Cable Logging Contract Rates in the Alps: the Effect of Regional Variability and Technical Constraints

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Abstract

A survey of cable logging contracts was conducted in 5 of the 8 Alpine countries, namely: France, Germany, Italy, Slovenia and Switzerland. The goals of the survey were to set a general reference for cable logging rates, to identify eventual differences between countries and to determine the effect of technical work parameters (i.e. piece size, removal per hectare, line length) on actual contract rates. With a total sample size of 566 units, the mean removal and rate were 165 m^3 ha^{-1} and 42.9 € m^{-3}, respectively. Both removal per hectare and contract logging rates varied considerably and the study found significant differences between countries. Switzerland stood out from the group with the highest removal (345 m^3 ha^{-1}), but also the highest contract rate (79.5 € m^{-3}). Removal per hectare was lowest in Italy with just 58.3 m^3 ha^{-1}, and logging rate lowest in Slovenia at 29.3 € m^{-3}. Logging rates were highly correlated with the average labour rate of each country. Technical factors such as tree size, line length and tract size explained about 40% of the variability in logging rates. Therefore, 60% of the variability is explained by other technical factors not included in our data and by non-technical factors, such as local market dynamics.

Keywords: harvesting, mountain, wood, forestry, yarder

1. Introduction

The Alps are one of the great mountain range systems of Europe, stretching 1200 km across 8 different countries, namely: Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland (Fig. 1). Despite national borders, the region is united by common ecological and cultural characteristics, which set it apart from the rest of Europe (Onida 2009). For this reason, trans-boundary regionalism has become a dominant trend in the economical and political integration of the alpine space. The process of regionalization offers new opportunities to innovation and sustainable development. This is best expressed by the Alpine Convention, signed in 1991 between the European Union and the eight states with territory in the Alps (Balsiger 2008).

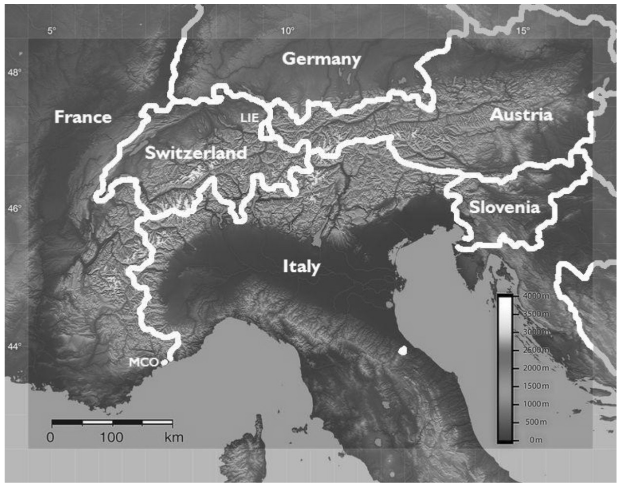

Fig. 1 The Alpine region and the 8 countries sharing territory within it

Forest cover represents 40% of the Alpine landscape. Forests have always played an important role in supporting the alpine economy, and that is still true today with the boom of engineered wood products and energy biomass (Onida 2009). Alpine forests also have a protective function, as they prevent soil erosion and shield settlements from avalanches and rock fall (Dorren et al. 2004).

The need to balance cost effective wood production with careful protection makes alpine forestry particularly complex. Continuous cover forestry is popular, as it offers a good compromise between these two vital functions. However, continuous cover forestry reduces harvest removal and it may constrain operation profitability (Mason et al. 1999). Low removals and the typical access constraints of the Alpine territory hinder the introduction of modern mechanisation, which is the only solution to cost containment in the face of increasing fuel and labour cost (Spinelli and Magagnotti 2011). As a consequence, silviculture is often delayed and results in a skewed age distribution (Binder et al. 2004). That contributes to the high vulnerability of Alpine forests to the effects of climate change (Seidl et al. 2011). Therefore, it is crucial to optimize forest operations in order to guarantee timely regeneration and maximize resiliency.

A first step towards optimization is cost control (Mathews 1942). To this end, it is necessary to know accurately the current harvesting contract rates, as well as their sensitivity to market factors (e.g. competition, labour cost, cost of living, etc.) and technical factors (e. g. line length, tree size, removal, etc.).

Time and motion studies are often used to develop an understanding of how individual elements in a logging system respond to stand and terrain parameters (Visser and Stampfer 2003). These studies can be combined to provide system cost figures. Otherwise, complex system models can be developed, using advanced simulation software. Such models are capable of combining stand, terrain and system information in order to produce reliable cost figures (McDonagh et al. 2004). However, all these tools provide information about the technical cost of harvesting, not the actual logging rate reported on the harvesting contract (Stuart and Grace 2011). The latter is influenced by many non-technical factors, related to market structure and contractor interaction (Visser 2009). For this reason, predictions based exclusively on technical factors may not reflect actual rates, weakening the ability to predict and manage logging costs.

In trans-boundary regions, further differences in logging rates can be expected to derive from the specific economic conditions encountered in the different states that share the common regional space. While the landscape and culture are indeed common, local differences are encountered in market competition, labour cost, fuel cost, access to credit, government subsidies and fiscal pressure, among others. Knowledge of these differences is especially important when planning for trans-border activities. For example, when concentrating a large international task force to face a sudden local crisis, such as catastrophic forest damage (CTBA 2004). Potential interface problems should be explored and solved well in advance, because the frequency and severity of catastrophic forest damage has been predicted to increase in the future, due to the unfavourable combination of climate change and past silvilcultural choices (Schelhaas et al. 2010, Klaus et al. 2011). This will also affect lumber prices (Koch et al. 2013).

Therefore, the goals of this study were to:

⇒ quantify the contract cable logging rates currently applied across the Alpine space,

⇒ determine the extent and the significance of possible national differences,

⇒ gauge the amount of variability introduced by non-technical local market factors (e.g. labour cost, cost of living, competition, etc.) in order to assess the potential error of relying only on technical factors.

This study focuses on cable logging (Fig. 2), which is the backbone of steep slope harvesting world-wide (Bont and Heinimann 2012). In 2012, there were over 350 cable logging contractors in alpine Italy alone (Spinelli et al. 2013). On steep terrain, cable logging is the cost effective alternative to building an extensive network of skidding trails and results in a much lower site impact compared to ground based logging (Spinelli et al. 2010). On the other hand, cable logging is inherently expensive because it is normally de-

Fig. 2 Representative cable logging operation

ployed on difficult sites. For this reason, cable logging offers lower profit margins compared to ground based logging. This justifies a stronger optimization effort, supported by a deeper knowledge of technical cost and market rates.

2. Material and methods

Actual contract data were obtained from forest owners in 5 of the 8 Alpine countries, namely: France, Germany, Italy, Slovenia and Switzerland. Owners were asked to provide information about the actual contract rate in € per m^3, as indicated in each individual contract. They were also asked to provide the following technical information relative to each contract: contract number; place name; forest compartment; total harvest volume; harvest area; number of harvested trees; line length; occurrence and inclusion of two staging in the contract rate. This information allowed calculating average tree size, tract size and removal per hectare, which are among the most important parameters affecting technical cost (Hasel 1946), together with line length.

A total of 566 data entries were collected: 64 from northern Italy (Friuli Venezia Giulia and Trentino), 96 from Switzerland, 42 from south-eastern France (Alpes du Nord), 227 from Slovenia and 127 from southern Germany. Contracts included all main work steps required for turning standing trees into merchandised logs, stacked at the landing (Spinelli and Magagnotti 2011). In particular, all contracts covered felling, processing and extraction to a landing. Since yarder landings are often small and remote, contracts may also include a further work step, namely: moving the logs from the yarder landing to a larger log yard that is accessible to on-road transportation, an operation that is commonly known as two staging (Spinelli et al. 2014). French, Italian and Swiss contracts did indicate two staging, and the Italian contracts also reported the actual two staging distance. However, German and Slovenian contracts provided no indication about the possible occurrence of two staging. The largest majority of the French, Italian and Slovenian contracts concerned public forests.

All contracts were based on regeneration cuts of mature stands, which were conducted according to different techniques, and especially selection cut and patch cut. The study included no clear cuts, which are generally banned in all the countries spanned by our survey in order to contain hydro geological risk. The type of cut applied in each contract was inferred from the removal per hectare. All stands were pure softwood or softwood-dominated mixed forests. Norway spruce (*Picea abies* Karst.) was the most common species, followed by larch (*Larix Europea* L.), silver fir (*Abies alba* L.), beech (*Fagus sylvatica* L.) and pines (*Pinus sylvestris* L. and *Pinus cembra* L.).

Most contracts were dated between 2010 and 2013. A few were older, and the oldest ones had been issued in 2002. For this reason, all rates were annualized to 2013 figures using the consumer price indices found in the respective national statistics. Figures of average hourly labour costs for each country were obtained from the Eurostat database (Eurostat 2013). Swiss rates were expressed in Swiss francs and they were converted into Euros using the official exchange rate of December 2013, equal to 0.81 Euro per 1 Swiss franc. Volume figures were generally provided under bark: the over bark figures were converted into their under bark equivalents using appropriate coefficients.

The German data set contained no information about tree size and line length, and therefore it was impossible to calculate the effect of these factors on the German contract rates.

Data were analyzed statistically using SPSS. As a first step, descriptive statistics were determined for each country. Then, the significance of these differences was tested through the analysis of variance, after checking that the data pool met all statistical assumptions. Regression analysis of the data allowed testing the relationship between contract rate and the main technical parameters listed above, and namely: removal, tree size, tract size, line length and the eventual inclusion of two staging in the contract. The regression coefficient R^2 was taken as an indicator of how strong the effect of the main technical parameters was on contract rate. Conversely, unexplained variability was considered to derive at least in part from non-technical parameters, such as: local competition, negotiation and general market dynamics.

3. Results and discussion

Mean contract rate was 42.9 € m^{-3}, while mean tree size was 1.3 m^3 (Table 1). The mean tract contained 500 trees, or 670 m^3. Line length ranged between 100 and 450 m (interquartile range). Variations in removals were even higher, ranging between 30 and 400 m^3 ha^{-1} (interquartile range).

Two staging was noted in Italy (81% of cases) and Switzerland (100% of cases), but not in France, Germany and Slovenia. Only Italy recorded the actual two staging distance, and the average was 3.7 km.

The study highlighted strong national differences (Table 2). In particular, tract size in m^3 was higher for

Table 1 Summary of data submitted for all countries

	n	Average	5th percentile	95th percentile
Number of trees, n	428	509	76	1499
Harvest area, ha	453	5.24	0.79	17.10
Total volume, m^3	553	671	107	1790
Piece size, m^3	415	1.33	0.37	2.47
Stand density, m^3/ha	440	165	33	405
Average extraction distance, m	426	285	86	500
Harvesting rate, €/m^3	566	42.9	17.6	86.5

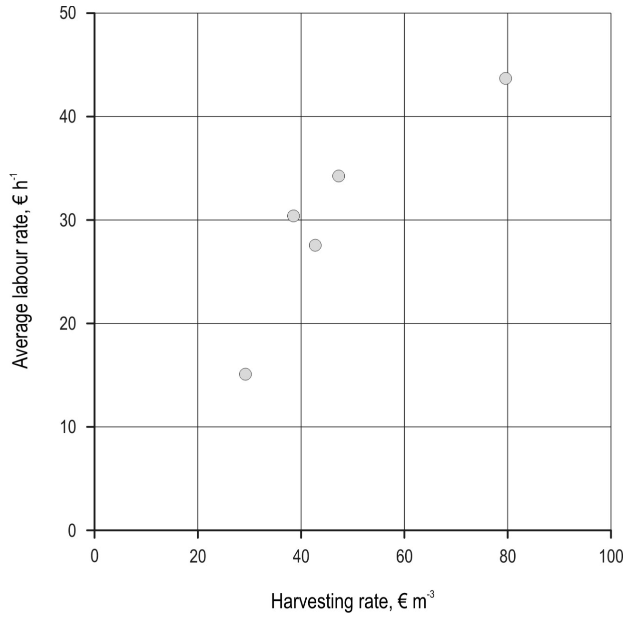

Fig. 3 Chart showing harvesting rate compared to average labour rate

France and Germany, compared to the rest. Removal per hectare was over three times larger in Switzerland (345 m^3 ha^{-1}) than in all the other countries. Italy showed the lowest removal (58.3 m^3 ha^{-1}), half the value as the combined average. In contrast, tree size was relatively even, with the French mean slightly higher than the means of all other countries. Mean line length was 591 m in France, significantly higher than the 353 m in Switzerland, which in turn was significantly higher than Italy and Slovenia (360 m and 220 m, respectively). Mean contract rate varied from 29 to 79 € m^{-3}, and it was significantly different between countries. It was lowest in Slovenia and highest in Switzerland. The mean contract rate recorded for Switzerland was twice as high as in all other countries combined. Contract rates showed a strong relationship with national labour cost data (Fig. 3).

Regression analysis showed a good relationship between contract rate and such technical work conditions as harvest area, piece size and line length (Eq. 1). Removal per hectare also had a significant effect, but this variable was excluded from the regression equation because of its strong collinearity with the country variable. Removal was much higher for Switzerland, which also had the highest contract rates. As a consequence, inclusion of removal in the regression would return a positive parameter, with contract rate increasing as a function of removal. Therefore, inclusion of this variable was contrary to sound statistical practice and it returned illogical results.

$$CR = 25.92 + 0.037\,L - 0.253\,A - 2.91\,TS$$
$$Sig.= 0.005;\ R^2 = 0.41$$

Where:

- *CR* Contract rate, € m^{-3};
- *L* Line length, m;
- *A* Harvest area, ha;
- *TS* Tree size, m^3.

Table 2 Breakdown by country showing average values and standard deviation

Country	Harvest area, ha		Harvest, m^3	Removal, m^3/ha		Piece size, m^3/tree		Line length, m		Harvesting rate 2013 €/m^3	
	Mean	Standard deviation	Mean	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
France	9.6a	6.1	997a	103a	60.3	1.7a	0.75	591a	302	47.2a	6.5
Germany	12.0b	6.9	1173b	97.6a	35.4	no data	no data	no data	no data	38.5b	7.7
Italy	9.9a	7.2	578c	58.3b	45.2	1.3b	0.88	246c	98	42.6c	7.5
Slovenia	4.0c	3.5	386d	97.5a	87.2	1.2b	0.63	209d	87	29.3d	10.3
Switzerland	1.6d	0.8	538c	345c	81.4	1.4b	0.59	353b	83	79.5e	27.2

Notes: Different letters along the same columns indicate statistically significant differences between country averages, checked by analysis of variance at the 5% level

Eq. 1 shows that the contract rate increases with line length and decreases with tract (harvest area) and tree size. This relationship is logical, because increasing line lengths tend to decrease productivity and increase cost, whereas increasing tract and tree size tend to increase productivity and decrease cost.

A careful literature search found no other surveys of Alpine or European logging contract rates, which highlights the value of our study and denies the possibility of any direct comparison with similar studies. Similar studies are available for the USA (Baker et al. 2013) and New Zealand (Visser 2012), but harvesting technology and work conditions are so different from the Alpine ones that it is virtually impossible to draw any meaningful comparisons (Smidt et al. 2009).

Cable logging is more complex and expensive than ground based logging, which places Alpine forestry at a general disadvantage in terms of pure harvesting cost. Even the lowest logging rates recorded in this study are much higher than the harvesting costs reported for the boreal forests of northern Europe (11 € m^{-3}, Gerasimov et al. 2013), the eucalypt plantations of western Europe (<20 € m^{-3}, Magagnotti et al. 2011) and South America (8 US$ t^{-1} or 6.5 € t^{-1}, Oliveira and Seixas 2012) or the pine plantations of the Southeastern USA (9–10 US$ m^{-3} or ca. 7 € m^{-3}, Conrad et al. 2013). The main problem is steep terrain, which prevents using cost effective ground-based logging. On Alpine highland plateaus, it is possible to resort to mechanised cut-to-length harvesting by deploying the classic harvester-forwarder chain (Zambelli et al. 2012), and in that case harvesting cost is not much higher than reported for northern Europe (ca. 12 € m^{-3}, Spinelli and Magagnotti 2013). Fortunately, the high cost of steep terrain logging is largely offset by the high value of slow growth alpine timber. In northern Italy, the current price of saw logs is higher than 75 € m^{-3} at the landing (IRE 2013). In Austria, saw log price often exceeds 90 € m^{-3}, for product delivered to the sawmill (Federal Ministry of Agriculture 2012). In Slovenia the average saw log prices vary between 70 € m^{-3} and 76 € m^{-3}, at landing (SI-Stat 2013).

Published data are available for the calculated technical cost of cable harvesting in a number of different Alpine countries. Stampfer et al. (2010) reported a cost of 32 € m^{-3} for a typical cable logging operation in Austria. Spinelli et al. (2008) reported figures between 28 and 40 € m^{-3} for northern Italy, based on two case studies. Pischedda et al. (2001) presented four case studies in the French and Italian Alps, with harvesting costs varying from 29 to 64 € m^{-3}. Chagnon and Pischedda (2005) indicated costs between 42 and 58 € m^{-3}, specifically for the French Alps. Finally, Thees et al. (2011) reported costs between 45 and 65 € m^{-3} for the Swiss Alps. Of course, these figures should first be annualized to 2013 values before making any comparisons. However, the bracket is so wide that these data could not offer much more than a general confirmation. In particular, it is not reasonable to use these data for gauging the difference between technical cost and market rate. In principle, such an attempt could be made by introducing the technical information contained in the contracts in one of the many cost calculators developed for Alpine cable harvesting operations, such as the Swiss Hepromo (Frutig et al. 2009), the French Newfor (Magaud 2013) or the Italian HEKK (Stauder 2013). These software programs return a technical harvesting cost based on user entered input data. However, all such programs can calculate a proper harvesting cost only if they receive accurate information about machine service life and annual use, which could not possibly be inferred from the content of the individual contracts. Such information is crucial to a reliable cost calculation, and it cannot be approximated without much prejudice for the accuracy of the eventual cost estimate (Spinelli et al. 2011).

For this reason, it is best to use the regression coefficient R^2 as the main indicator for the effect of non-technical parameters on logging rate. In fact, the main reason for developing such a general multi country model was to use its regression coefficient as a basis for discussing the relative weight of technical and non-technical factors, not for predicting general contract rates that do not exist in reality, since every country has its own individual market rates. The regression equation estimated from the study data can only explain 40% of the variability in the data pool. This is the variability caused by such main technical factors as tree size, line length and tract size. Therefore, 60% of the variability in the data pool is caused by other factors, both technical and non-technical. There are many technical factors that were not included in the current regression, and especially lateral yarding distance and two staging. The latter was not included in the regression because information was available only for two of the five countries included in the survey, and therefore inclusion of two staging as an independent variable would have generated a large number of missing values, determining severe unbalance. The same is true for silvicultural treatment, which may significantly affect cable logging cost (Hartley and Han 2007). In this study, information about silvicultural treatment was not collected directly, but it could have been inferred from removal per hectare. An alternative measure for removal that relates more directly to the use of the cable yarding system is to use the volume per unit length of cable corridor (m^3 m^{-1}). For example, for the French data there was a very strong relationship between Contract Rate (€ m^{-3}) and volume per metre of cable corridor. Unfortunately, for both of these measures collinearity prevented using removal as a meaningful independent variable.

However, the regression included both tree size and line length, which have long been recognized as the most important variables when predicting yarder productivity (LeDoux 1985). Tract size is also an important predictor of harvesting cost (Greene et al. 1997, Moldenhauer and Bolding 2009, Visser 2012) and it was included as an independent variable in our regression equation. For this reason, it is unlikely that the technical factors excluded from our equation may account for 60% of the variability in the data pool: a substantial part of that variability may be explained by non-technical factors, and especially local market dynamics and national economics.

National differences certainly play an important role, especially for Switzerland. The Swiss contract rates are significantly higher, which is in part explained by the much higher labour cost, and a low productivity caused by several circumstances (e.g. difficult terrain/working conditions). In fact, higher wages cause many foreign nationals to look for employment in Switzerland from the neighbouring countries and justify a sustained cross border commuting pattern (Banfi et al. 2005).

The French contract rates are the second highest, and that could be explained by the longer mean line length. Harvesting cost generally increases with line length, and such increase can become quite steep if the distance exceeds the capacity of modern tower yarders, as it often occurs in France. In that case, it is necessary to resort to traditional long distance cable systems, which incur much higher set up and dismantle costs compared with modern tower yarders (Stampfer et al. 2006). The high French rates may also be caused by the unbalance between the demand for yarding services and the actual availability. Grulois (2007) reports about the decline of cable yarding in France, which occurred over the past decades, when skidders became the exclusive choice of loggers in the French Alps. Efforts are being made to re-introduce cable yarding in southern France, but it will take several years before a large enough yarder fleet will be available in the area. In the meantime there are very few yarder operators in the French Alps, although the demand for cable yarding services is increasing. The longer line length and the larger tree size found in France may also depend on the preference for skidder operations in the past decades. French yarding operators are likely targeting those forests that are far from the road and have turned over-mature due to delayed regeneration harvests.

The study also highlights some important differences in the silvicultural practice applied in different countries. In particular, removals are much higher in Switzerland than in any other country included in this study. However, no contracts in our survey concerned clear cuts, and the very intense Swiss cuts were still selection cuts, applied to heavily overstocked stands. Of course, this is only the case of those owners who joined the study: we did not conduct comprehensive national surveys, and therefore our results cannot lead to any conclusions about the prevalent silvicultural practice in any of the participating countries. However, our results may be indicative of trends, and they point to a very low removal in Italy and at a rather large one in Switzerland. It is certainly worth noticing that the Swiss contract rates are very high. This may further support the hypothesis of a large influence on non-technical market factors on establishing local cable logging rates.

4. Conclusion

Contract rates differ significantly between countries, and are proportional to local labour cost. Differences are related to different work conditions, and especially removal per hectare, line length, tract size and tree size. However, technical factors explain only part of the difference in local contract rates, and non-technical market factors also seem to have a strong effect. In turn, that may make cross border activity a good business for those loggers based where labour cost is lowest. Contract rate differences must be considered especially in the event of assembling a large international task force to face a sudden local crisis, such as catastrophic forest damage. Loggers cannot be drawn to countries with lower contract rates, unless rates are adjusted. While showing that actual contract rates are only partly related to technical factors, this study also highlights the lack of other similar studies, which contrasts with the large number of studies about technical cost. Future research should pay more attention to actual contract rates and expand this survey to cover a larger number of countries: this type of information is especially relevant to sound forest management, because actual contract rates may limit silvicultural choice.

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