UNIVERSITÀ DEGLI STUDI DI PADOVA

Department of Land, Environment Agriculture and Forestry

Second Cycle Degree (MSc) in Forest Science

Economic evaluation of a sawmill of Lower Austria

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Summary

1. Introduction

1.1 Case study: a sawmill in Lower Austria

Austrian sawmilling industry, with 1000 companies which involve 6000 employees, represents the major wood processor in the country. Despite being constituted by essentially small and medium-size businesses, the 40 largest companies cover up to 90% of the total production volume (UNECE;2018). In such a competitive environment, it is very interesting to analyse how a small business can manage to represent a profitable reality. To understand whether and how it is possible, this study implemented an economic evaluation on one of these small sawmills. The company taken as a case study is a medium size hardwood sawmill, situated in a small village of Lower Austria. The company is family-managed and has about 20 employees working along with the family members. The company is running since three family generations but was constantly renovated from the technical viewpoint, to keep the pace with the market. Nowadays, the company carries out internally all phases of the production chain, in which round-wood is cut into sawn-wood, sorted, dried and occasionally steamed, planed and packed. Furthermore, a consistent share of the company's profit comes from its work as a contractor for other companies, mainly for steaming essences and secondarily also to apply the other processes. Since 2014 the company is in the hands of the youngest generation. The new management aims at reaching a sustainable production by self-generating electricity and heating power and working only with local and SFM certified timber. The present situation is close to reaching the target, as all the heating power need is produced with by-products as chips and bark, and most of the electricity is provided by a hydroelectric generator which stands at the close-by torrent. All the round-wood bought and processed under the present management is PEFC certified and from local sources.

The interest of the study fell on this company because of its orientation towards sustainability. Despite the additional costs that occur in following such path, it is very interesting to understand how a family-owned company could nevertheless manage to be a profitable business.

1.2 Thesis objectives

The aim of this thesis is defined by the manager's objectives, provided during an interview prior to the start of the study. They are:

- <u>To obtain a measure of profitability</u> and to identify some key indicators for each major species, capable to define the revenue flow and its components
- <u>To distinguish</u>, for the period 2013-2019, <u>the gross profit</u> from '**contractual work**' and '**sawn-wood**': these terms will be used in the rest of the thesis to identify **contractual work** as wood which belongs to other companies that pay for it to be processed in the sawmill, and **sawn-wood** as the round-wood bought and internally processed into sawn-wood at the company's own expense

- To estimate the total amount of costs and their distribution for the period 2014-2019 and their share in contractual work and sawn-wood
- Define the net revenue obtained by the company in the period 2013-2019 and differentiate, as far as possible, the net profit generated by contractual work and by sawn-wood
- To generate, starting from historic data, prospects of the possible development of the company in the next 5 years, with a specific focus on what would happen if ash wood turns out to be unprofitable, focus due to a specific request of the manager

The fear of losing ash timber in the area was reported to the manager from his round-wood furnishers, who sustain that due to an illness, the pressure on *Fraxinus e*. intensified during the last years, to prevent good specimens from an infection that would deplete their economic value. This study couldn't confirm the reliability of this rumours, but literature records an ash dieback caused by a fungi, "the ascomycete *Hymenoscyphus pseudoalbidus* (anamorph *Chalara fraxinea*) causes a lethal disease known as ash dieback on *Fraxinus excelsior* and *Fraxinus angustifolia* in Europe. The pathogen was probably introduced from East Asia and the disease emerged in Poland in the early 1990s; the subsequent epidemic is spreading to the entire native distribution range of the host trees" (Gross et al., 2014).

The data collection work was combined with an on-field experience that improved the understanding of the real-life dynamics occurring daily in the company. The data provided by the manager were essential for the understanding the cost distribution and were further checked for a more detailed distribution amongst process and products.

In chapter 2, each objective will be treated as a different sub-chapter and the target indicators for each objective explained accurately.

1.3 Austrian timber market

The forest sector in Austria, is a dynamic and well-developed example of forest management with interesting outcomes in terms of production and marketing of wood and its derivates. In fact, in 2018 Austrian timber market produced more than 10 million cubic meters of sawn wood, 5.8 million of which were exported to European and International partners. Sawn softwood dominates the production, surpassing hardwood by 10 times. Austrian sawmills had a production value of 2.15€ billions in 2017. Export destinations are Italy (which accounts for 2.6 of the total 5.32 million m^3) and Germany (995.000 m^3). Imports come mainly from the Czech Republic and Germany, with respectively 2.9 and 1.7 million m^3. As regards certified wood, PEFC is the predominant certification company with around 63 thousand forest owners holding 3 million certified hectares and 484 chain of custody valid certificates. As regards FSC, data reported are 587 hectares and 289 chain of custody certifications (UNECE, 2018). Fig.1 shows the trend of sawn-wood imports of the last five years, reporting the main countries partner of Austria and the value (€) involved yearly. In the last five years

Germany led solidly the market, as first importer of sawn-wood to Austria, with a constant growth going from 200€ million in 2015 to 250€ million in 2019. The second most important importer in Austria is the Czech Republic, with around 100-150€ million worth of sawn-wood. The three following partner countries, far from the values registered by the first two leading nations, are Finland, whose share increased constantly in the last five years, bringing this country from the fifth to the third position, then Poland, which had a first rise followed by a bounce back in 2018 (which still persists), and, lastly, Hungary, whose performance in monetary terms constantly decreased, in the reported quinquennial.

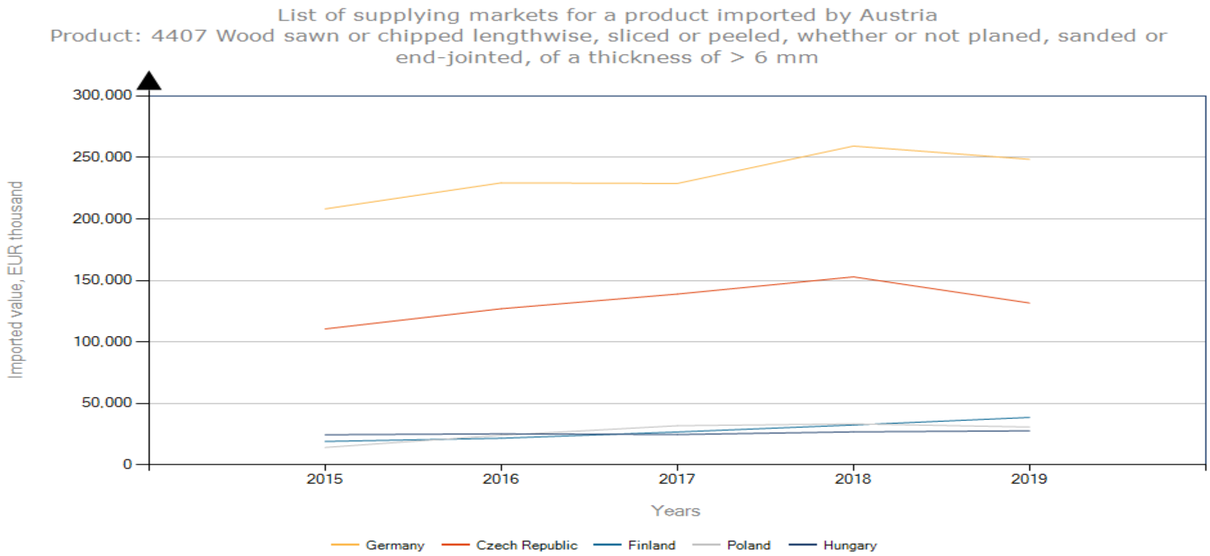

Fig.1: Sawn-wood Austrian imports of the period 2015-2019 (International Trade Centre, 2020).

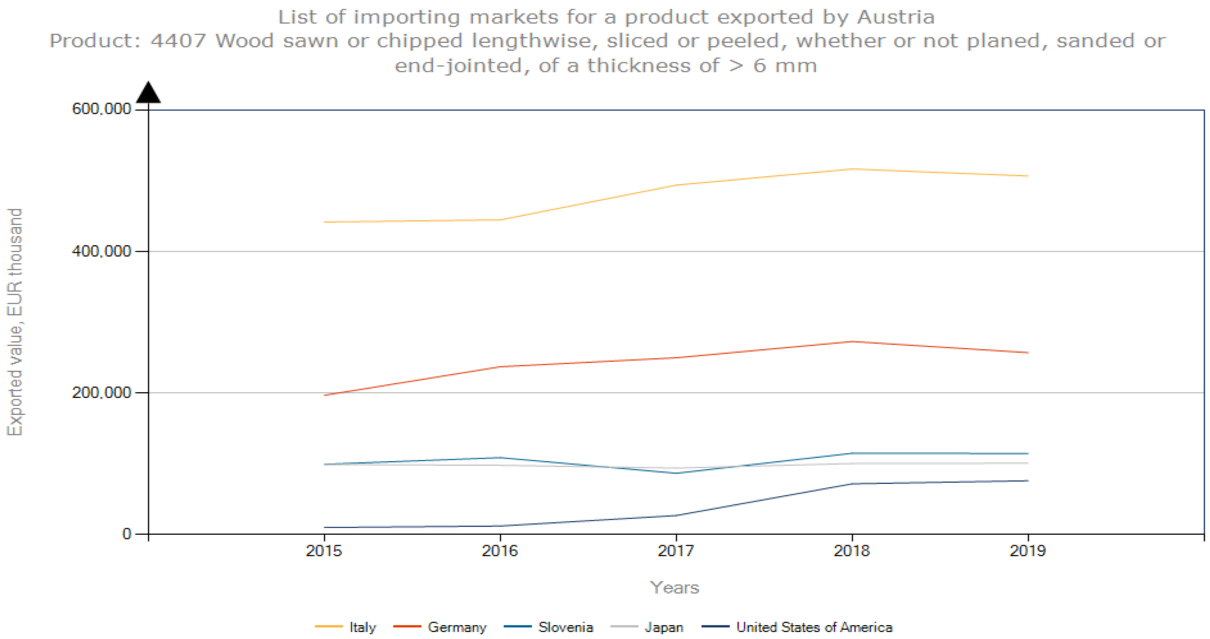

Fig.2: Austrian exports of the period 2015-2019 (International Trade Centre, 2020).

As regards the export partners, Fig.2 indicates that in 2015-2019 Austrian sawn-wood was sold mainly to Italy, which is by far the most prominent market in the last five years, with 400-500€ million year purchase of in Austrian sawn-wood. With a growing trend with some ups and downs. The second place is taken by Germany, which purchased around 200€ million annually, and whose demand for Austrian sawn-wood kept growing with a pattern similar to that of the Italian market. Similar to what happens for the imports, the third, fourth and fifth main exporting partners for sawn-wood are very close to each other, with Japan and Slovenia having a seemingly constant request and floating between the third and fourth position. United States have developed a growing interest for Austrian sawn-wood, as shown by the steadily increasing blue curve in fig.2, that had a strong increase in the last three years.

Another aspect of sawn-wood market in Austria is connected to the quantities produced and traded. In the next figures, the volume in m^3 of sawn-wood produced, imported and exported from Austria in the recent period will be reported. The data are taking from the FAOSTAT website, which reports data until 2019.

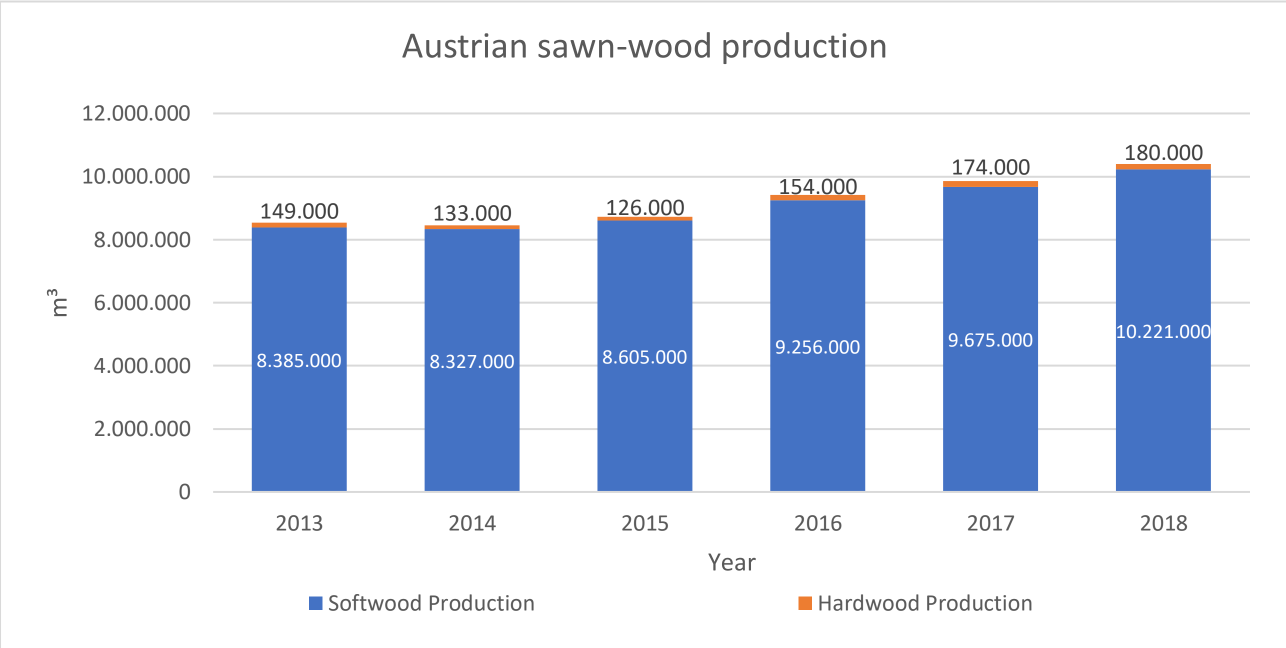

Fig.3: Austrian sawn-wood production. (FAOSTAT; 2020).

Fig.3 reports the amount of sawn-wood produced in Austria for the period 2013-2018. The total volume is divided between hardwood and softwood. The data in FIG. 3show that the volumes of the two categories are very different, with softwood covering almost completely the production, whereas hardwood occupies only a little portion of the total annual volume produced. Considering the total volume, after a decline in 2014, total production has steadily increased for the following four years, moving from8.731.000 m^3 in 2015 to 10.401.000 m^3 in 2019.

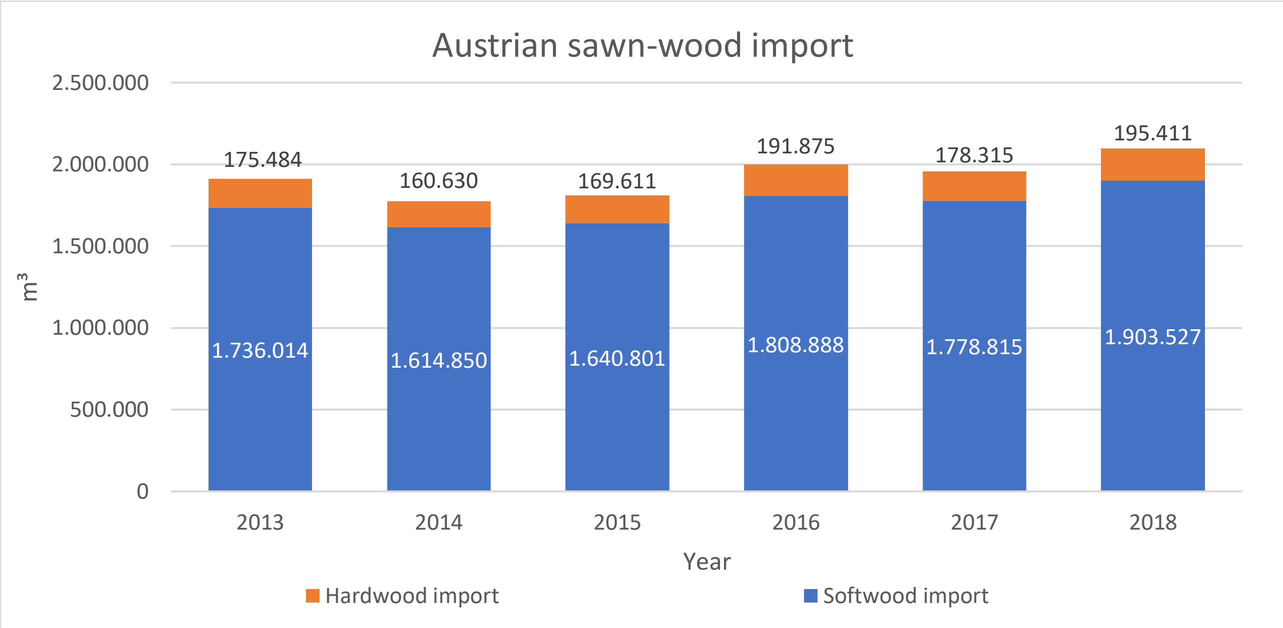

Fig.4: Austrian sawn-wood import (FAOSTAT; 2020).

The sawn-wood quantities imported annually from Austria are shown in Fig.4, which is again split into hardwood and softwood. Once again, softwood occupies a much higher share than hardwood, with values approximately ten times higher each year. The oscillation of the total imports has a less clear path than for production, as from 2013 to 2019 values grew and fell almost yearly. Although the strong variability, in the considered period both softwood and hardwood imports managed to increase in absolute numbers, which are higher in 2019 than in all precedent years. This fact can have multiple explanations: it could be a demand-driven purchase or be motivated by the lower prices sawn-wood has in other countries. In this scenario, the growth shown in Fig.3 could explain Fig.5's parallel rise in the sawn-wood export. In fact, if imports are a strategy to face market demand, a growing export could be, in an optimistic situation, the consequence of a solid, constant growth of the national production, but even the consequence of an internal market stagnation. What the real Austrian situation could be, between the two mentioned possibilities can be understood in 2018's UNECE Austrian market report, which states "Austria's national economy is in the second year of a phase of economic boom", trend sustained by "both domestic demand and foreign trade". As regards the forest sector, the report states "figures of the wood-processing industry were increasing in 2017. This favourable trend has continued in 2018. After a 5.3% increase in timber harvesting (2017), a further rise is expected for 2018". The paper also provides further information about the import growth, which is reportedly due to "difficult round-wood hauling as a result of high snow in the mountains and to the abundant supply after damaging events in Germany and the Czech Republic."(UNECE; 2018).

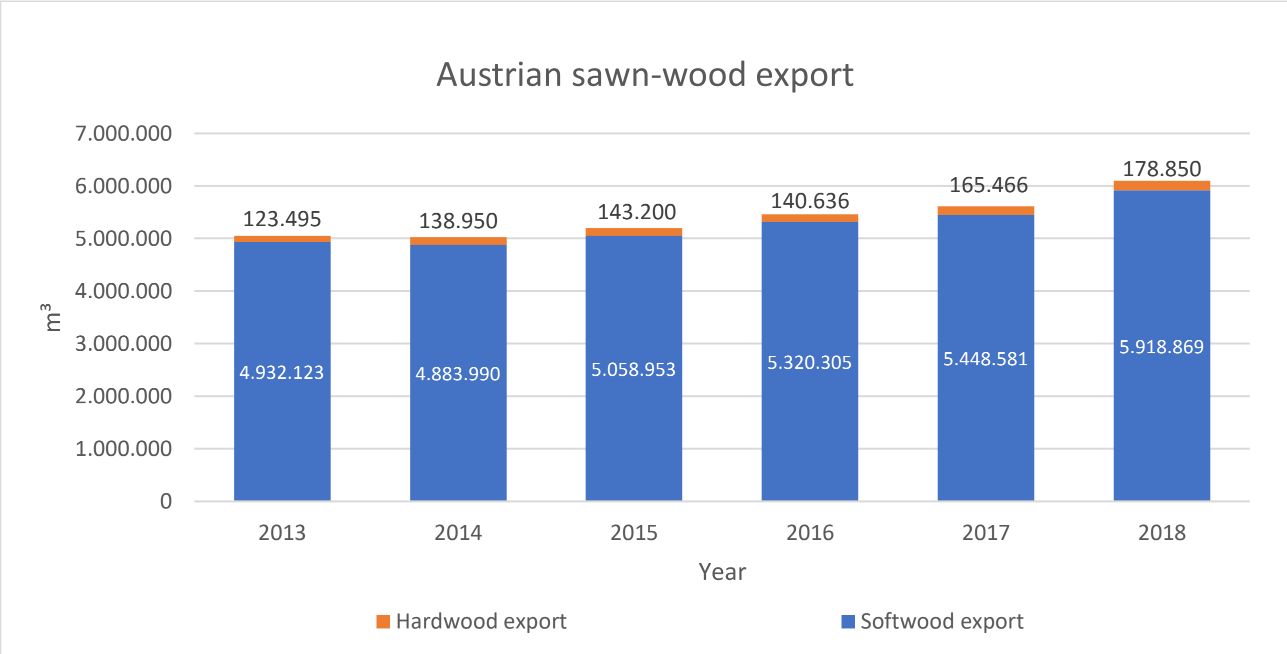

Fig.5: Austrian sawn-wood export (FAOSTAT; 2020).

Softwood and hardwood share the same growing trend, with proportions between each other similar to those of production and imports.

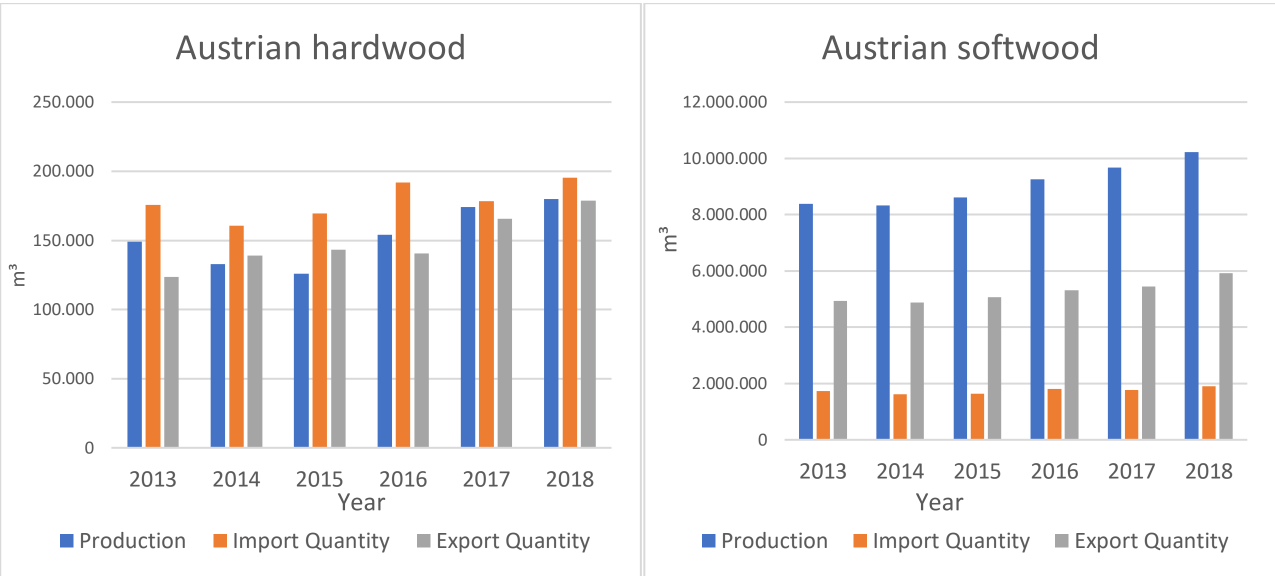

Fig.6: Comparison between Austrian hardwood and softwood: production, import, export (FAOSTAT; 2020).

Lastly, Fig.6 compares hardwood and softwood in the previously discussed categories: production, import and export for the period 2013-2018. Hardwood quantities are very similar in all categories, with import values slightly higher than the others, while production and exports quantities are at times higher or lower the one in respect to the other.

Softwood has a completely different situation, as production is twice the exported volume, and up to ten times (2018) higher than the annual import quantity.

The scales of the volumes reported are very different, as hardwood never reaches 200.000 m^3 in any category, while softwood production hit 10.000.000 m^3 in 2018. The disproportion is explained with the fact that Austrian forests are composed of 74,8% conifers and 25,2% broadleaves (FAO; 1995). In addition, European softwood consumption was 99.9 million m^3 in 2018, with Austria being the second country for per-capita consumption after Estonia, while hardwood consumption was only 13.1 million m^3 (UNECE, 2019).

2. Materials and methods

2.1 Materials

The data adopted to perform the economic evaluation have been obtained from the company's official records, as invoices, inventories, the ledger, annual balance sheets provided by the company's business consulting agency. Since the nature of these data is confidential, part of the information present in the Results (chapter 3) is reported just as an indication necessary for the sake of the study's comprehension, without expressing the actual values and quantities the company deals with.

In the next paragraphs, it will be explained which indicators have been used to reach the objectives set in the previous chapter. Objectives and interested indicators are:

- Obtain a gross profitability and differentiate 'contractual work' and 'sawn-wood'
    - ∂_t , the difference between revenues and costs in year t;
    - Δ%, the yearly variation of ∂_t from reference year 2002;
    - R_t^{sw}, R_t^{pr}, R_t^{tot}, three gross revenue indicators used to differentiate 'contractual work' and 'sawn-wood' from the total yearly revenue;
- Calculate costs
    - Δ costs, or every cost aside from the round-wood price;
    - Δ shared costs, or the part of Δ costs that can't be proportioned between 'contractual work' and 'sawn-wood';
- Defy the net revenue
    - The indicators used are the ones of the two previous objectives combined;
- Generate prospects
    - CAGR, an index that provides an average rate of return, given the revenue of the initial and final year of investment;
    - V_n, a value (annual cost or revenue) that if multiplied by CAGR generates the following year's value, was used to create the prospect for both cost and revenue;
    - γ, the ratio between selling price and round-wood cost of a wood species in a given year;
    - Ω, the volumetric ratio between sawn-wood sold and round-wood bought;
    - ROE, or Return on Equity, is the ratio between net yearly revenue and net capital;
    - NPV, or Net Present Value, is the actualized revenue of an investment that is to be done in the future;
    - R/C, the Benefit-Cost Ratio, is the actualized value of the ratio between benefits and costs of a future investment.

2.2 Methods

2.2.1 Gross revenue

Firstly, the price per cubic meter (€/m³), quantity (m³), value (€) was calculated year by year, from 2002 to 2020, for both round-wood bought and sawn-wood sold.

Then, the species which had the higher number of data available were separated from the other species with less data, to refine the analysis at least for some species.

- The variation of the price per cubic metre in percentage, taking 2002 as the starting year for the process. This was needed t in order to find, year by year, if the difference of selling price minus buying cost had a positive or negative trend. The formulas used were:

  $$(1)\ \partial_t = (R_t - C_t);\quad (2)\ \Delta\% = \left(\frac{(\partial_t * 100)}{\partial_{2002}}\right) - 100$$

  Where ∂_t(€/m³), is the difference, for a given year **t**, between the sawn-wood price R_t(€/m³) and the round-wood price C_t (€/m³). Then, Δ% (%) is the variation in percentage of the difference ∂_t of any year from the reference year∂_{2002}.
  Clearly, the results refer to gross revenues, while to identify the actual profitability for the company it would be necessary to include also the costs to process the round-wood into the final product.

- the revenue from the sole sawn-wood R_t^{sw} (€), which was obtained subtracting from the total gross revenue in any year **t**, R_t^{tot} the revenue provided by the wood processed for contractors R_t^{pr} :

  $$(3)\ R_t^{sw} = R_t^{tot} - R_t^{pr}$$

  Again, the processing costs were not considered in the calculation, therefore the outcome is a gross estimation. Using this method, it was then possible to have a picture, year by year, of the weight of each species in the final balance. Having the possibility to isolate each species was essential to elaborate the prospects treated in chapter 2.4.

2.2.2 Costs estimation

To obtain a clear distinction of the costs occurring on both processes, the first action was the identification of the principal steps of the production chain, according to which six macro-cost categories where defined:

1. Log yard and sawmill: costs for stocking the round-wood in the yard, bringing it inside the sawmill and sawing it
2. Classification: costs of operators who select the sawn-wood and classify in into different quality classes, according to the criteria used in Austria

3. Drying: Costs for dying, when the piles are moved into kiln driers by forklift operators and then left drying for a given period of time
4. Steaming: costs for steaming for that part of the sawn-wood sent into steamers before being dried; part of the contractors' material undergoes only this process, and is sent back without being then kiln dried
5. Storage: After all of the previous processes, the material is stocked into another storage area, where it lays before the final processing or already packaged and ready to be sold, storage costs involve labour costs and the forklift depreciation
6. Cutting and planing: Part of the low quality and defected lumber is sold in cut and/or planed sticks, therefore this further process involves labour and machine cost

After having identified the major steps of the process, the analysis was taken forward by estimating the yearly distribution (in m^3) of the costs for the timber processed by the company, distinguishing the costs for internally processed sawn-wood and for contractors work. The percentage distribution of each of the two processes and year has then been applied to the total costs of each step of the process, resulting in a neat and clear diversification of the costs per m^3 for each product category and year.

As regards the costs for energy consumption, the issue was understanding the amount of savings derived from burning sawdust and chips instead of acquiring firewood to use in the furnace that generates the heat used in the kiln driers. The savings cost per cubic metre has been obtained by averaging the firewood price occurred yearly from 2014 to 2019. The price has been multiplied by the by- products' quantity produced every year by the sawing processes to obtain the final yearly savings.

2.2.3 Net revenue

The next step was to adjust the net revenue with the new 'Δ cost' proportion. The gross revenue and costs have been turned in €/m^3 and then the costs occurring exclusively for each category were subtracted. Finally, the net revenues were returned into € and the part of 'Δ cost' which wasn't possible to attribute proportionately was subtracted. In this way, it was possible to identify in detail the net revenue of each one of the two processes and then to identify the effect of overheads into the final annual balance.

2.2.4 Prospects

The prospect estimation was obtained by multiplying the 2019 costs and revenues by the Compound Average Growth Rate (CAGR) of the period 2013-2019.

$$(4) \quad V_n = V_{n-1} * (1 + CAGR); \quad (5) \quad CAGR = (V_{2019}/V_{2013})^\wedge(\frac{1}{n})\text{-}1$$

In the formula V_n is the value of the year considered, and V_{n-1} is the value of the year before, and n is the number of years, in this case we considered 7 years (2013-2019). The formula has been applied to each year from 2020-2024 to obtain the prospect of the whole period.

After having calculated both costs and revenues, the first indicator used was NPV, estimated by actualizing the items with an interest rate r=10.81%, which is the CAGR obtained if applied to the *net yearly profit* of the company for the period 2013-2019.

The other indicators used were R/C ratio and ROE, Return On Equity, which is a useful tool to understand the proportion of invested capital to return in net profit on a yearly basis:

$$(6) \quad ROE = \frac{NR}{NC}$$

Where NR is the yearly net revenue and NC is the net capital invested in the same year.

The cited indexes have been applied in different scenarios, i.e.:

A. Baseline, or what would happen if the company keeps working with the same modules and patterns of the last 7 years;
B. Only sawn-wood or only contractual work, or the hypothetical drifting of the management towards exclusively one of the two main production types;
C. Ash unprofitability, or the re-balancing of the company's costs into alternative directions from buying ash

For scenario A, the process was as explained, with the projection done using CAGR and the consequent calculation of the indicators.

As regards the Scenarios B, it was necessary to estimate the proportion to which the two processes participate in the total costs and profit, therefore it was necessary to use a proportion applied also to the 'Δ shared' costs.

Finally, a more complex procedure was applied for scenarios C, i.e. in defining the different strategies to replace ash, which now accounts on average for 40% of the total raw material costs. It was therefore necessary to apply a series of strategies to predict the possible future changes. Given the nature of the local wood market, like that where this company is, it was also essential to create a safety measure to accurately re-set the selling prices in case the company would face a profitability decrease, measures to be applied for each single species traded.

The procedure used to replace ash started form the baseline costs projection, from which the future proportion of the raw material costs connected to ash was extracted. Once the value in € was obtained by using average prices from the period 2013-2019, it was possible to derive how many cubic metres of ash this value corresponded to, and, hence, the profit lost.

As regards the specific gross profitability of sawn-wood, this has been calculated as the ratio between sawn-wood revenue (€/m^3) and round-wood cost (€/m^3):

$$(7) \quad \gamma = \frac{R_{sw}}{C_{rw}}$$

Where γ is the ratio, R_{sw} is the sawn-wood revenue and C_{rw} the round-wood cost.

The average value for the period 2013-2019, considering all the species, is $\boldsymbol{\gamma}$**=1.78**. This parameter will be indicated and suggested as the threshold under which the final revenue provided by the sales will not grant the same performance obtained in the 2013-2019 period.

The indicator γ has then calculated, for the same period of time, for ash and for each of the candidate species considered for its replacement, i.e., maple, oak, beech.

After having set a safety threshold, and recalling the estimate of the costs proportion of the ash round-wood, it was possible to convert this € amount into the corresponding volume of cubic meters for the candidate species, given a fixed percentage based on their γ, the higher the ratio, the higher the percentage. The round-wood amount was then multiplied by the 2013-2019 average of sawn-wood value (€/m^3) and for the specific efficiency Ω:

$$(8) \quad \Omega = \frac{SW_n}{RW_n}$$

Where SW (m^3) is the volume of sawn-wood sold and RW (m^3) is the volume of round-wood bought for a given year n. The yearly results have been averaged for the period 2013-2019.

The averaged specific efficiency Ω has been used to estimate the value in € on the new gross revenue of each candidate species. Then the three indicators (NPV, R/C, ROE) were applied to the final outcome of the scenario.

The profitability indeed changes with the changing of the combination in percentage, therefore multiple sub-scenarios have been tested, always considering the volumes sold historically and keeping in mind that, the more a species is sold, the lower γ will probably be. This is due to an hypotheses sustained by what is shown in Fig.29, where the historical record indicates that, for higher volumes, there's a higher round-wood cost and a lower sawn-wood revenue.

3. Results

The results will be divided in the same way as the previous chapter. Using tables and graphs, the data will be explained and justified by a few comments.

3.1 Gross revenue

The outcomes of the gross revenue estimation are synthetized by the following graphics. In Fig.1a, it is possible to notice that the gross profitability, after a slow contraction in the decade 2003-2013, is on a growing trend that took the gross profitability to surpass the 2003 performance in 2018 and 2019.

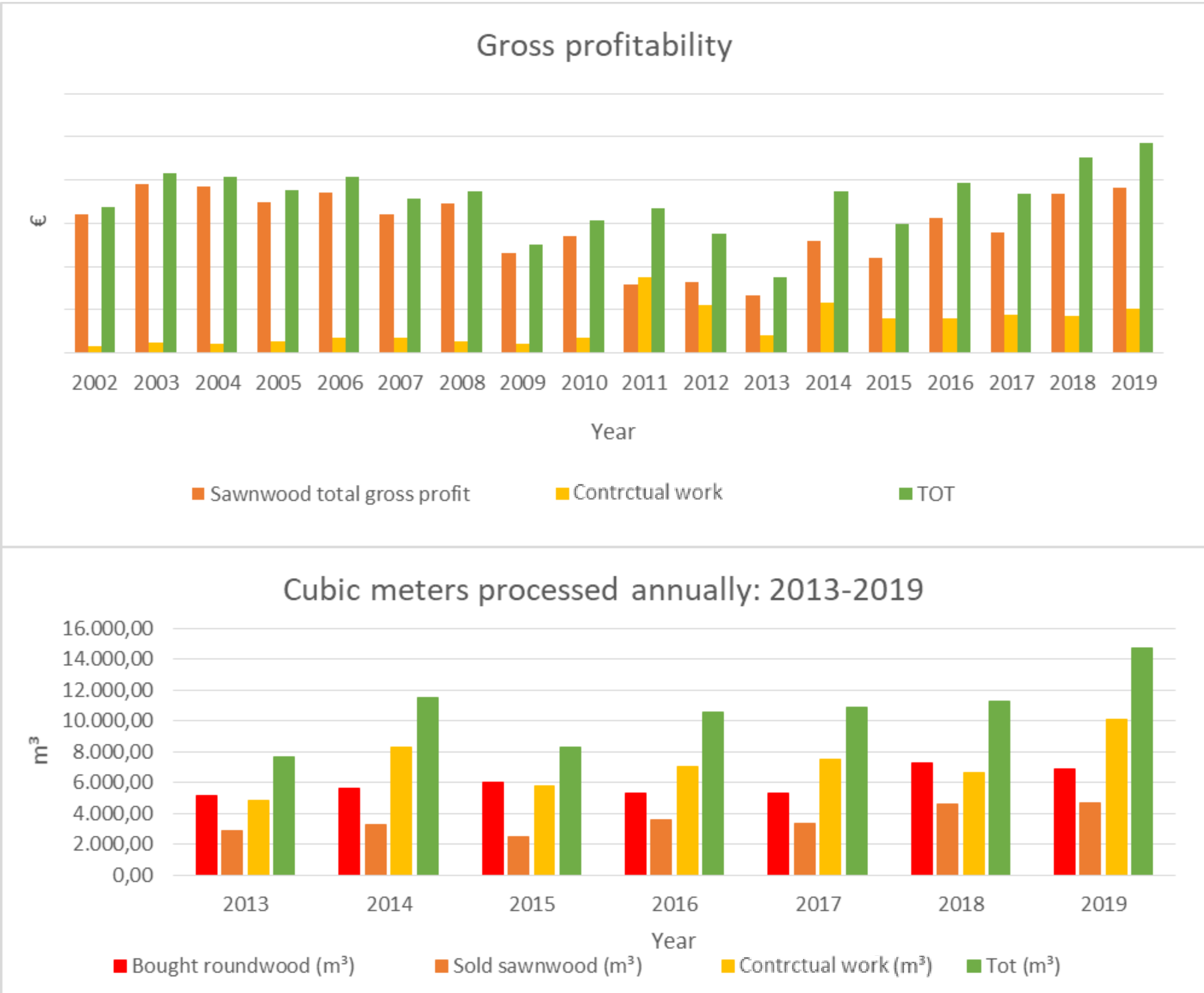

Fig.7a: Gross profitability and its components (2002-2020). Fig.7b: Volumes traded to reach the gross profit shown above (2013-2019).

The amount of earnings due to sawn-wood sales are the principal source of income, while the contractual work activities have always been secondary, except in 2011 where the dominance was from the latter. Fig.7b offers an insight in the volumes cut and sold during the new management. In Fig.7a it is used the term 'other sources' instead of contractual work because for years before 2013 it is inappropriate to use the latter term.

Contractual work is in a constant lead, with values that, occasionally, reach more than the double of sawn-wood's sales. As regards the difference between round-wood bought and sawn-wood sold, it is due to processing losses, as chips and bark after sawing, shrinkage after drying. Globally, quantities have been increasing in both categories, another indicative sign of a constantly enlarging market, at least in quantitative terms. Whether there is a growth also in profitability will be discussed in subchapter *c)*.

Taking a closer look to sawn-wood, Fig.8 presents a comparison between sales and investments.

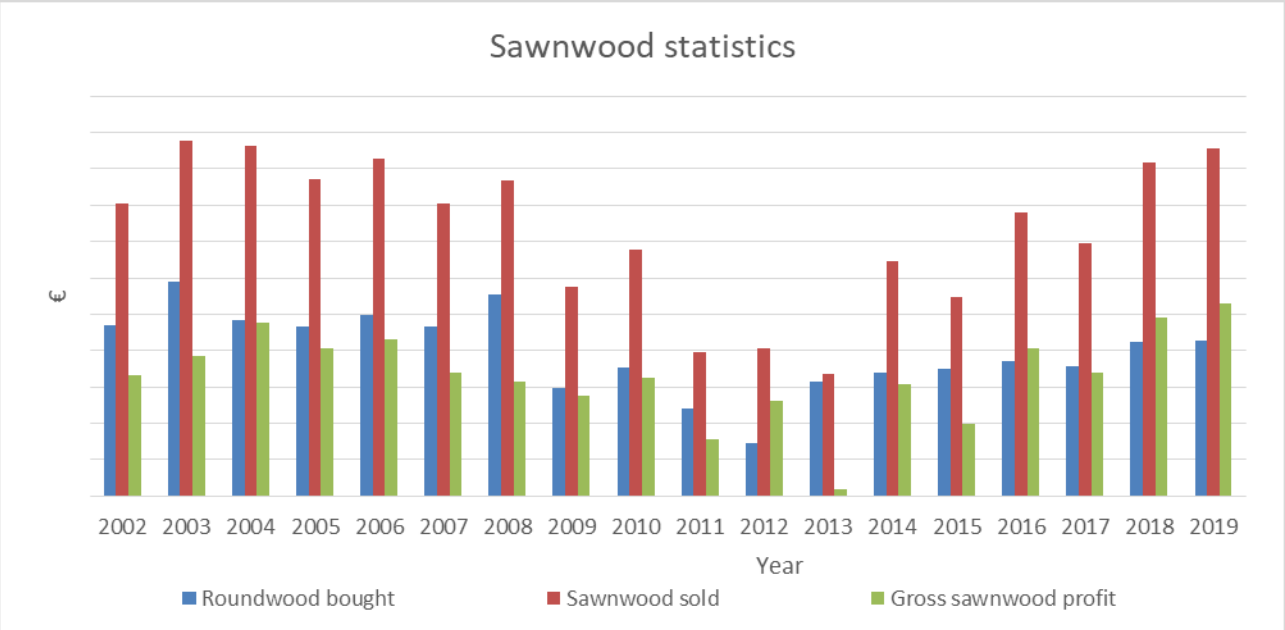

Fig.8: Gross profitability, focus on sawn-wood (2002-2020).

It is possible to appreciate that the gross profitability, over the years, has revealed to be quite unstable, with oscillations caused more by the selling price in respect to the gross round-wood value, which, as shown by Fig.9, appears more constant.

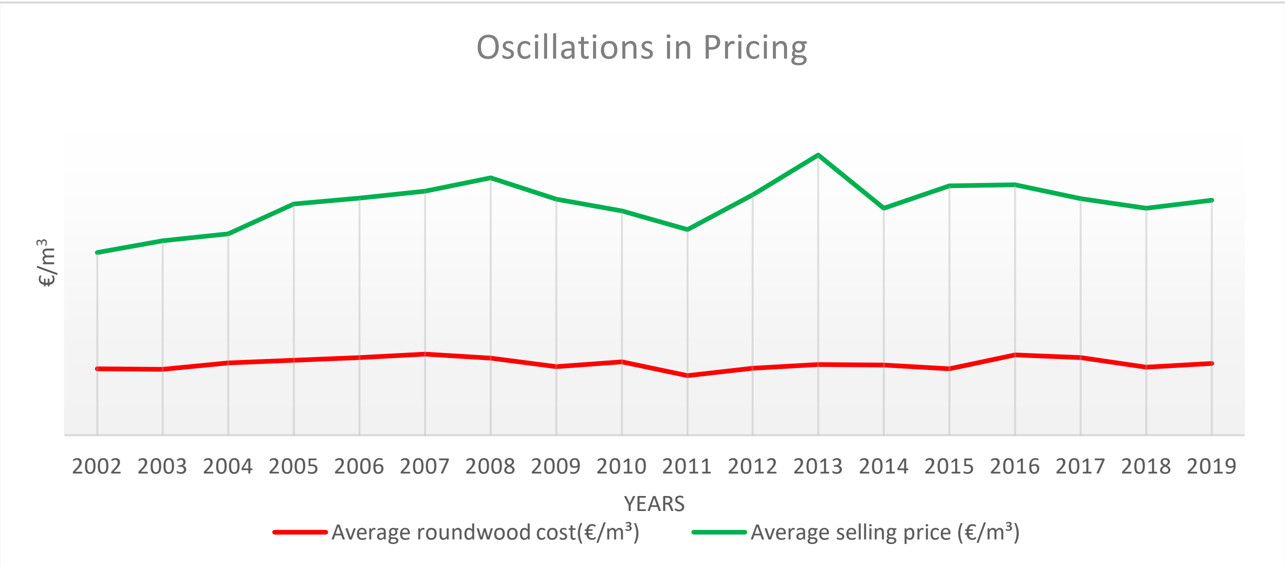

Fig.9: Oscillation of the value of round-wood and sawn-wood in €/m³, (2002-2020).

Fig.10 shows the outcome of the application of formulas (1) and (2), for the total sawn-wood sold and for single species. It is easy to notice that, even if the total itself is remarkably unstable (2011-2013), prices of single species not only do not follow the same trend, but can behave in the opposite way, as in the case of oak, or can even be undisturbed as happens with ash.

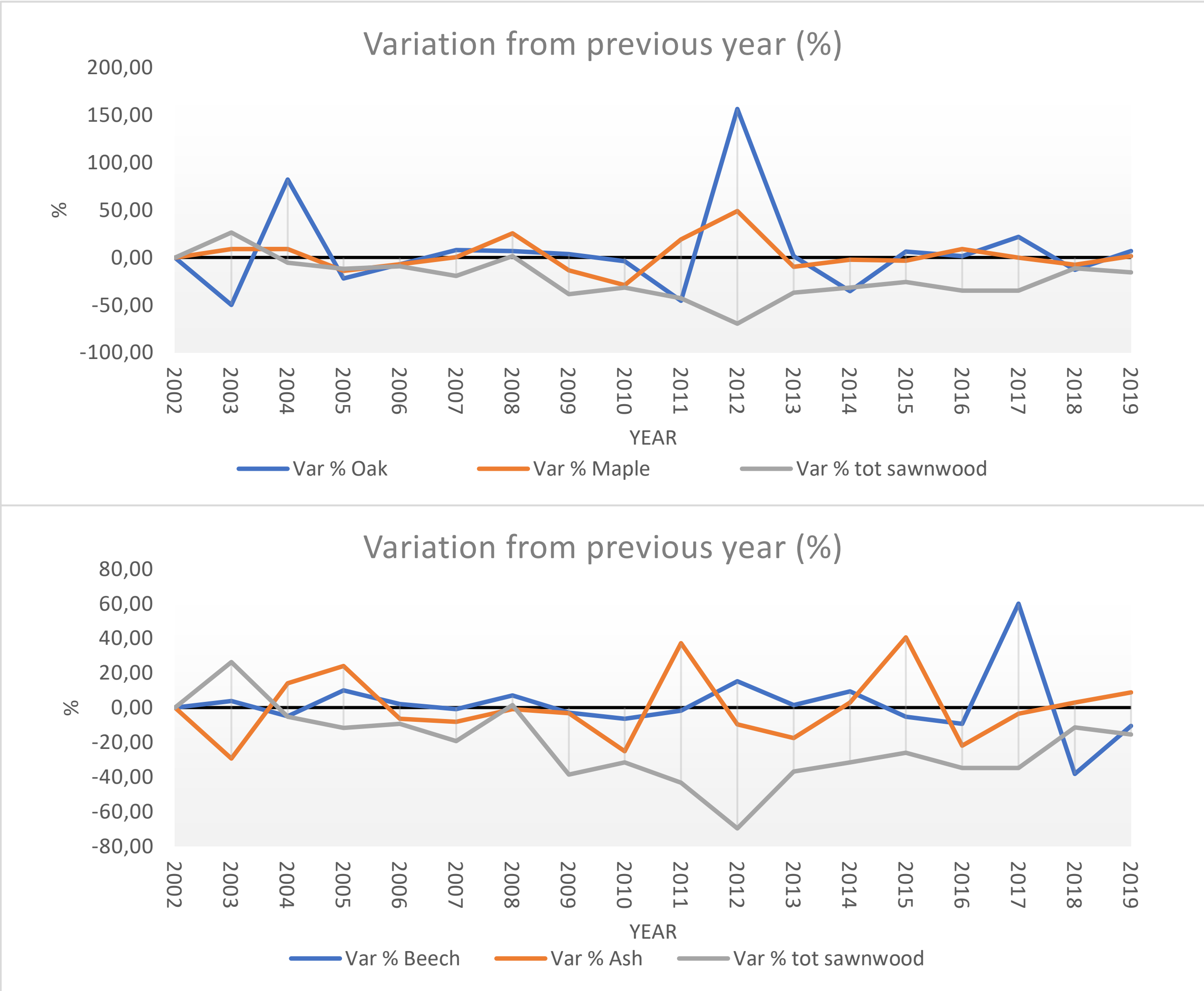

Fig.10: Examples of the oscillation in gross profitability given two species and the total (2002-2020).

The high annual variability of prices indicate that the company is approaching a dynamic market, and has to adapt annually to the requests and opportunities without the possibility of having any absolute certainty about the years to follow. Therefore, it will be essential to understand the main patterns of the past to be able to give guidelines and suggestions to consider in the future.

Fig.11 show a series of graphics representing the role of the portion of the species with most data available in gapping years, expressed in percentage from the total amount of sawn-wood of that same year. It is easy to notice that the role of different species changed consistently in the last two decades, in example the role of beech decreased, with ash taking the lead and many species increasing and decreasing in the ark of less than ten years.

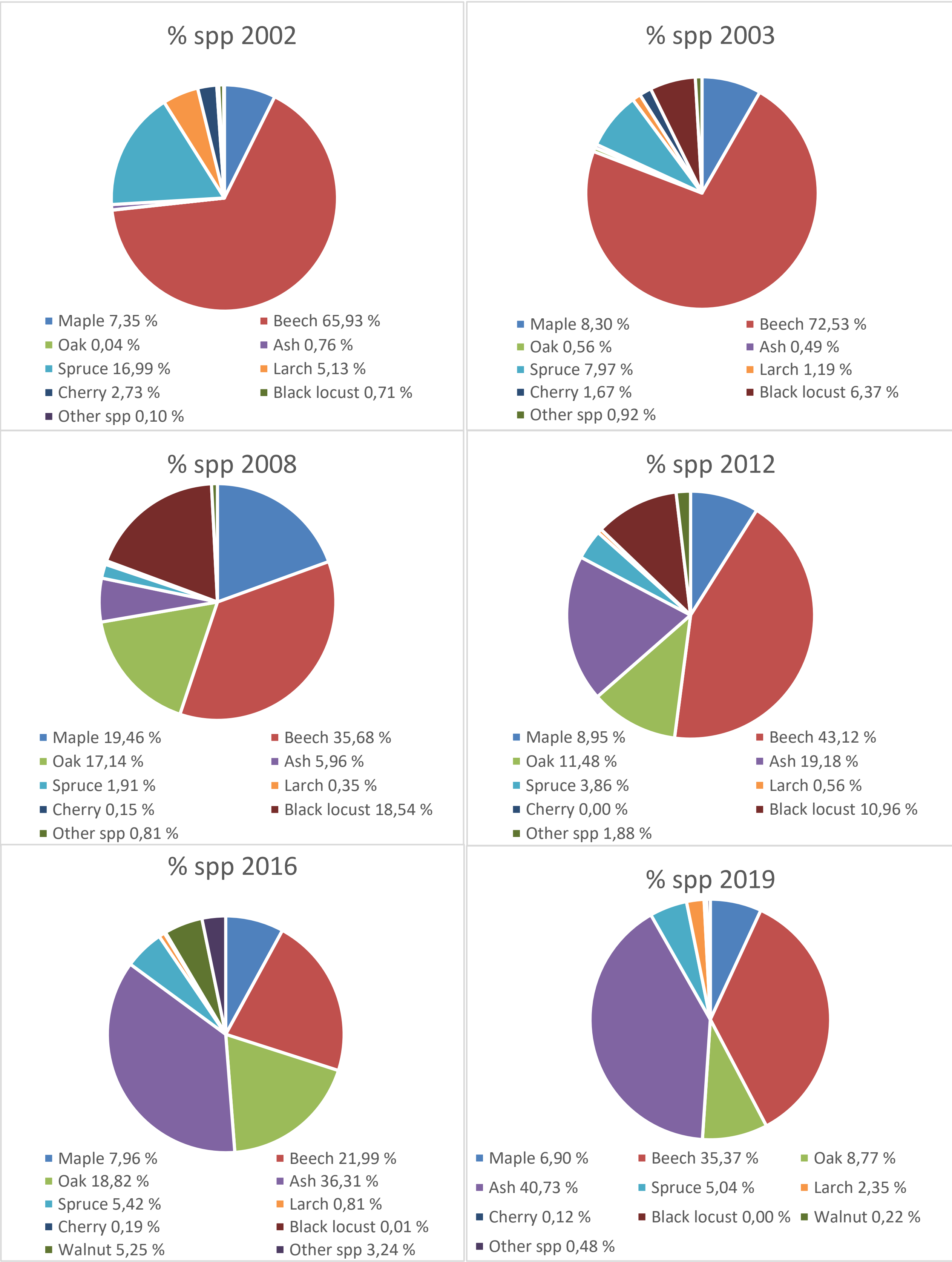

Fig.11: Role of the main species into the sawnwood sale value (%).

The causes of the fluctuation, in quantitative terms, at the level of single species, at this time are hardly understandable. Although, further attempts to explicate the reasons driving the business choices will be tried.

3.2 Costs estimation

The results of the first part of this further analysis are presented in Fig.6 that showed how the gross revenue developed during the period 2014/2019, together with some representative years from the earlier period. From 2013, contractual work assumed an important role in generating the total gross revenue, going from 2.03% and 4.34% of the share in 2002 and 2004 to 28.21% in 2014, then settling at around 25% in the following years (Tab.1).

Year	Sawnwood (%)	Contractual work (%)
2002	97,97%	2,03%
2008	95,66%	4,34%
2013	77,49%	22,51%
2014	71,79%	28,21%
2015	76,05%	23,95%
2016	77,35%	22,65%
2017	75,84%	24,16%
2018	83,12%	16,88%
2019	76,83%	23,17%

Tab.1: Share of sawn wood and contractual work in the total gross revenue (2013-2019).

This increase is due to an investment strategy that started with the new management in 2013, when a partnership with another company was started. This other company sells a peculiar series of steamed products, which are produced by the company under study. As regards the components of contractual work, Fig.12 reports their distribution in the same period of Tab.1, providing a clear image of their evolution in the course of the studied period. It can be noticed that, during the first five years of the new strategy, the amount of sawn wood sold sensibly fell in respect to former times. Nevertheless, from 2018 the gross revenue is showing a recalibration between the two elements, with sawn-wood numbers closer to what they were in the early 2000’s, whereas contractual work is oscillating around the value of 20% of the total revenue.

The steaming process had a leading role in the whole period, covering up to the 60% of the total contractual work gross revenue, followed by drying, which had a constant 20-25%, and the two sawing typologies, who oscillated more intensely. Of the two, ‘zuschnitt’, which is a longitudinal cut, usually combined with planing, is the voice that with time lost importance in the composition of the gross revenue. The reason is simple: after the purchase of the first machine, in late 90’s, there has been no further investment in this processing sector. It was sufficient to just apply the necessary maintenance to the already available equipment, as blade sharpening and occasional mechanic reparations, to fulfil a market demand which never required the manager to apply any expansion or improvement in the ‘zuschnitt’ area. A different situation concerns drying and steaming, which as it will be shown later, have been the second biggest investment component of the period 2013-2019, and therefore have a higher share connected to the depreciation and installation costs.

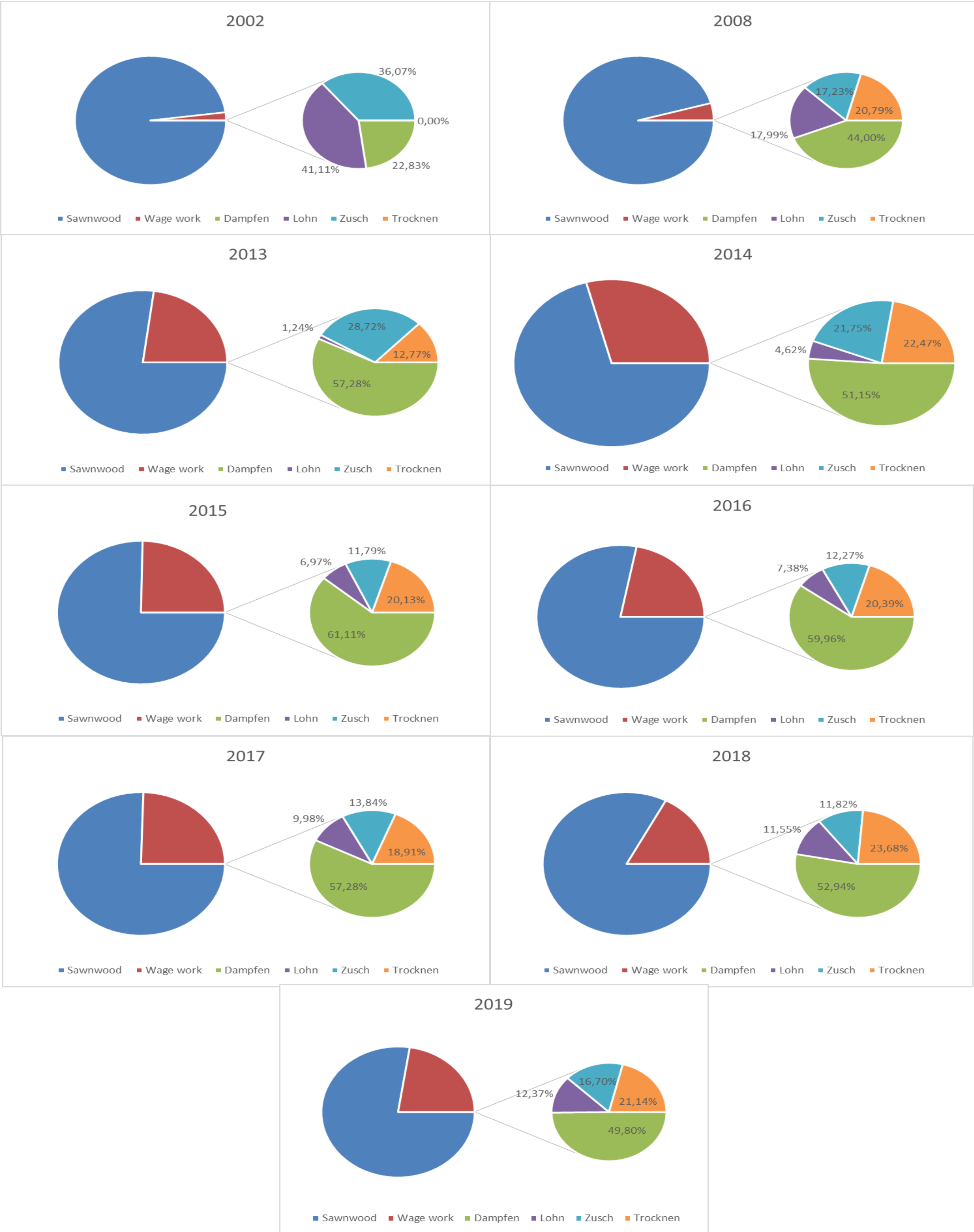

Fig.12: Yearly composition of the gross revenue, with a focus on the contractual work (here called 'wage work') categories (%). Dampfen means steaming, Trocknen is drying, 'Lohn' and 'Zusch' refer to two cutting typologies.

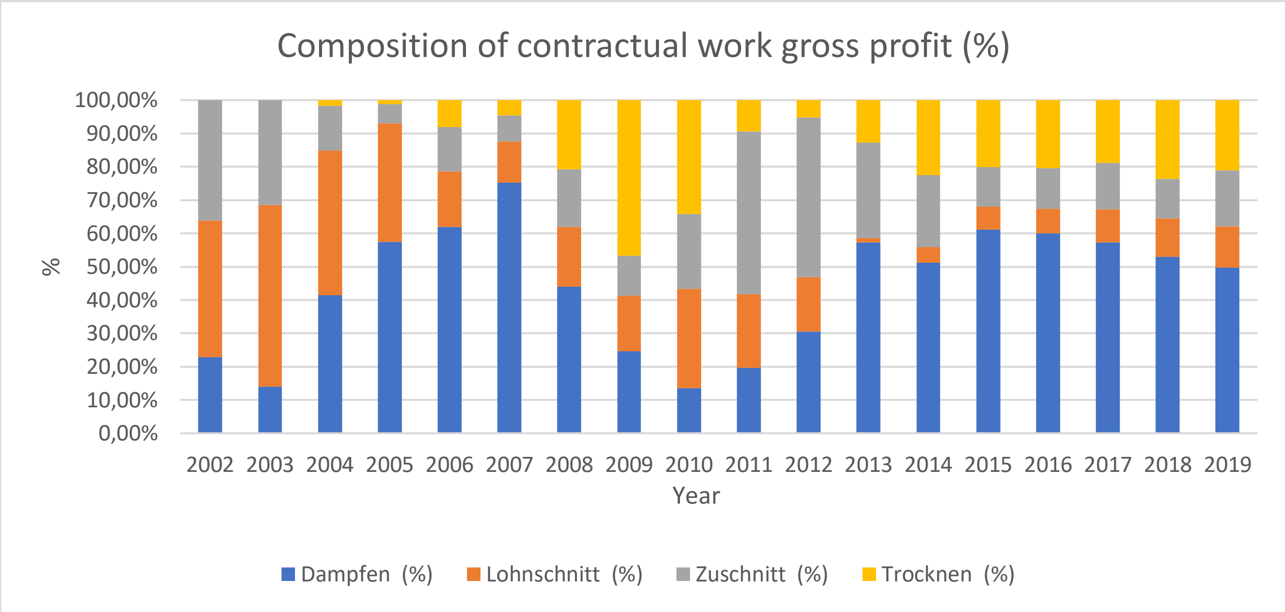

Fig.13: Composition of the contractual work gross profitability (2002-2019).

Fig.13 gives a further description of the contractual work categories' percentage oscillation during the period 2002-2019, with multi-coloured columns that indicate each share variation in the period. The data show that drying contractual work occupied a considerable part of the share from time to time, and then stabilized around 20% during the quinquennium 2014-2019.

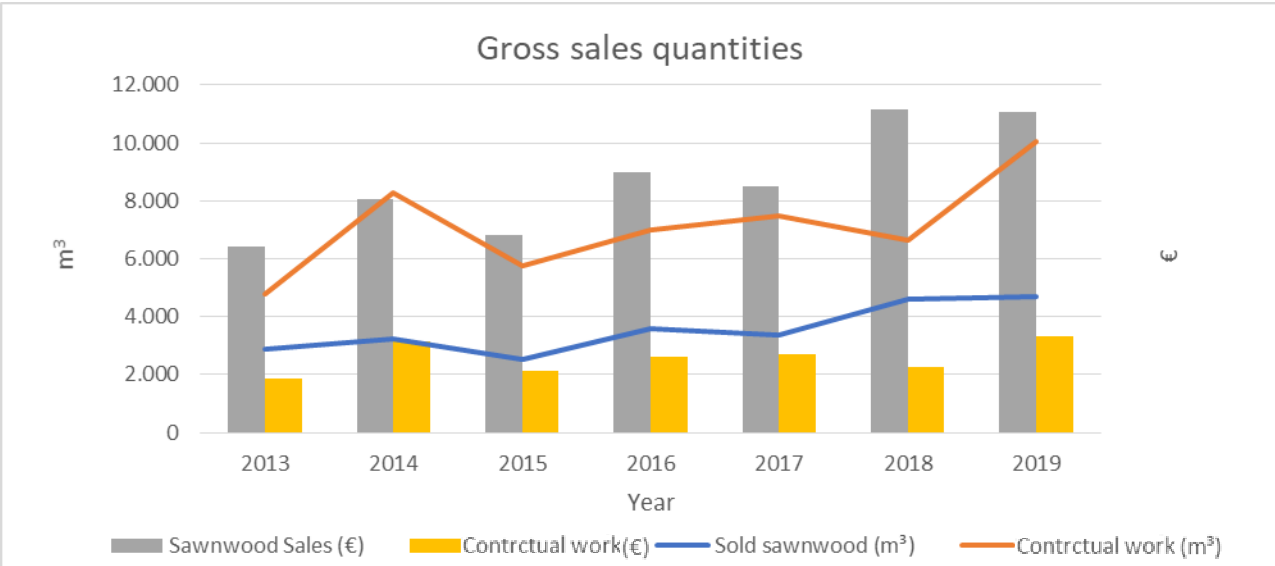

Fig.14: Gross revenue and quantity sold for contractual work and sawn-wood (2013/2019).

Lastly, Fig.14 represents the gross revenues and quantities sold for the two studied products in the period 2013-2019. It is clear that contractual work had a great increase in quantitative terms, yet its weight on the total gross revenue remained constant. On the other hand, sawn-wood quantity did not have the same growth but instead its share on the total gross revenue has become preponderant.

The second issue analysed was the cost category. As previously told, the data were extracted directly by the official balance sheets for the periods under exam, so they are fully reliable.

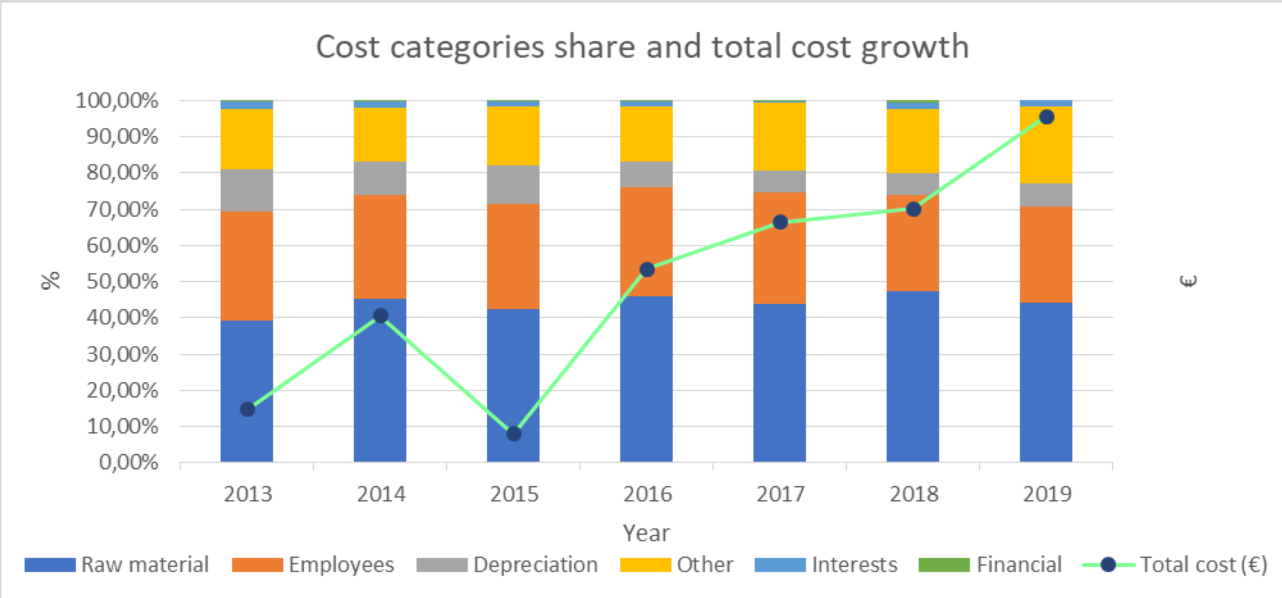

Fig.15: Cost categories and total cost growth (2013-2019).

Fig.15 shows the total cost growth over the years (green line) combined with the share of the main cost items during the same period. A significant element is the constant growth of the curve from 2013 to 2019, due to several technological investments made in the period by the new management, which focused on implementing both sawmill and drying-steaming maximum capacity. To achieve this goal, the old sawmill was replaced by a faster one and the number of kilns and steamers was increased. This led to an increase in the maintenance costs, which are the variable most affecting the 'other costs' item (yellow column). Consequently raw material costs grew too, to spread the costs amongst a higher amount of cubic meter processed and sold. Despite the elevate number of investments, the most noticeable aspect is the constant share of the raw material costs (dark-blue column), that kept constantly at 40% of the total instead of decreasing progressively. This flat trend might be justified by the fact that the total amount of round-wood bought (Fig.7b) grew, while its average cost (Fig.9) was constant. Passive interests and financial costs occupy the smallest share, followed by depreciation that for many investments is meant to start being paid with a few years of delay in respect to the actual starting year, so that many recent purchases will start to be paid in a few years from now.

An insight of the cost analysis is provided in Fig.16, where the main item shares oscillation is compared. As shown in the previous figure, the investments occurred in the period considered caused an increase in the voice 'other' to more than 20%, while the labour costs decreased more and more if compared to the total amount invested. The faster pace of 'other' costs growth is mainly related to two the most frequent maintenance expense that occur when increasing the mechanization of the various processes. Therefore, even if the employee number increased during the period considered, it still is a small growth if compared to the more intense technical improvements gained in the same time. Finally, as previously stated, the raw material cost share is constant during the whole period, indicating that its growth is very similar to that of the total costs.

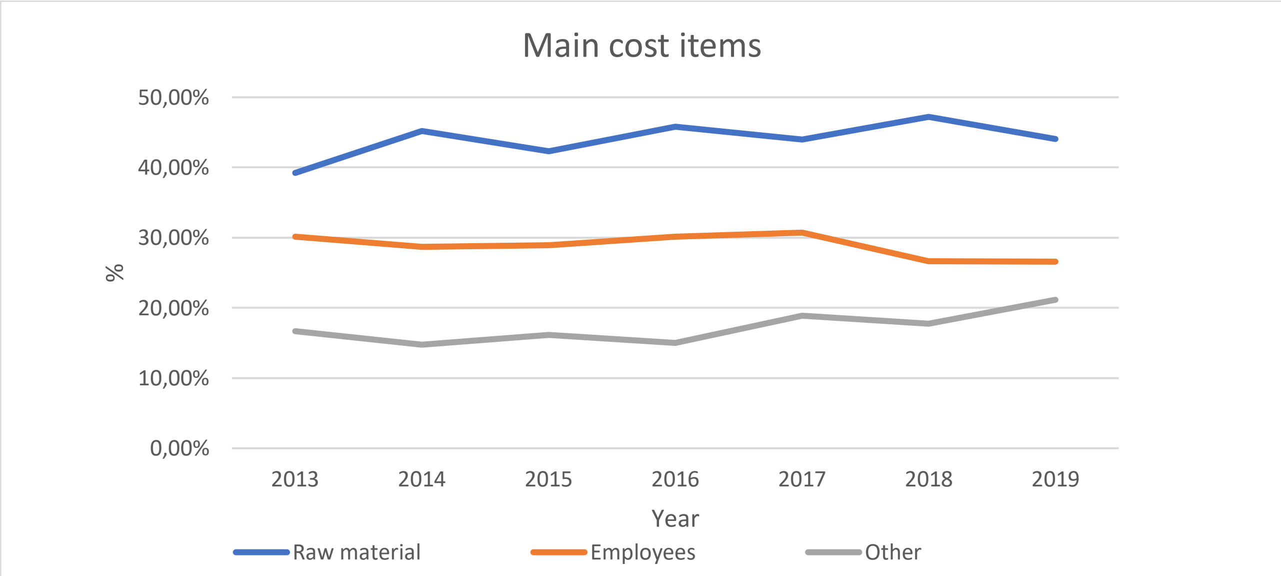

Fig.16: Main cost items and their share during the period 2013-2019

Estimating the cost led to the estimation of the net profits the company earned during the period 2013-2019.

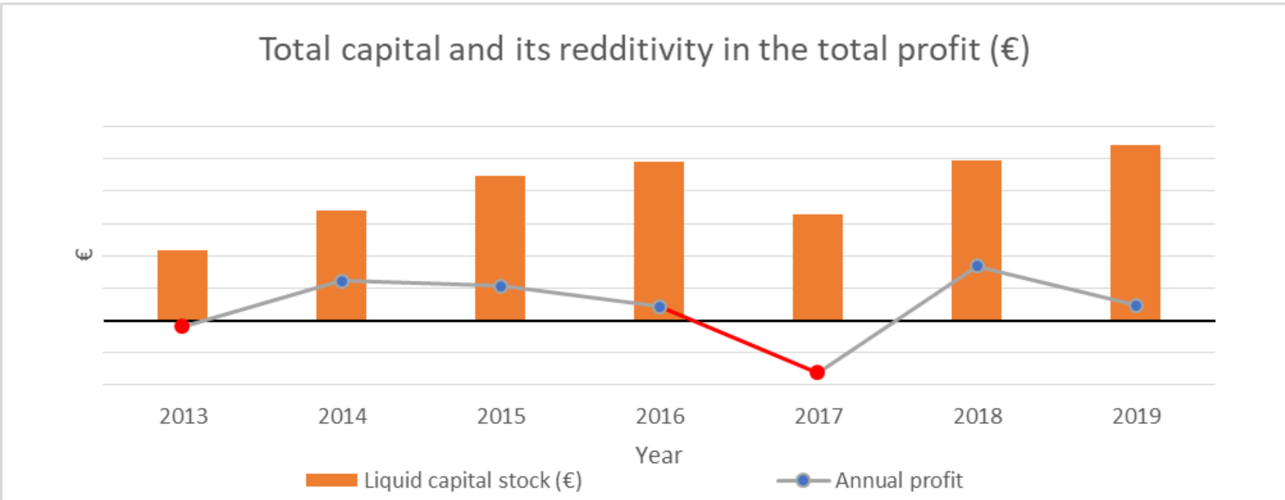

Fig.17: Representation of the total liquid assets owned by the company and its yearly variation (2013-2019).

As Fig.17 shows, the amount of liquid assets owned by the company increased, in the period 2013-2019. However, the growth has not been constant, and two years (2013, 2017) had a negative outcome. Despite the many investments undertaken by the new management, the total liquidity owned by the company has more than doubled. This first result is indicative of the fact that, from a general point of view, the new company strategy has been effective in the seven-years period. It is now crucial to break the profit into contractual work and sawn-wood, for better understanding which production line has contributed more to the successful performance of the new management.

The two tables below show the steps taken to estimate the net revenue of sawn-wood and contractual work.

Year	*Sawnwood (%)*	*Contractual work (%)*	*Contractual work (m³)*	*Sold sawnwood (m³)*
2013	77,49%	22,51%	4.804,304	2.879,09
2014	71,79%	28,21%	8.297,831	3.246,04
2015	76,05%	23,95%	5.775,883	2.525,02
2016	77,35%	22,65%	7.003,000	3.590,99
2017	75,84%	24,16%	7.502,401	3.382,68
2018	83,12%	16,88%	6.662,185	4.599,95
2019	76,83%	23,17%	10.064,873	4.680,10

Tab.2: Gross sales and their % on the total

In Tab.1, it has been calculated the share (%) on the total revenue for the two categories, the quantity sold is reported also in Tab.2 because it is essential in the last phase of calculation. In fact, the data will be used to estimate cost and revenue voices, in €/m^3, isolating contractual work and sawn-wood as components of the total amounts of costs and revenues. After that procedure, each net (€/m^3) will be multiplied by the number of cubic meters sold to obtain a preliminary net profit. This will then be subtracted by the shared costs to obtain the real annual net profit. In this sequence, Tab.2 stands in the estimation of the revenue in €/m^3 of the two categories. As previously stated for Tab.1, the most of the revenue gained in the period derives from sawn-wood, which never fell under 70% of the total share, even if, in quantitative terms, the situation is the opposite. In fact contractual work surpasses constantly sawn-wood for m^3 sold, occasionally doubling its counterpart.

Year	*Raw material cost*	*Δ*
2013	39,22%	60,78%
2014	45,18%	54,82%
2015	42,32%	57,68%
2016	45,83%	54,17%
2017	43,99%	56,01%
2018	47,21%	52,79%
2019	44,05%	55,95%

Tab.3: Total costs, raw material's costs and their difference

As regards Tab.3, it reports an initial split of the costs into two main categories, raw material costs and the difference between them and the total costs, which in this study will be called Δ costs. The separation is necessary because the raw material costs only affect sawn-wood, while Δ costs affect both sawn-wood and contractual work. Hence, it is the repartition of the Δ costs to play the key role in estimating correctly the net profitability of the two product types analysed.

Before entering in a more detailed examination of the Δ costs share, it is important to state that within this cost category there are two sub-categories. The first is 'Δ *tailored* costs', as it is a compound of various voices that affect, with different intensity, both sawn-wood and contractual work. Therefore, tailored refers to the estimation of the weight each of the two products have in every process falling within the 'Δ tailored costs'. The second sub-category is 'Δ *shared* costs ', and it comprises every expense which can't be split into contractual work and sawn-wood, forcing the study to add it *in toto*, right before the final estimation of the annual net profit.

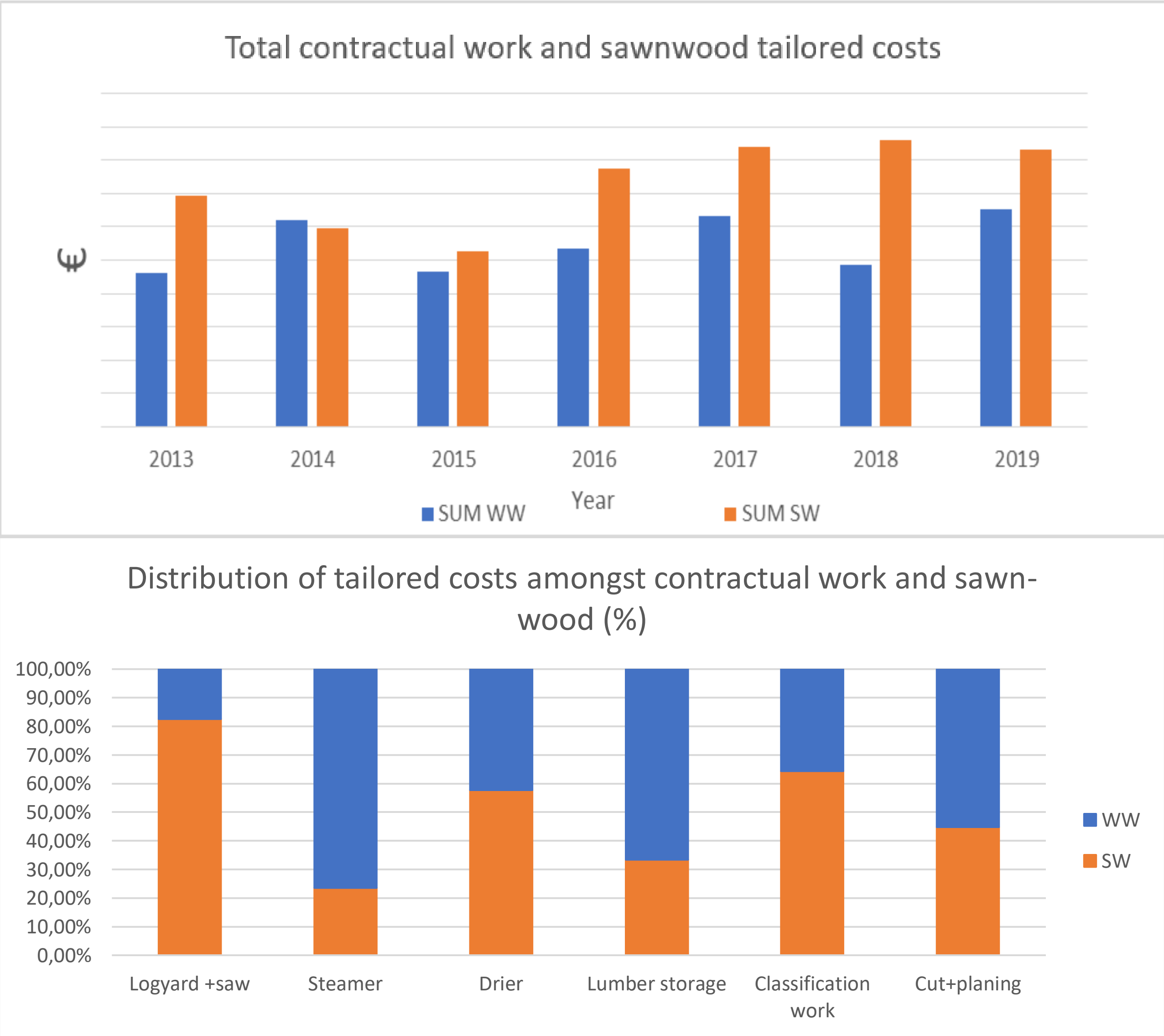

Fig.18: Comparison of contractual work and sawn wood tailored costs. WW= contractual work, SW=sawn-wood.

Fig.18 it shows the comparison between contractual work and sawn-wood tailored costs, while Fig.13 gives a big picture perspective of the cost categories divided in the study. Every year, sawn-wood tailored costs were bigger than contractual works', while they never covered the entire Δ costs, as a fraction of the mentioned category has always been treated as 'shared'. Therefore, in the calculations it has always been included right before the estimation of the final net yearly profitability. Henceforth, the calculation of the singular contractual work and sawn-wood net was possible only *a priori* the addition of the so called 'Δ shared costs'.

The second graph in Fig.18 reports the distribution of the main tailored cost typologies between sawn-wood and contractual work. Sawing costs are regarding almost only sawn-wood, which holds almost the 80% of them, while contractual work absorbs around the same share of steaming costs, leading also in 'cut+planing', drying and storage costs. The distribution into categories offered by the second part of Fig.18 could be misleading in this sense, as contractual work exceeds sawn-wood in most categories. Nevertheless, the graph is in percentage, while the data in absolute values, shown in Fig.19, Fig.20 and Fig.21, confirm what is reported in the first part of Fig.18.

Fig.19 also indicates that within Δ costs, the share occupied by 'shared costs' is consistent and in some years, as 2019 and 2018, is comparable to the totality tailored costs. This fact shall emphasize the need to separate the two portions of the Δ costs when estimating net profitability, because summing shared costs with the same yearly proportion used for tailored costs would mislead results, offering an unrealistic and biased representation of reality.

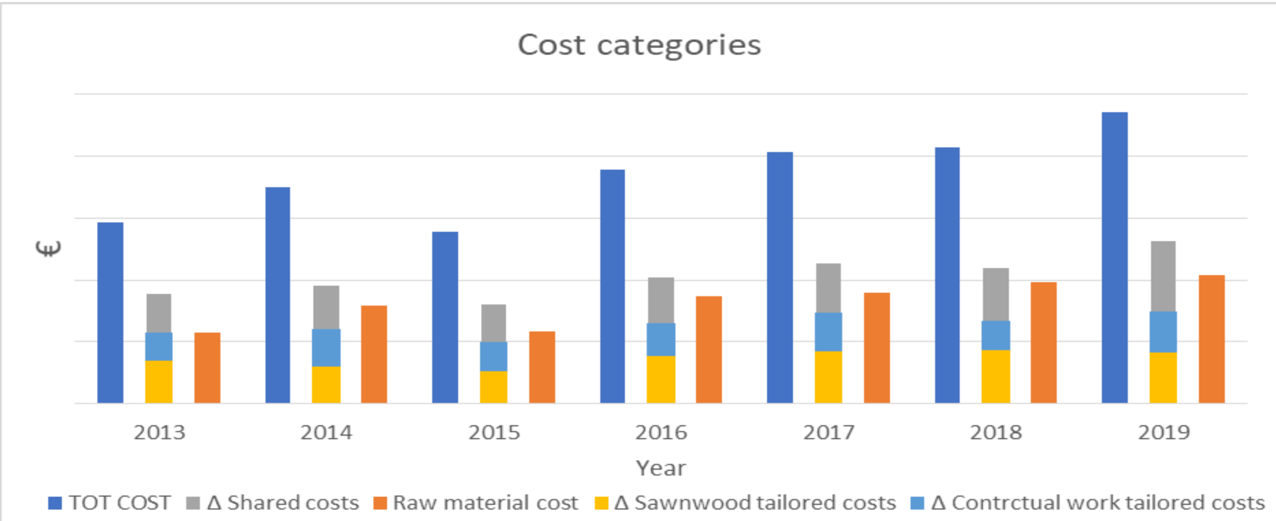

Fig.19: Representation of all the cost categories

After having shown the general picture of costs estimation and division, it is now convenient to go more in depth and represent more in detail what and how tailored costs have been defined.

In Fig.20, the focus is set on contractual work, which is mostly affected by steaming costs, followed by the others in a grading that changes yearly, with the rest at a similar level through the years. It is interesting to notice that there are not strong oscillations, exception made for classification costs after 2014, which decreased.

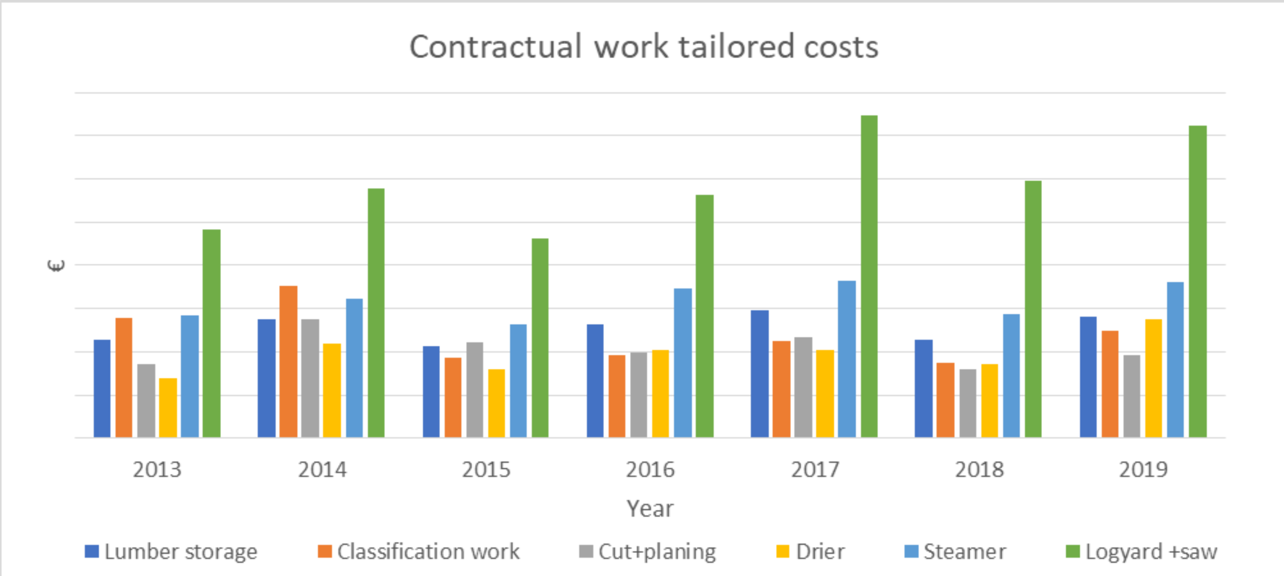

Fig.20: Contractual work tailored costs for the period 2013/2019.

A further explanation of the composition of the costs occurring only for contractual work is given by Fig.21, which reports in percentage the data seen before. Interesting fact, despite the annual increase of the contractual work tailored costs in absolute terms reported in Fig.18; the proportions offered by Fig.21 demonstrate that the distribution of the processes needed to obtain the final product did not suffer drastic changes. Variability is present only in low grades, as for the growth of sawing work, which is caused simply by the fact that in recent years there has been more material to cut.

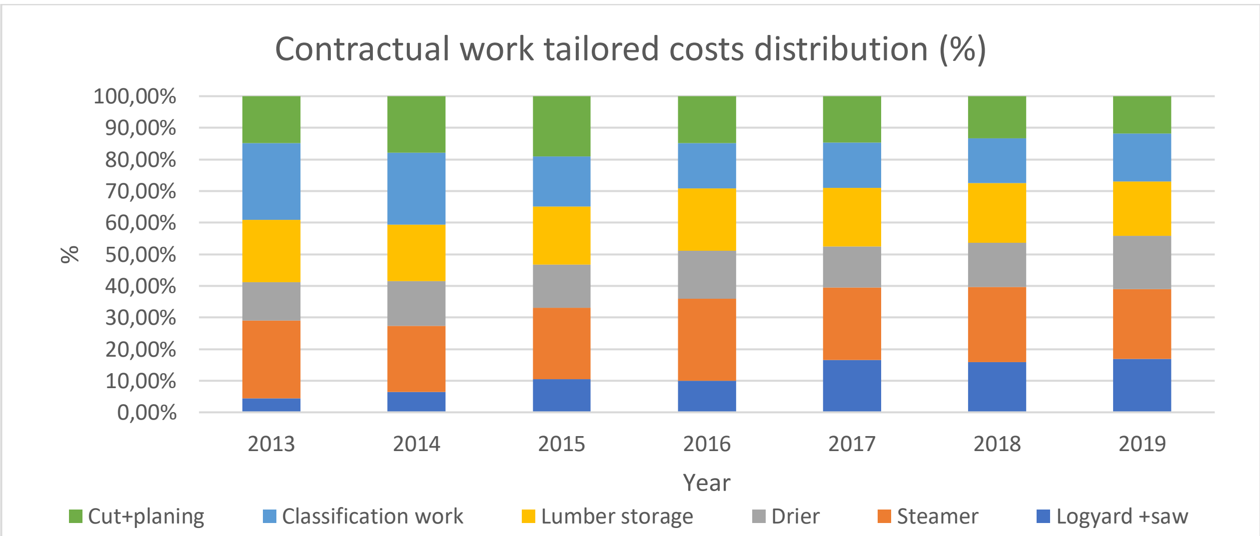

Fig.21: Percentage distribution of costs affecting only contractual work

The same analysis is provided for sawn-wood from Fig.22 and Fig.23, which show a different situation from the contractual work. In fact, sawing work represents the highest cost, followed by almost equally expenses for classification and drying timber, and in recent years cutting and planing had an always higher share of the total tailored costs.

Most probably, sawing and drying costs are higher for sawn-wood because in the period the highest amount of timber sawn and dried belonged to that category, while a higher share of contractual work has been only dried and steamed, as in many cases clients who don't have steamers happen to possess driers and personnel in charge of the classification.

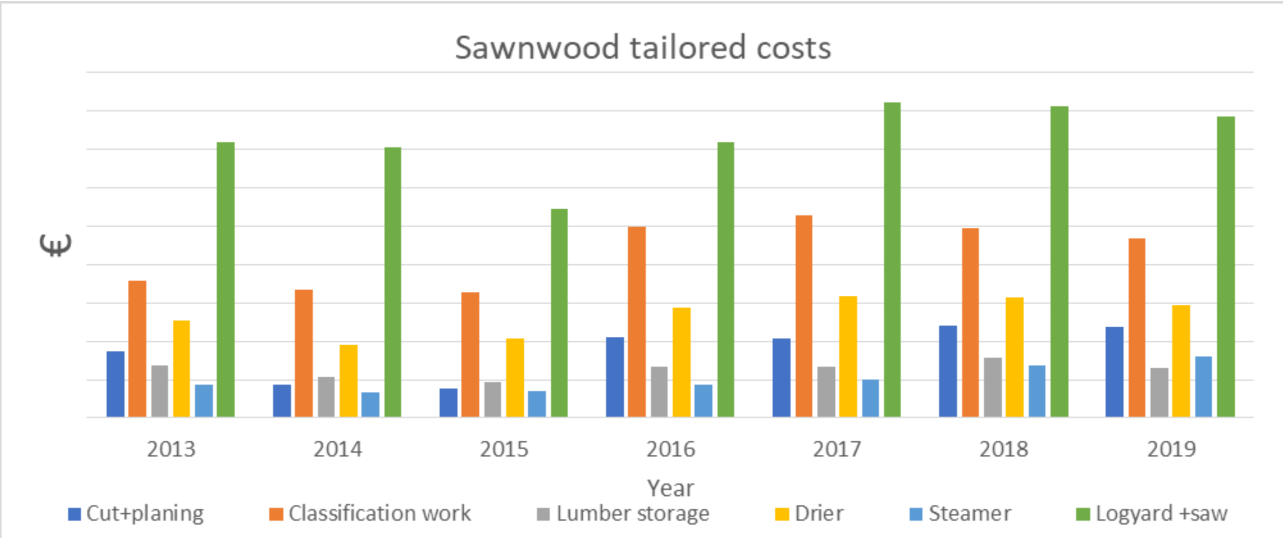

Fig.22: Sawn-wood tailored costs 2013/2019.

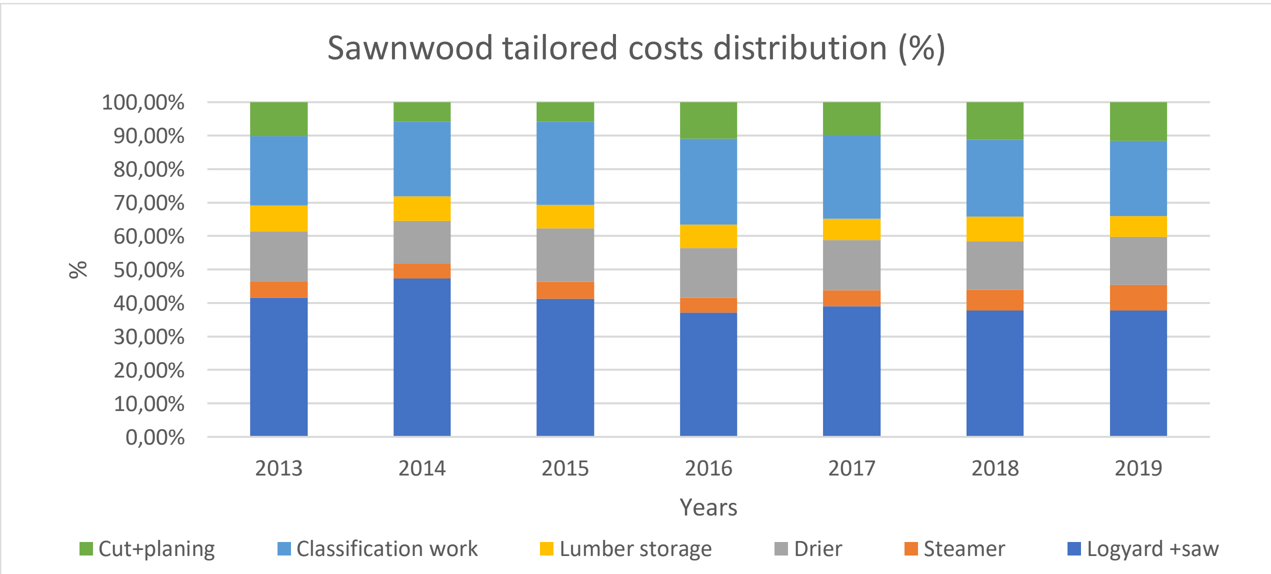

Fig.23: Sawn-wood tailored costs percentage distribution

3.2.1 *Energy externality*

A peculiar aspect that has been added in this chapter is the calculation of the costs related to heating energy. The heating station consumes every year a sensible quantity of energy, the cost of which was unknown to the company. It is important to state that the heating station consumes fuel-wood, part of which is provided by side products of sawing, cutting and planing. The amount of savings the company benefits from the use of their own side products is expressed in Fig.22.

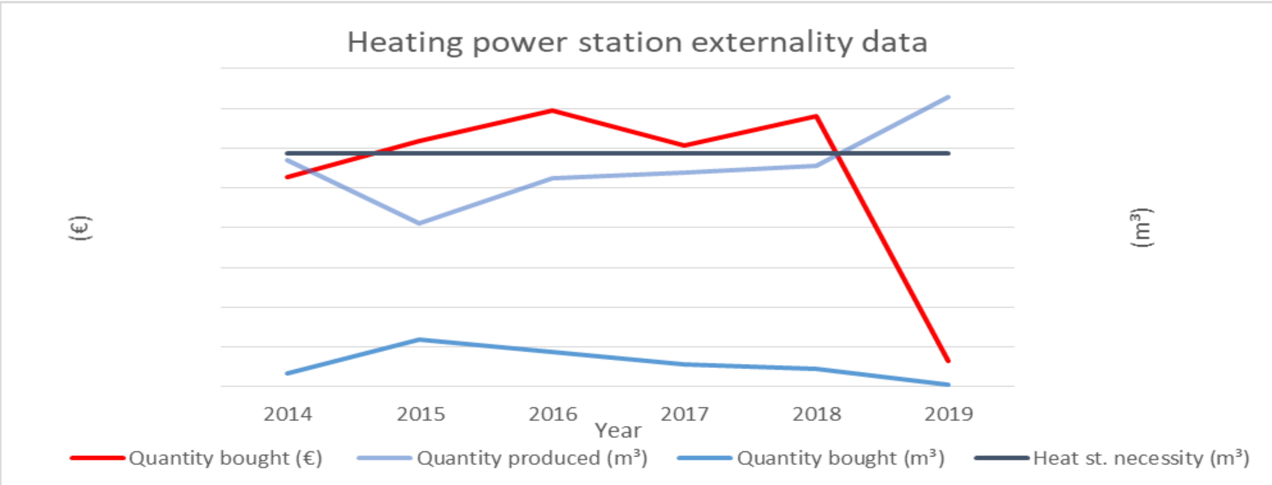

Fig.24: Heating station costs and savings in the period 2013-2019

For what concerns the evaluation of the energy savings, the process was conducted by estimating the cost per cubic meter of the firewood bought and then multiply the mean value for the side products, which substitute it, that are produced and burnt every year. As shown, the quantity bought decreases as the internal production gets closer to the powerhouse yearly necessity. Through the years the total production increased, therefore also the savings total amount did. 2019 was the first year in which the side products' quantity produced was sufficient to cover the entire annual energy requirements, in fact Fig.24 shows a sharp decrease in the purchase of fire-wood, which most probably has been justified for preventive reasons.

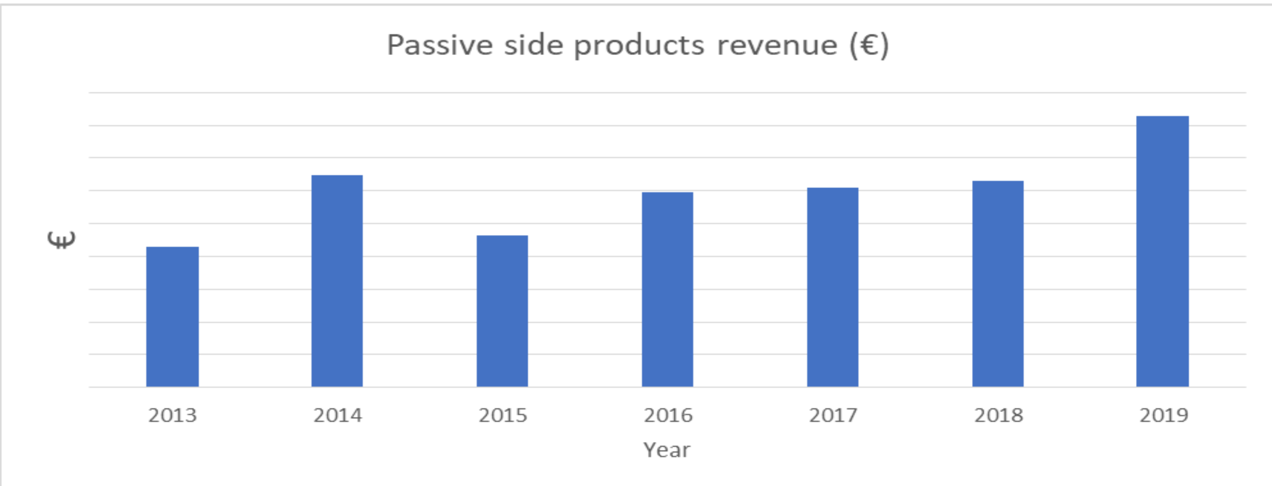

Fig.25: Passive side products revenue

The yearly savings are presented by Fig.25, and demonstrate more clearly the convenience of recovering and burning side products. In the considered period, the company saved a constantly increasing amount of money, up to 2019 when it compelled with the heating requirements, recycling the whole heat produced.

3.3 Net revenue

Finally, Fig.26 shows the yearly net profit gained by the company in the period 2013-2019.

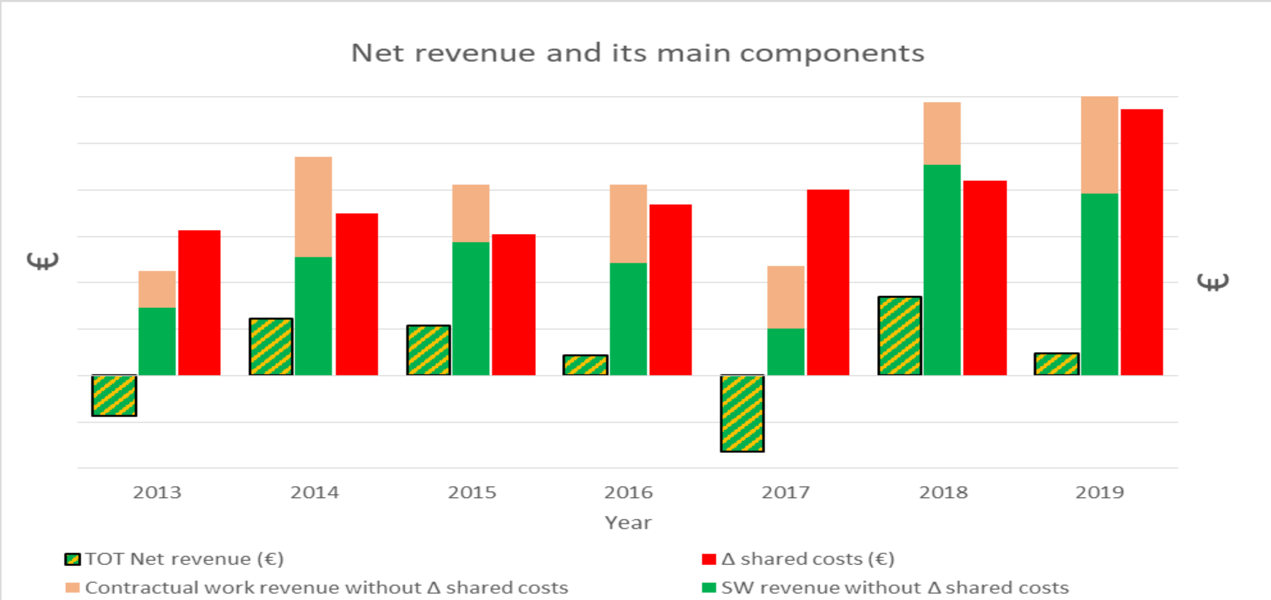

Fig.26: Net profit and its components, SW=sawn-wood.

It is possible to see how the components grew, with a downfall in 2013 and 2017 explained by investments payed with liquid capital, meanwhile in 2019 some other liquid money was used to front expensive but necessary maintenance operations. The green and orange piled column represent the contribution of respectively sawn-wood and contractual work to the final profit. Every year, sawn-wood provided the higher amount of income, while contractual work had a great share in the annual revenue at spots, as for 2014 and 2017. It is also important to consider that contractual work, as a stable investment, began in 2013, therefore it is understandable that year's negative income. Promising signals are coming from 2019, where the share was higher, hopefully because of a demand growth and a stabilization of the clients' requests. An interesting issue is the fact that Δ shared costs growth appears to be quite constant, and detached from the revenue variation. It is very hard to explain such behaviour, as this cost typology is wide and not bounded to any peculiarity of the company functioning. What can be supposed is that they grow consequently together with the amount of timber processed, which implies a higher amount of expenses that affect the company in general, without being possibly identified as consequence of sawn-wood or contractual work alone.

All in all, the net profit increased quite constantly during the period, even if the profitability obtained by sawn-wood revealed to be higher than the contractual work one.

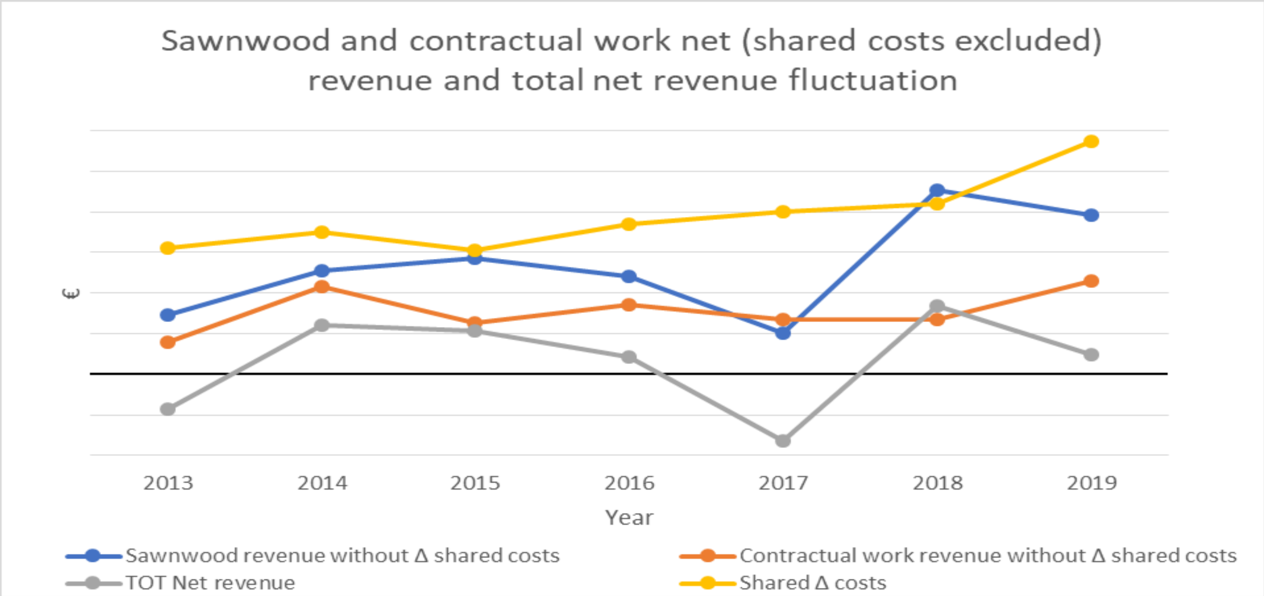

Fig.27: Net revenues and shared costs

Fig.27 is explicit in evidencing the issue of selecting a direction for the future investments. In fact, the total net revenue appears to be in one hand coming more prevalently from sawn-wood, even if contractual work's profitability is lower but more constant and therefore more trustable.

As regards the fact that the costs curve (yellow curve) is higher than the two profit sources, it is just because the two have to be added to obtain the total net revenue.

Category	***Mean (2013-2019)***
% SW on tot revenue	61,46%
% SW on tot cost	74,88%
% WW on tot revenue	38,54%
% WW on tot cost	25,12%
% Δ shared on total cost	21,03%

Tab.4: Average percentage of some parameters in the period 2013-2019. SW= sawn-wood, WW= contractual work.

Category	***CAGR (2013-2019)***
SW-only costs	-0,44%
SW revenue	7,39%
WW-only costs	-5,47%
WW revenue	4,80%
Δ shared cost	9,10%

Tab.5: CAGR used to estimate the growth of the parameters of Tab.4

To get more insights on the structure of net revenue, Tab.4 and Tab.5 show some information worth being commented. In Tab.4, it is shown that sawn-wood covers a higher share of both costs and revenue, having a positive profitability (as shown in Fig.26) even if the costs covered exceed the revenue share. The opposite case is involving contractual work, which is less consistent, at least in absolute terms. The fact that in both categories costs are decreasing is due to many factors, of which probably, the most affecting one is depreciation. In fact, as shown by Fig.18 and Fig.22, sawn-wood covers more costs than contractual work, especially heavy ones as the sawing expenses, that pend mostly on the sawn-wood cutting. As regards Δ shared costs, they affected for the 21.03% the total profit in the considered period. Tab.5 then uses CAGR to visualise the pace to which, on average, each previously cited parameter grew. Sawn-wood costs grew much less than contractual work ones, while revenue growth had the opposite result, with sawn-wood revenue growing almost the double of contractual work's. Shared costs growth was the highest, most probably because of the higher intensity of investment that, as for maintenance, involve both the categories indistinctively.

As a summarising statement, the data obtained from the net revenue, in the period 2013-2019, indicate that sawn-wood and contractual work are both remunerative activities. Of the two, sawn-wood was the most profitable in absolute terms, covering also the main part of the expenses when looking at the raw material tailored costs, while contractual work, probably also due to being a fairly recent investment, performed with less strength in absolute terms, though showing a higher costs reduction during the period. Always in terms of growth, the sawn-wood activity doubled the numbers obtained by contractual work. A warning issue represents the fact that of all categories considered, Δ shared cost grew with the highest pace. Nonetheless, as reported in the next chapter, the overall growth of the company had an even higher pace.

3.4 Prospect

First of all, it is essential to know how CAGR has been obtained. As showed in Tab.6, CAGR is calculated as the average capital growth of years 2013-2019, and consequently it is used as interest rate ***r*** in the estimation of the coefficient ***q***, used in the NPV calculation (Tab.8).

Year	***Annual profit***	***Liquid capital stock (€)***	***Year***	***n***	***Q^n=(1+r)^n***
2012		XXXXXX		-	-
2013	XXXXXX	XXXXXX	*2020*	0	1,00
2014	XXXXXX	XXXXXX	*2021*	1	1,11
2015	XXXXXX	XXXXXX	*2022*	2	1,23
2016	XXXXXX	XXXXXX	*2023*	3	1,36
2017	XXXXXX	XXXXXX	*2024*	4	1,51
2018	XXXXXX	XXXXXX			
2019	XXXXXX	XXXXXX			
CAGR		**10,81%**			

Tab.6: Calculation of CAGR.

The annual profitability of the interested period is therefore to be considered as having a yearly growth of 10.81%. Then, looking at the same estimation done for the total costs and revenue oscillation of the same period, it is possible to notice that their coefficient differs. In fact, as costs grow with a pace of 7.01% per-year, revenues have a stronger increase, precisely 8.26% annually. This is an indicative factor of the profitability of the effectiveness of the management, which enabled not only the total liquid capital to grow on a satisfactory average trend of 10% annually, but furthermore was capable of reaching a higher economic performance with a lesser capital invested in costs.

Year	*TOT Costs*	*TOT Revenue*
2013/2019 CAGR	**7,01%**	**8,26%**

Tab.7: Calculation of CAGR for costs and revenue growth.

The calculation of CAGR is used by this study not only to express the managerial performance recurred in the past period, but also to project the costs and revenues in the future, considering the factor's growth constant for 5 more years.

3.4.1 Baseline prospect

Year	*Act Cost*	*Act Rev*	*Tot NPV*	*Net capital*	*ROE*
2020	XXXX	XXXX	XXXXXX	XXXXXX	12,92%
2021	XXXX	XXXX	XXXXXX	XXXXXX	16,23%
2022	XXXX	XXXX	XXXXXX	XXXXXX	18,78%
2023	XXXX	XXXX	XXXXXX	XXXXXX	20,76%
2024	XXXX	XXXX	XXXXXX	XXXXXX	22,36%
				NPV	XXXXXX
				R/C	**1,06**
				ROE (average)	**17,02%**

Tab.8: Forecast estimation of NPV, R/C and ROE, act= actualized.

Tab.8 reports the projection, for 2020-2024, of the voices previously analysed with CAGR. Costs and revenues have been kept growing of respectively 7.01% and 8.26% per-year, and then were actualised using the coefficient ***q,*** which uses as interest rate ***r*** the liquid capital growth's CAGR.

As a result, in this scenario called baseline, R/C is 1.06 and the average ROE is 17,02%. The meaning of these parameters is that the absolute value returning from the next 5-years investments is positive, the growth ratio of revenues vs costs is roughly 6%, and for every € invested in net capital around 20 €/cent will return as net revenue.

3.4.2 Alternative scenarios

Amongst the alternative scenarios proposed, the one to which the manager showed more interest was the one in which Ash (*Fraxinus excelsior*) price rises enough to be an unprofitable investment. Therefore, it was necessary to implement a preventive strategy, aimed at forecasting the most effective possible solution to face the eventuality of ash being infected also in the local area, where the company purchases all its raw material.

To answer the manager's question, the study started by calculating an index capable of pinpointing under what circumstances a species' trade becomes unprofitable. The first move was understanding the average ratio between sawn-wood sales price and raw material cost.

To start understanding specific profitability, the study firstly divided into species the quantity of sawn wood sold, and the result is presented in Fig.28.

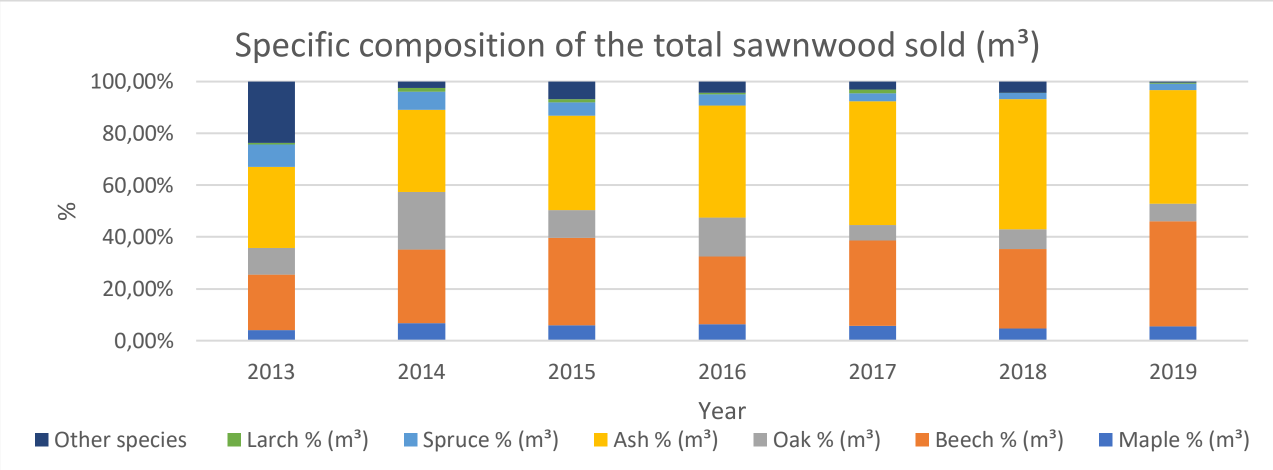

Fig.28: Species composing the sawn-wood sales in the period 2013-2019.

Ash is, as mentioned in Fig.11, the main species sold by the company, followed by beech at the constant second place. Maple and oak occupy a very small and variable proportion, though they still represent the third and fourth most sold species, and as will be shown later, they are a valuable source of profit. To unveil which are the most profitable species in compare with the average, it is now presented a series of tables showing and explaining the indexes chosen for this task and the results obtained.

Year	*Sold sawnwood (€/m³)*	*RM cost (€/m³)*	γ
2013	XXXXXX	XXXXXX	1,86
2014	XXXXXX	XXXXXX	1,70
2015	XXXXXX	XXXXXX	1,94
2016	XXXXXX	XXXXXX	1,73
2017	XXXXXX	XXXXXX	1,59
2018	XXXXXX	XXXXXX	1,90
2019	XXXXXX	XXXXXX	1,78
Average	XXXXXX	XXXXXX	**1,78**

Tab.9: Calculation of the average γ value for the period 2013-2019.

When considering the period 2013-2019 (Tab.11), the ratio, called γ, is **1.78**. This means that if a m³ of round-wood costs 1€, the average selling price, that allowed the company to cover the costs and gain a profit likewise the one obtained in the period, is 1,78€. It was possible to define to 1.78 the threshold value of minimum profitability, under mentioned value the species is sold at an unprofitable price.

Species	***Ω***	***γ***	***Cost growth (%) to get 1,78 at average sales price***
Ash	0,60	**1,90**	3,75%
Maple	0,51	**1,99**	7,51%
Oak	0,75	**2,09**	16,16%
Beech	0,53	**1,82**	1,40%
Average	0,60	**1,78**	-

Tab.10: γ value of the major species in 2013-2019 and their distance (%) to 1.78 at average sales price.

The indicator was then applied to all major species, selected for their good profitability. The **Ω** efficiency was used to correct the ratio, as the sales price has to be reduced by the loss of material that occurred in various production stages. The higher **γ** is, the more prices has to rise for it to fall to 1.78. Amongst the species, oak has the best performance, granted by its high efficiency, it is followed by maple, species that as oak is sold at a high price, due to its rarity in the market and a strong demand for high quality lumber. These very profitable species carry a dangerous issue, which will be discussed later. Beech and ash have less performing numbers, even if they represent the greater share of annual sales in volume (Fig.6). The two things are correlated, in fact the higher the offer, the lower the price.

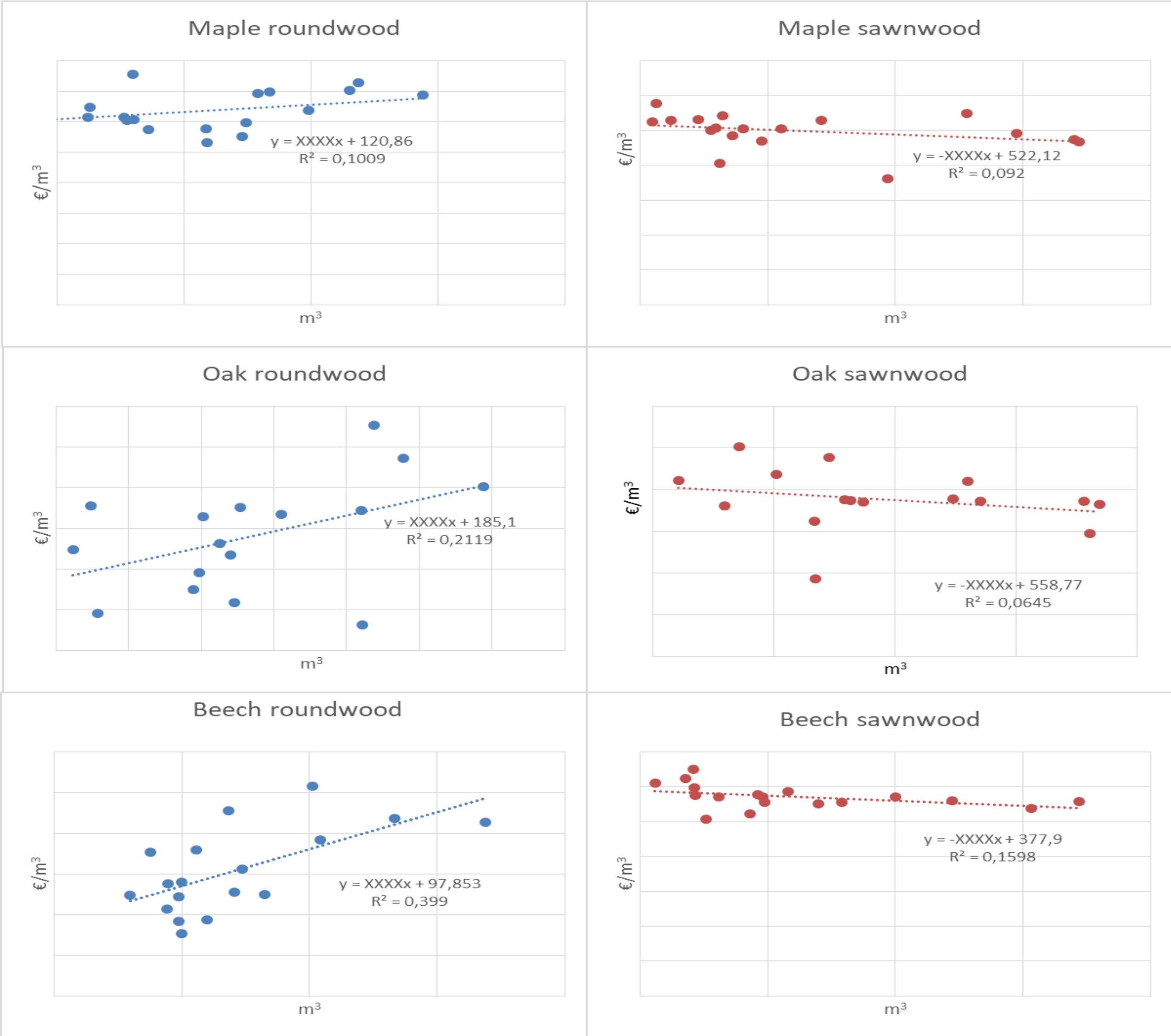

Fig.29: Trends in sales and purchase price for each major species considered, y axis is in (2002-2019).

Fig.29 represents the historical data regarding quantity and value (€/m^3) of sales and purchases for the species previously considered. R^2 is the essential factor to consider in the graphs, as it indicates the reliability of each of the lines used to describe each trend. The more it is distant to 1, the less the equation is reliable. As we can appreciate, beech is very solid, thanks to the high volumes bought through the years, and in the two other species, for the same reason, purchases are more reliable than sales due to the fact that less quantities are sold than bought.

Another reassuring fact is that each trend falls within the logic of demand and offer, as in the blue lines the price grows with demand (the company is the buyer) and in the red one it falls against higher volumes (the company role is the offer, the seller).

The ratio between red and blue dots is used to obtain Ω and most importantly **γ,** and the equations offer the possibility to forecast, given the cost parameter, what should be the indicative selling price given historical evidence. This notion will be fundamental in understanding that, over a certain offered quantity, prices will fall, giving a crucial indicator for substituting ash with the proper amount of m^3 for each species.

Tab.11 finally shows the three different approaches adopted to solve the ash issue.

Scenario_2: No ash

	a) Baseline	b) Only s-w	c) sw+ww
NPV	**XXXXXXX**	**XXXXXXXX**	**XXXXXXXX**
R/C	**1,11**	**1,50**	**1,05**
ROE	**17,00%**	**32,92%**	**11,06%**

Tab.11: Main scenarios studied, one with ash and no contractual work, three to substitute ash in different ways.

In defining scenario_2, the starting point is that ash has to be substituted with other investments. Tab.11 shows that the 'only sawn-wood' scenario, 2b), is misleading and insensately optimistic. The approach leading this scenario was to substitute ash almost entirely with oak, the best performing species, but results indicated an alarming consequent response from the market. Nevertheless, two other balances have been found, in case a) ash was substituted by sawn-wood with the proportions species had in baseline, and in case c) adding even some contractual work to balance profits and pressure less the local timber market, especially considering rare species as oak and maple unknown responses. This is why case a) results more profitable in all indexes, as ash is substituted with the more remunerative sawn-wood, whereas contractual work already showed itself being cheaper but with lesser growth, so that in this new combination it stabilizes profits in an outcome closer to the total values of Tab.8.

Giving a closer look to Scenario 2b), which uses a full sawn-wood revenue, as in scenario_1, and substitutes ash only with sawn-wood. This study tried to estimate the consequence on the profitability of each species, whose percentage in the total revenue has been chosen **only** considering the performances shown in Tab.10, without any second thought regarding the market answers, which indeed are going to be shown now.

Year	***Maple m^3***	***Oak m^3***	***Beech m^3***	***Maple €/m^3***	***Oak €/m^3***	***Beech €/m^3***	
2020	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2021	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2022	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2023	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2024	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
γ				**2,13**	**1,23**	**1,83**	
γ tot							**1,51**

Tab.12: Average selling price and quantities used in the first estimation of scenario 2b) of ash substitution

Tab.15 reports the total amount of round-wood which would be worked if:

- The company would discard contractual work
- Ash would be substituted only with the three major species previously considered: 67,5% oak, 27,5% beech, 5% maple
- Results in m^3 (on the left) are the total amount sold yearly, sum of the normal quantity and the substitutive quantity

The selling price, as in all the other scenarios, is the average obtained in the period 2013-2019, in all the future period 2020-2024. **γ** results are very explicit. Oak price would be strongly unprofitable, whereas beech and maple would resist the stress. In fact, as the quantity of oak grew enormously in respect to the historical sold quantities, the other two species would have a comparable amount to former times. The global outcome in terms of γ_{tot} are also very negative, in fact the quantity of oak considered is excessive.

Margins estimated with historical prices

	Costs			Sales			
Year	**Maple €/m³**	**Oak €/m³**	**Beech €/m³**	**Maple €/m³**	**Oak €/m³**	**Beech €/m³**	
2020	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2021	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2022	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2023	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
2024	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	
γ				**4,10**	**1,03**	**3,37**	
γ_{tot}							**2,12**

Tab.13: Profitability ratio γ with data from historical records. Oak still unprofitable.

Tab.13 then offers the comparison with sales prices, for the quantities seen in Tab.12, suggested by the historical prices obtained with the expressions of Fig.23. Maple and beech, being at very favourable quantities, should be sold at a higher price than the average considered in Tab.16, with tremendously higher γ ratios if compared to the costs, whereas oak would be even more unprofitable than in the other prospect. Fact testifying that *a too elevated quantity sold is rejected by the market.*

To give an example of a case in which volumes are balanced in harmony with the historical projections, here are reported the data from scenario 2c).

Year	***Sales***			
Average	**Maple €/m3**	**Oak €/m3**	**Beech €/m3**	
2020	XXXXXX	XXXXXX	XXXXXX	
2021	XXXXXX	XXXXXX	XXXXXX	
2022	XXXXXX	XXXXXX	XXXXXX	
2023	XXXXXX	XXXXXX	XXXXXX	
2024	XXXXXX	XXXXXX	XXXXXX	
	2,18	**1,78**	**1,98**	
				1,88
Historical	***Maple €/m³***	***Oak €/m³***	***Beech €/m³***	
2020	XXXXXX	XXXXXX	XXXXXX	
2021	XXXXXX	XXXXXX	XXXXXX	
2022	XXXXXX	XXXXXX	XXXXXX	
2023	XXXXXX	XXXXXX	XXXXXX	
2024	XXXXXX	XXXXXX	XXXXXX	
	4,26	**2,23**	**3,71**	
				2,92

Tab.14: Average and historical γ for scenario 2c).

The information provided by Tab.14 underline how a different investment combination could bring to results that show more continuity with the data obtained by the analysis of the past. For scenario 2c), not only indicators as NPV, R/C and ROE (reported in Tab.11) show more affinity with the baseline data reported in Tab.8, but also the γ performance of the species, when combined with a share of contractual work, respond with better performances. Especially oak, which is exactly 1.78 in the average and could be sold up to a 2.23 as suggested by the historical data. Furthermore, all of the species considered could be sold at higher prices, given the quantity bought, in every year of the quinquennial.

4. Conclusions

The development of the study followed a deductive logic, from a general description towards a particular and detailed speculation, from gross data and volumes to categorized net profitability. This kind of approach was meant to facilitate the assimilation of a wide series of data and information that does not necessary link to each other in the logical correlation here presented.

The aims stated in the introduction of this project were: obtain a gross profitability, differentiate gross profit into 'contractual work' and 'sawn-wood' for 2013-2019, calculate costs , define the net revenue, generate prospects for the next 5 years. Results showed that every objective has been reached successfully, providing a complete evaluation of the company's economic activity and its components.

The first important statement to report is that the company's strategy was to use a balance of hardwood species that followed the market's requests, without specializing in any particular timber. Hence, essences ad beech and ash, which are more requested from clients, are the main source of revenue in gross terms, while oak and maple, two more prestigious and expensive species, are more profitable but occupy a smaller portion of the sold volume. A possible future strategy could be investing more strongly in the most profitable species, but the risk is not matching the market and reducing the final revenue. This study suggests that keeping investments close to the former years' species balance as the safest move, especially if the company will want to keep following its ethics of using local material in a sustainable way.

The second essential issue to obtain was a comparison between sawn-wood and contractual work. This study showed that the former is more profitable in absolute terms; it has a higher growth in net capital, but is second when looking at the cost absorption. Contractual work is an investment started only a few years ago, so in this first period its profitability might be affected by the installation costs. Nevertheless, it showed a better cost reduction in the period considered, still providing constantly a positive revenue. Both investments show positive signals for the future, this study supports the idea of keeping them both going, with an eye on their proportion. Data from Results subchapter 3.3 support the hypothesis of a sawn-wood dominance and a lesser investment on contractual work. In fact, until the heavier depreciation costs cease, sawn-wood will represent the better performing investment of the two.

Thanks to the possibility of studying directly from the official balance sheets, it was possible to push this study a little forward by providing a trustworthy series of future scenarios. Nevertheless, the company could face unpredicted situations, consequence of unexpected market variations. To face such an ungraceful possibility, the study suggests the use of γ indicator as a validation tool applicable to every species sold. Keeping γ ratio above 1.78, given historical performances, should help keep the company's profitability close to what it was in the period 2013-2019. In case any species, e.g. ash, could not sustain to be traded at the threshold ratio, it is suggested to adopt one of the strategies offered in the Results subchapter 3.4.2.

5. References

5.1 Articles

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