1983; Eckmüllner *et al.* 2007) and have been confirmed by interviews (Friedl 2021, Holzer 2021, Montecucoli 2021).

Table 3 shows the correlation results between the shares of total timber from salvage logging and final cuts, further disaggregated by coniferous and non-coniferous timber. With the exception of the FF, where comparatively low correlations exist and only for non-coniferous timber, there are highly significant and strong correlations. Although we have no empirical prove, we suspect that the low level of correlations in FF can partly be explained by the fact that the FF is a forest enterprise structured into ten regional enterprises distributed over most of Austria. To meet the economic interests of the entire company regional enterprises, which are less affected by a calamity, could reduce their harvests or decrease their final cuts and increase thinnings and compensate for salvage logging in more affected enterprises. But in general, the correlations show that calamities affect final cuts more than thinnings.

Table 3: Correlations between share of total timber from salvage logging and share of final cuts, by species and ownership categories (annual data: 2006-2023) (significant results in **bold***).*

Tabelle 3: Korrelationen zwischen dem Schadholzanteil und dem Anteil von Endnutzung sowie Durchforstung am Gesamteinschlag nach Nadel- und Laubholz sowie Eigentumsarten (jährliche Daten: 2006–2023) (signifikante Ergebnisse **fett**).

	share of total timber from salvage logging: correlation with share of final cuts (correlation coefficients)			
	ownership category			
Species	∑ all forests	SPH < 200 ha	FE > 200 ha	FF
coniferous	**0,88****	**0,86****	**0,93****	0,14
non-coniferous	**0,87****	**0,86****	**0,85****	**0,62****
∑ total	**0,89****	**0,86****	**0,95****	0,24

Level of significance: ** p<=,01; * p<=,05

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML (2023-2024), own calculations

The ANOVA results (table 4) confirm the results of the correlation analysis with the exception that there is no significant difference between low and high share of timber from salvage logging in FF for both, coniferous and non-coniferous timber. The levels of means for final cuts are all (coniferous, non-coniferous and total) significantly different for SFH < 200 ha, FE > 200 ha and all forests.

Table 4: ANOVA (t-Test): Means of the shares of final cuts by the shares of total timber from salvage logging (low = below and equal median; high = above median of damage caused timber share) (annual data: 2006-2023) (significant results in **bold***).*

Tabelle 4: Varianzanalyse (t-Test): Mittelwerte der Anteile von Endnutzung (abhängige Variable) nach Schadholzanteil (low = kleiner/gleich Median; high = größer als Median des jeweiligen Schadholzanteils) (jährliche Daten: 2006-2023) (signifikante Ergebnisse **fett**).

		mean shares of final cuts			
		ownership category			
species	share of total timber from salvage logging	∑ all forests	SFH < 200 ha	FE > 200 ha	FF
coniferous	low	**0,70****	**0,70****	**0,70****	0,63
	high	**0,77****	**0,79****	**0,78****	0,69
non-coniferous	low	**0,67****	**0,67****	**0,68****	0,57
	high	**0,73****	**0,76****	**0,74****	0,62
∑ total	low	**0,70****	**0,69****	**0,69****	0,62
	high	**0,76****	**0,79****	**0,77****	0,67

Level of significance: ** p<=,01; * p<=,05

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML 2023-2024), own calculation

4 Discussion and Conclusions

This section includes answers to the research questions and hypotheses, a critical assessment of the research results as well as some follow-up options for further research.

Answering the research questions and research questions not asked

Research question/hypothesis 1: Does the amount of total timber from salvage logging have an impact on the conversion of timber into the assortments of sawlogs, pulpwood and wood for energy? Does this impact differ by ownership categories and wood species groups (coniferous – non-coniferous)?

There are no statistically significant correlations between the share of total coniferous timber from salvage logging and the share of the respective assortments for all ownership categories. Regarding coniferous timber hypothesis 1 has to be rejected.

For non-coniferous timber and by ownership categories the share of total timber from salvage logging correlates statistically positive with pulpwood supply (not for FF) and negative with wood for energy supply; except for FF there is no significant correlation with sawlog supply. The positive correlation with pulpwood supply and the negative correlation with wood for energy can be (partly) explained with higher costs for fuelwood procurement and also the importance of non-coniferous pulpwood for the pulp-industry (kraft process). Regarding non-coniferous timber hypothesis 1 has to be rejected regarding the supply of sawlogs and wood for energy but not for the supply of pulpwood.

Research question/hypothesis 2: Do causes of calamities (especially storm vs. other than storm) have an impact on the conversion of timber into intermediate product assortments?

There is a clear difference between the causes „only storm" and „other than storm". Although in most cases not statistically significant, storm damaged coniferous timber (larger dimensions) correlates positively with the sawlog supply share and negatively with the shares of pulpwood and wood for energy. The share of coniferous timber from salvage logging other than by storm (smaller dimensions) correlates (partly) significantly negative with the supply share of sawlogs and (partly) significantly positive with the supply share of pulpwood and/or wood for energy.

An increase in the share of non-coniferous storm damage also increases the supply share of non-coniferous sawlogs and decreases the share of non-coniferous wood for energy (partly significantly; exception FF), an increase in the share of damage caused by other reasons than storms decreases the share of non-coniferous sawlogs (partly significant), and significantly increases the supply share of non-coniferous pulpwood (positive, but insignificant for FF); no significant relationship with the share of non-coniferous wood for energy.

Hypothesis 2 can therefore not be rejected for both coniferous and non-coniferous timber.

Research question/hypothesis 3: Does the amount of total timber from salvage logging have an impact on the shares of thinnings and final-cuts in total harvests (as well as vice-versa) and does this impact differ by ownership categories and wood species group?

With the exception of FF, where comparatively low correlations exist and only for non-coniferous timber, there are highly significant and strong correlations. These correlations indicate that calamities affect older stands – and therefore – final cuts more than younger stands and thinnings. This is also an explanation that in some categories increased damage caused timber is also (surprisingly and mostly insignificantly, however) leading to a higher supply of sawlogs.

Hypothesis 3 can therefore not be rejected.

Originally, we had two more research questions: Are there time-lags between the occurrence of calamities and the emergence of timber from salvage logging, by causes of calamities and/or by assortments? Our hypothesis was that the damage by bark beetles many times occurs in the aftermath and as a lagged result of storm damage (see *e.g.* Suliman & Ledermann 2025), which may lead to a lag in the bucking of pulpwood and wood for energy, following the immediate bucking of an increased amount of sawlogs. However, the data situation is a barrier to address this research question. The amount of salvage logging is reported in the TFRs in the same year as all other harvests. However, if or how much salvage timber is not reported in the same year but carried over to the next year, is unknown. However, we did carry out correlation analyses of lagged salvage timber amount with the distribution of assortments in the respective following years; no statistically significant correlations could be established. We also analyzed whether the amount of salvage timber caused by storms/wind-breaks in the current years is correlated to the amount of salvage logging by other reasons (bark beetle) in the respective following year. No statistical significance could be established.

Another research question would have been to check, whether and to what extend the amount of assortments from salvage logging (*e.g.* sawlogs from salvage logging) has an impact on the regular harvest of assortments (*e.g.* on the amount of sawlogs from regular harvests). This research question could not be addressed, because the data for salvage logging do not distinguish between assortments – they only include the total of the assortments in the respective categories.

Critical assessment of the results

This analysis is mainly based on data of the Austrian Timber Felling Reports (TFRs), the data quality of which is not undisputable, in particular for the ownership category SFH < 200 ha (see *e.g.* Ettwein *et al.* 2015). But this is the only existing database which offers annual time series with such a high level of differentiation regarding ownership categories, species, assortments, final cuts/thinnings, timber from salvage logging (incl. reasons for damage). Considering the limits, it is therefore the only database for such an analysis in order to avoid time-consuming and very expensive primary data surveys.

In addition, the TFRs do not report logging waste that remains in the forest. It can be assumed that the amount of logging waste is higher in cases of calamities and salvage logging compared to regular harvests. This could contribute to a higher share of sawlogs and a lower share of wood for energy in salvage loggings.

Another problematic aspect of this analysis is the length of the time series. Due to inconsistencies in the data (structural break, see chapter 3.) we only could use 18 annual observations. On the other hand, the share of timber from salvage logging in total harvests between 2006 and 2023 is much higher (39%; BMLFUW 2001-2017, BMNT 2017-2018, BMLRT 2019-2022, BML 2023-2024) than in the period 1996-2005 (29%; BMLFUW 2001-2017), which makes the analysis quite focused.

There are two more shortcomings in the data. The categories of the assortments in the TFRs are not reported considering quality and prices. Potential lower wood quality and prices are not at all reflected in the data, which would be especially relevant for the assortment sawlogs (*e.g.* increased amount of sawlogs in (low) Cx quality). Furthermore, damage caused storm timber cannot be further disaggregated into windthrows and windbreaks, which also is an important criterion for the quality, again in particular for sawlogs. According to Friedl (2021) and Holzer (2021) windbreaks lead to a higher share of wood for energy, while windthrows lead to higher share of sawlogs. Windbreaks usually happen in the lower parts of the stems and therefore reduce the potential for sawlog production, while windbreaks usually do not affect wood quality and therefore do not necessarily reduce the potential for sawlog production (Montecuccoli 2021).

Potential follow-up research activities

Due to the existing limitations regarding this analysis several follow-up research activities can be considered:

The analysis could be repeated at a later stage with longer time series and additional qualitative expert interviews with foresters and sales persons in the roundwood market could be conducted to better complement the statistical analysis of secondary data. Primary data surveys on specific bucking activities on damaged forest areas could be conducted, in particular considering the aspect of windthrows vs. windbreaks, but also the aspect of calamities affecting larger areas vs. calamities affecting single trees or smaller pockets of trees. In addition, the aspects of quality and prices of assortments, relevant for bucking decisions, could be addressed. For FE a specific analysis of the Austrian Forest Accountancy Data Network [Testbetriebsnetz] (see *e.g.* Sekot & Metzker 2024) could be revealing, because these data include – among many other aspects – also the share of salvage logging in timber harvests, broken down by thinnings and final cuts and – at least for some FE - data on the share of sawlogs in Cx quality (low sawlog quality). For FF the internal (unpublished) database could be analysed – if made available -, because these most likely include in a consistent way and for a long time period data on storage of salvage logged timber, and also the share of low quality sawlogs. Not a direct research option but a data improvement possibility: The TFRs could be complemented with data disaggregating the storm damage data by windthrows and windbreaks as well as data regarding calamities on larger areas vs. calamities affecting single trees or smaller pockets of trees (see above). In addition, the TFRs could distinguish salvage logging amounts into assortments. However, in both cases the validity of these data may be questionable.

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Supplementary Material

Data used for the statistical analysis.

Table S1: Harvests all forests – total of all ownership categories.

Tabelle S1: Gesamteinschlag – Summe aller Eigentumskategorien.

	Harvests in 1000 cum u.b.																
year	Total (conif. & non conif.)	Conf. sawlogs	Conif. pulpw.	Conif. wood for energy	Non-conf. sawlogs	Non-conif. pulpw.	Non-conif. wood for energy	Conf. final cuts	Conf. thin-nings	Non-conf. final cuts	Non-conf. thin-nings	Conif. salvage logging (total)	Conif. salvage logging (storm)	Conif. salvage logging (other than storm)	Non-conif. salvage logging (total)	Non-conif. salvage logging (storm)	Non-conif. salvage logging (other than storm)
2006	19135	11094	2436	2822	409	507	1882	11617	4720	1867	932	6016	1092	4924	314	127	187
2007	21317	12951	2638	3057	430	521	1740	14557	4070	1898	792	9847	7106	2741	660	535	125
2008	21695	12744	2979	3162	419	631	1862	15132	3753	2053	758	12952	10106	2846	902	769	133
2009	16873	8912	2527	2766	288	511	1849	10405	3820	1833	816	6559	2545	4014	592	407	185
2010	17831	9893	2649	2754	274	465	1795	11020	4277	1657	877	4732	1231	3501	372	234	138
2011	18696	10065	2719	2944	321	526	2121	10925	4802	1976	992	3228	584	2644	269	123	146
2012	18021	9359	2578	2996	295	599	2194	10001	4932	2043	1045	2991	1121	1870	282	105	177
2013	17390	9052	2508	2859	267	606	2098	9543	4876	1945	1025	3091	1047	2044	306	114	192
2014	17089	8585	2483	2854	270	692	2205	9468	4453	2012	1154	4179	1422	2757	521	143	378
2015	17550	9194	2378	2999	297	702	1980	10482	4089	2047	932	6791	2566	4225	636	163	473
2016	16763	8686	2459	2710	321	708	1880	9556	4298	1993	916	4826	1300	3526	531	117	414
2017	17647	9237	2485	2873	299	718	2036	10676	3918	2115	937	5780	2094	3686	697	210	487
2018	19192	10070	2751	3218	326	802	2026	12698	3341	2328	826	8909	4190	4719	1019	410	609
2019	18904	9568	2774	3634	302	680	1945	12640	3337	2191	736	10717	4110	6607	1018	302	716
2020	16790	8229	2358	3359	275	600	1968	10490	3457	2108	736	7965	2822	5144	945	285	660
2021	18420	10410	2531	2993	280	570	1907	11619	4044	2057	700	5306	1367	3939	738	179	559
2022	19358	10688	2576	3248	329	647	2176	12455	3751	2364	789	6510	2127	4384	749	178	572
2023	19018	9752	2637	3451	285	672	2220	12573	3268	2377	801	8169	2965	5204	848	315	533

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML (2023-2024)

Table S2: Harvests small forest holdings (< 200ha).

Tabelle S2: Einschlag Kleinwald (< 200ha).

	Harvests in 1000 cum u.b.																
year	Total (conif. & non conif.)	Conf. sawlogs	Conif. pulpw.	Conif. wood for energy	Non-conf. sawlogs	Non-conif. pulpw.	Non-conif. wood for energy	Conf. final cuts	Conf. thin-nings	Non-conf. final cuts	Non-conf. thin-nings	Conif. salvage logging (total)	Conif. salvage logging (storm)	Conif. salvage logging (other than storm)	Non-conif. salvage logging (total)	Non-conif. salvage logging (storm)	Non-conif. salvage logging (other than storm)
2006	11484	6327	1155	2311	187	103	1401	6803	2990	1085	606	2970	611	2359	161	76	85
2007	11696	6492	1166	2419	223	121	1275	7723	2353	1119	500	4228	3040	1188	274	213	60
2008	12288	6732	1384	2372	221	161	1417	8290	2198	1295	505	6394	5295	1099	370	324	46
2009	8896	4332	973	2050	228	88	1309	5175	2180	1047	494	2476	997	1480	210	141	70
2010	10182	5462	1141	2079	243	104	1254	6143	2539	979	521	1645	439	1206	122	74	49
2011	11343	5978	1402	2253	169	126	1543	6566	2939	1229	608	1216	235	980	111	52	59
2012	10815	5379	1192	2330	162	137	1615	5927	2974	1266	647	1371	540	831	143	44	99
2013	10305	5189	1140	2248	139	129	1461	5693	2884	1152	577	1523	560	963	159	58	101
2014	9890	4740	1071	2251	136	147	1545	5544	2518	1146	681	2131	713	1419	313	76	237
2015	10013	4947	1017	2314	152	182	1401	6146	2133	1199	535	3450	1165	2285	311	73	238
2016	9639	4735	1074	2134	176	162	1358	5540	2403	1205	492	2400	664	1735	279	55	224
2017	10370	5260	1087	2271	162	140	1450	6536	2081	1285	467	3348	1226	2122	385	135	249
2018	11343	5719	1204	2551	175	244	1450	7752	1723	1431	438	4902	1782	3120	560	208	352
2019	11078	5221	1163	2921	163	182	1427	7786	1520	1400	372	5846	1948	3898	575	124	451
2020	9249	4017	832	2588	161	145	1507	5949	1488	1396	416	3770	1296	2474	584	145	439
2021	10848	5804	962	2316	168	134	1464	6947	2135	1387	379	2388	679	1709	453	103	351
2022	11361	5882	1062	2493	187	153	1584	7431	2006	1556	368	3279	1164	2115	450	116	333
2023	11145	5348	1163	2603	170	219	1643	7517	1598	1617	414	4350	1661	2689	578	241	337

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML (2023-2024)

Table S3: Harvests forest enterprises (> 200ha).

Tabelle S3: Einschlag Betriebe (> 200ha).

	Harvests in 1000 cum u.b.																
year	Total (conif. & non conif.)	Conf. sawlogs	Conif. pulpw.	Conif. wood for energy	Non-conf. sawlogs	Non-conif. pulpw.	Non-conif. wood for energy	Conf. final cuts	Conf. thin-nings	Non-conf. final cuts	Non-conf. thin-nings	Conif. salvage logging (total)	Conif. salvage logging (storm)	Conif. salvage logging (other than storm)	Non-conif. salvage logging (total)	Non-conif. salvage logging (storm)	Non-conif. salvage logging (other than storm)
2006	5847	3706	987	355	154	267	379	3689	1359	581	219	1961	342	1619	100	26	75
2007	6943	4637	1122	418	135	271	358	4891	1287	562	203	3746	2751	995	217	166	51
2008	6943	4473	1176	489	136	324	346	5098	1039	625	180	4428	3323	1105	302	243	58
2009	5869	3416	1132	471	105	286	459	3747	1272	595	255	2562	914	1647	195	114	81
2010	5829	3481	1112	424	100	271	441	3623	1394	538	274	1933	535	1397	125	71	54
2011	5726	3273	1137	460	102	287	468	3367	1502	580	277	1329	246	1083	93	35	58
2012	5558	3159	1053	456	131	286	472	3160	1509	603	286	1161	445	716	90	33	58
2013	5420	3029	1058	411	123	311	488	2968	1530	611	311	1118	358	760	99	34	66
2014	5568	3020	1096	445	113	375	519	3116	1444	661	346	1571	541	1030	155	44	111
2015	5906	3425	1064	493	118	356	450	3673	1309	641	283	2443	1051	1392	212	54	158
2016	5524	3106	1078	433	120	366	421	3245	1372	607	300	1733	423	1310	176	26	150
2017	5702	3181	1086	461	118	388	468	3395	1333	664	310	1828	647	1181	237	42	195
2018	6228	3564	1200	517	129	371	447	4165	1116	722	226	3118	1788	1330	344	141	203
2019	6208	3530	1252	554	119	341	412	4204	1132	661	211	3753	1705	2048	341	126	215
2020	5782	3240	1178	571	101	316	376	3797	1192	598	195	2917	1102	1815	274	95	179
2021	5736	3350	1159	488	97	289	351	3741	1257	549	189	1917	443	1474	229	51	178
2022	6016	3470	1098	570	116	307	455	3974	1164	626	252	2329	835	1494	258	44	214
2023	5906	3345	1054	654	94	292	467	3978	1075	601	252	2823	1108	1715	228	53	175

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML (2023-2024)

Table S4: Harvests Federal Forests.

Tabelle S4: Einschlag Österreichische Bundesforste.

	Harvests in 1000 cum u.b.																
year	Total (conif. & non conif.)	Conf. sawlogs	Conif. pulpw.	Conif. wood for energy	Non-conf. sawlogs	Non-conif. pulpw.	Non-conif. wood for energy	Conf. final cuts	Conf. thin-nings	Non-conf. final cuts	Non-conf. thin-nings	Conif. salvage logging (total)	Conif. salvage logging (storm)	Conif. salvage logging (other than storm)	Non-conif. salvage logging (total)	Non-conif. salvage logging (storm)	Non-conif. salvage logging (other than storm)
2006	1803	1044	295	157	68	137	102	1125	371	201	106	1086	140	946	52	25	27
2007	2678	1802	350	219	71	130	106	1943	429	217	89	1874	1315	559	170	155	15
2008	2565	1539	418	302	62	145	98	1744	515	233	73	2130	1488	641	231	202	29
2009	1963	1068	423	214	39	137	81	1337	368	191	67	1494	619	875	186	152	34
2010	1820	950	396	252	32	90	101	1254	344	140	82	1154	257	898	125	89	35
2011	1626	814	306	231	50	113	110	991	361	167	107	684	102	582	65	36	29
2012	1648	821	332	209	31	148	106	914	449	174	111	459	136	323	49	28	21
2013	1665	835	310	200	13	158	150	882	462	183	138	450	129	321	48	22	25
2014	1631	825	316	159	21	170	140	808	491	205	127	477	169	309	53	24	29
2015	1631	822	296	192	27	164	129	663	648	207	114	898	349	549	113	36	76
2016	1600	844	308	143	24	180	102	772	523	181	124	693	212	481	77	37	40
2017	1576	796	312	141	18	190	117	745	504	166	160	603	221	382	76	33	43
2018	1621	787	348	149	22	187	128	782	502	175	162	889	621	269	115	61	54
2019	1618	817	359	160	20	157	106	650	685	130	153	1118	458	661	102	52	50
2020	1758	972	347	201	13	140	85	744	776	114	124	1278	424	855	88	45	43
2021	1837	985	410	189	15	147	91	932	651	121	132	1001	245	756	56	25	30
2022	1981	1030	416	184	26	188	137	1050	581	181	169	902	128	774	42	18	24
2023	1967	1184	420	195	21	161	111	1079	595	158	134	996	196	800	42	20	21

Sources: BMLFUW (2001-2017), BMNT (2018-2019), BMLRT (2020-2022), BML (2023-2024)