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# The potential for estimation of log value by the use of traceability concepts

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## Abstract

It is a well known fact that within log grades, the value of the timber produced from the different logs varies. To monitor this, a full traceability backwards from boards to the original log is needed. Such systems do not exist commercially today, and the main objective of the biggest forest-wood project in European history, Indisputable Key, is to facilitate such traceability systems for the forest-wood chain. This paper tries to highlight the potential of such a traceability system by analysing a data set where all information about sites, trees, logs and boards were connected.

The value of the logs were the calculated by summing the value of the obtained sawn timber grades, the pulpwood chips and saw dust in each log The results showed that the traditional saw log grades in Norway did not reflect a consistent expression of log value. Also a major part of the logs not fulfilling the saw log grade requirement proved to be economically interesting to saw, and shows a potential for sawing larger quantities of the log volume produced by the trees in Norway. This is a very important finding since there currently is a shortage of saw logs in Norway, mostly because of low prices for pulpwood, making the interest of forest owners for logging sluggish.

## 1 Introduction

To decide if a log will be profitable to saw in to boards is almost impossible to ascertain in beforehand. Some indications are possible to deduct from exterior features, and normally these features are the bases for log grading rules. However, in a set of grading rules measures have to be taken to make them interpretable for log graders, and sometimes this makes the grades poorer in their ability to reflect the real log value. More dynamic systems, where several features are combined to make algorithms, have shown higher ability in predicting the value, but are hard to implement (Petutschnigg and Katz 2005a; Petutschnigg and Katz 2005b; Petutschnigg *et al*. 2009).

When the Norwegian grading rules for saw logs were developed in the late 1960s, the aim was that saw logs graded as “prima” should yield sawn timber grade third and fourth according to the “ØS-rules”(Anonymous 1981). Saw logs graded as “second” should yield boards of grade fifth, but if one board was grade sixth, the other should be of third or fourth (Müller 1984). The system was based on a two board centre yield sawn with 1/3 vane, giving thicknesses ranging from 50 mm to 100 mm. Since it is not common to produce boards

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thicker than 63 mm anymore, four or even more boards are nowadays produced from the centre yield from larger logs. The grading rules for both saw logs and sawn timber have been modified several times since the 1960s, without paying much attention to the relationship between log grade and yield of sawn timber grade. This has weakened the ability to predict grade yield from certain log grades (Dalen and Høibø 1985; Haugen 1996). The rules are so poor that cross-cutting trees in fixed lengths, with no quality assessment and putting all logs through the saw mill give better economic recovery (Birkeland and Øvrum 2005). This has resulted in that the Norwegian sawmilling industry often buy logs with no distinction between “prima” and “second”, only saw logs as opposed to pulp logs. This makes the saw logs category very broad, and obviously many of these logs are not profitable to saw.

Different log models for grade yield of Norway spruce have been presented (Brännström *et al*. 2007; Edlund *et al*. 2006; Jäppinen 2000; Oja *et al*. 2001), but even if such systems establish relationships between log variables and different sawn timber properties, the cross-cutting is usually carried out prior to these optimizing processes, and some economic yield is lost. An optimal system would involve cross-cutting the stems according to the required wood properties and dimensions (*i.e.* thickness, width and length) of the final product. In order to function properly, good models for predicting the properties of the wood and skilful handling throughout the whole conversion chain are needed. The relationship between price and quality is also important. Therefore, such systems will only be worth considering if the quality within the stem and stand varies considerably, and the range in prices between qualities is large enough. To quantify the differences in value of different logs representing the natural variation in the procurement area of a medium sized saw mill was the aim of this study. This was done to explore the gains of an improved allocation of logs by some sort of traceability system in the wood value chain.

## 2 Material and methods

The logs in this study were collected from six study stands. The stands were selected based on the occurrence of splay knots and crook caused by top breakage, and categorised as poor, medium or good. All stands were located within a circumference of 10 km to reflect the variation within the procurement area of a medium-sized sawmill in Norway. The altitude ranged from 350 meters to 770 meters above sea level, with site indices ranging from G11 to G20 in the H40 system (Tveite 1977). The silvicultural history of the stands was unknown except that all stands were naturally regenerated mature stands of Norway spruce which were about to be clear cut. In each stand all trees within a specific area were cross measured at breast height and ranked by diameter. The trees were then grouped in three groups defined as dominant, co-dominant and suppressed. Within each group 6 trees were randomly selected resulting in 18 sample trees from each stand. The trees were cross-cut in fixed lengths of 4 m or 6 m resulting in 229 logs in total, which all were graded according to the national log grading rules of Norway (Anonymous 1994a).

The logs were sawn according to Nordic practice (Anonymous 1994), with heart splitting giving either 2, 4 or 6 cant in the centre yield depending on the small-end diameter of the log processed. Boards were commercially dimensioned as determined by the sawing pattern giving the maximum volume yield from each log, and the dimensions ranged from 38 x 100 $mm^2$ to 50 x 225 $mm^2$.

All boards were graded for general appearance according to the grading rules in Nordic Timber (Anonymous 1994b) and for a sound knot grade using the market norm for sound knot timber for interior panelling and flooring in Norway. Boards thicker than 32 mm were also strength graded by visual inspection according to INSTA 142 (Anonymous 1997). Based on the current market values for the respective grades, the value of the sawn timber from each log was calculated. The value of the pulp wood chips and saw dust produced was also added to get the total value of the log. Table 1 summarizes the grades and their respective values in the calculations.

Table 1 Set market value of the different sawn timber grades

| **Grade** | **Value (NOK/$m^3$)** |
|---|---|
| Nordic Timber, grade A3 | 2000 |
| Nordic Timber, grade A4 | 1800 |
| Nordic Timber, grade B | 1500 |
| Nordic Timber, grade C | 1000 |
| Nordic Timber, grade D | 700 |
| Sound knot timber | 1900 |
| INSTA 142, grade T3/C30 | 1700 |
| INSTA 142, grade T2/C24 | 1600 |
| INSTA 142, grade T1/C18 | 1550 |
| Pulp wood chips | 250 |
| Saw dust | 150 |

## 3 Results

The mean log value was found to be 924 NOK/$m^3$, with a standard deviation of 171 NOK/$m^3$. In Figure 1 the distribution of the value in the logs is shown in NOK/$m^3$.

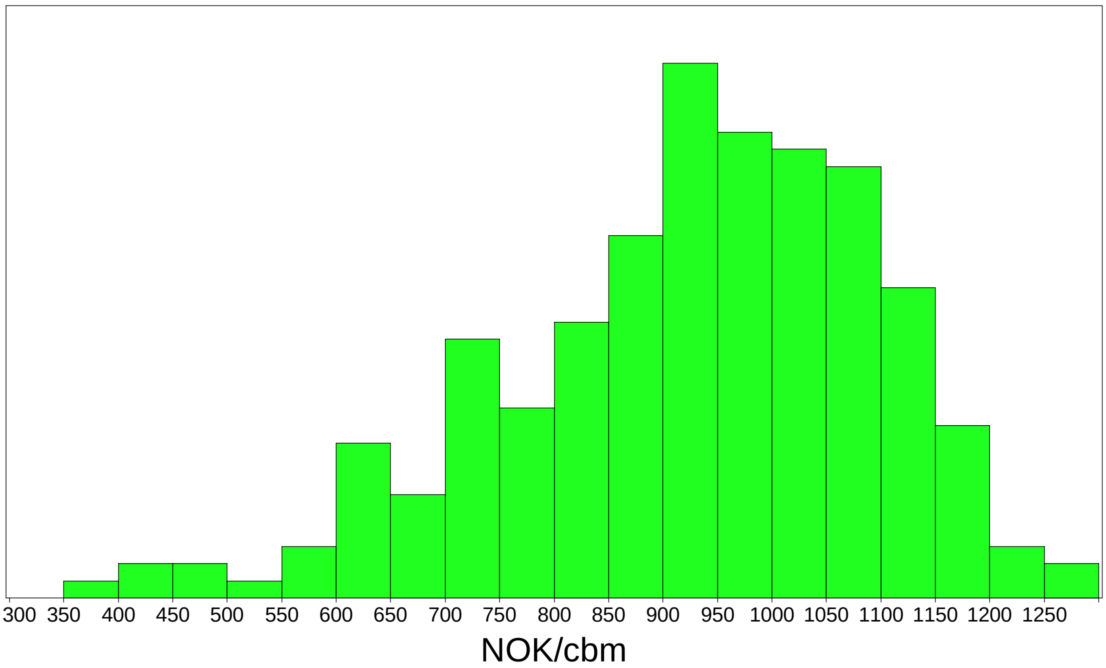


Figure 1: The distribution of value in NOK/m$^3$ for the logs in the study

First of all the difference between, and the distribution within the log grades is of interest. This indicates how well the log grades reflect the final product value for the mills. The highest saw log grade, Prima, yielded an average log value of 969 NOK/m$^3$ with a standard deviation of 141 NOK/m$^3$ while the lowest saw log grade, Second, yielded an average log value of 926 NOK/m$^3$ with a standard deviation of 186 NOK/m$^3$. The logs not satisfying the saw log grades yielded an average log value of 849 NOK/m$^3$ with a standard deviation of 182 NOK/m$^3$.

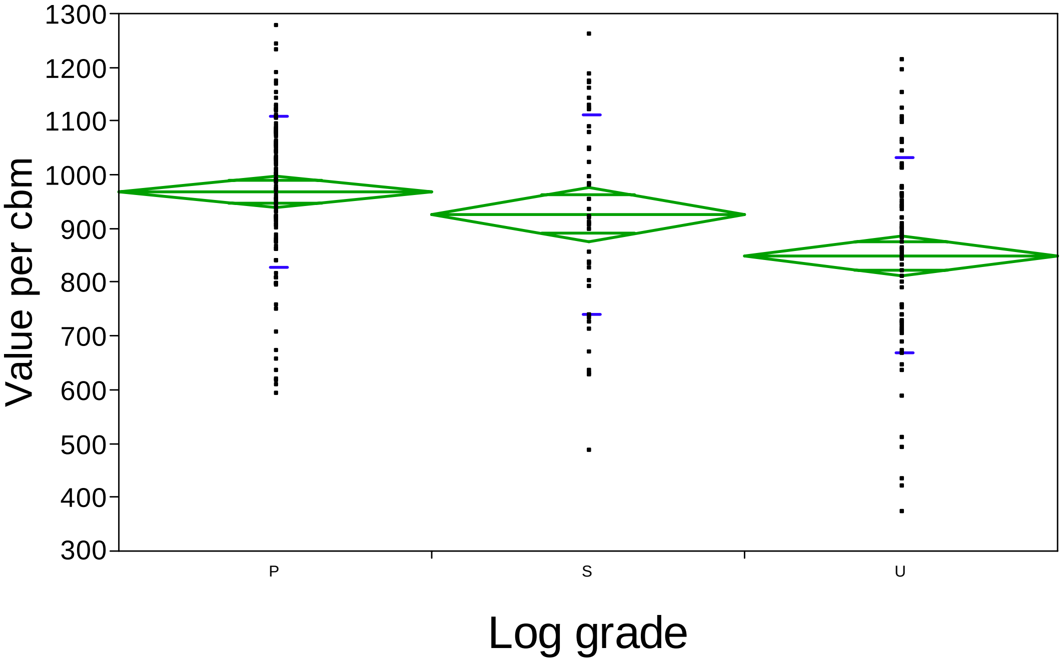


Figure 2: The value of the logs in the different log grades

Statistically only the logs graded to reject by the log grading rules were found to have a lower value than the accepted saw logs. Between the saw log grades no statistically significant differences were found. The test performed was a Tukey-Kramer analysis of variance with a significance level of 5%.

The log measurements in this work were not very precise, and no scanning of any kind was performed. Only grading according to the log grading rules, and a diameter measurement every meter on falling cant by a calliper was executed. The correlation between these surface features and the value in all logs, and for only the logs satisfying the log grading rules are shown in Table 2.

Table 2: Correlation between external measures on the logs and the log value

| | **Value in all logs** | **Value in saw logs** |
|---|---|---|
| Log diameter in top end | 0,35 | 0,48 |
| Log volume | 0,26 | 0,40 |
| Log taper | 0,08 | 0,17 |

A Tukey-Kramer analysis of variance with a significance level of 5% was also performed to test if there were differences between the log values of the different categorised stand types. No statistically significant differences were found either when all logs were included or just the accepted saw logs.

Between tree statuses within a stand however, statistically significant differences in log values were found both when all logs were included, and when only the saw logs were considered. The ranking was from highest value to lowest; dominant, co-dominant and suppressed trees.

## 4 Discussion

The results show a very large difference in final product value between logs. This is in itself not a big surprise, and to be able to get only profitable logs in to a saw mill is probably not achievable. In the forest business today saw mills have to purchase logs not being profitable in order to get access to the more profitable logs from their suppliers. In practice this means buying logs from top diameter 13 ub and upwards. Most mills would, if they had the chance, only saw logs from 18 to 30 in top diameter since their technology is optimized for these dimensions, and the sawing patterns are also yielding the most interesting dimensions in these log diameters. However, if saw mills get a better knowledge of which logs they are profiting on, they will be able to consider other use of logs not profitable to saw. Alternatives can be chipping for pulpwood, bio energy, or simplified sawing to “rougher” products with lower quality requirements.

Countless models for wood properties and grade yield exist, but are not able to explain the variance in log conversion one hundred percent. A traceability system could in an ideal situation make it possible for log suppliers to get paid based on the log value obtained for the primary processer. However this appears a bit naive since a lot of process conditions will influence the yield, and there is also a business transaction involved. However, some kind of bonus for suppliers delivering high value logs could be imagined.

As Birkeland and Øvrum (2005) showed, sawing the whole tree may be in many cases yield the highest economic recovery. However, this result is based on a lot of assumptions in the processes from forest to final product. The sawmilling industry is on the other hand constantly making progress technically, and especially the increased use of scanners for grading and other kinds of quality management make the sawmilling process more flexible and efficient in terms of separating different qualities to their respective end products. This will make the sawmills more able to process a larger spectre of log qualities. Also the small difference between the values in the log grades indicates that one can consider sawing the whole tree, and deal with the grading later on in the process.

New 3D scanners and x-ray scanners will give much more measuring points making it possible to define value in logs more precisely. If traceability concepts like the ones displayed in the Indisputable Key is implemented in the wood value chain this might facilitate a new way of purchasing logs by sharing the surplus of a produced logs between the buyer and seller of the logs. An example of such integration in Norway is planing mills not accepting delivered timber batches yielding more reject than a defined threshold value when splitting, planing and grading for interior panelling.

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