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Assessing the timber value: A case study in the Italian Alps

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ABSTRACT

In the Piedmont region, in North-West Italy, the abundance of unmanaged woods has led to negative environmental and economic consequences, generating a decrease in the ecosystem services supplied and in the provision of low-value timber products. In this context, increased logging activities could create new development opportunities for the rural areas in which most of the abandoned stands are situated.

This work analyses a forest harvest by creating a model to evaluate its timber value. The economic results were analysed to investigate the structural and logistic factors influencing the profitability of a harvest. The results obtained revealed that a small profit margin is achievable for small local logging companies, even if strongly influenced by the hourly costs of labourers.

To quantify the influence of each factor of the model on the timber value, a sensitivity analysis was performed. Then, to test the robustness of the results a Monte Carlo simulation was carried out simultaneously varying the factors involved. Finally, a scenario analysis was performed, in which the standard conditions referring to the most common private forest company typologies were examined.

Overall, these methods were found to be suitable for our aims and capable of supplying important results to analyse a forest harvest from an economic perspective.

1. Introduction

It is commonly accepted how the active management of forests can enhance the liveability of local communities in rural areas both from a socio-economic and environmental perspective, supporting local timber markets and ensuring the provision of several valuable Ecosystem Services, such as protection from natural hazards, recreation and biodiversity (Frank et al., 2015; Fürst et al., 2010). Therefore, in some European countries characterized by low rates of forest exploitation (as is the case in Italy, where the harvest rate is 23% of the growth rate) (Secco et al., 2017), measures and instruments capable of assisting forestry operations could play an important role in supporting the forestry sector at both policy and economic levels. In this context of under-exploitation of forest resources, enhancing the value of the existing coppice forests can represent a consistent opportunity, where these new measures and instruments could be adopted.

Coppice forests, that cover more than 18 M ha in Europe (19% of which are in Italy) (Angelini et al., 2013) represent a paradigmatic example of a natural environment which has been profoundly shaped by human intervention. Past management has modified the species composition and structure in order to mainly provide small-sized fuelwood production (Fabbio, 2016). Due to this close relationship with the surrounding human settlements, exploitation of coppices has followed the evolution of society. In Italy, over the last 70 years, these rural areas, where most of these forests are located, have suffered a vast depopulation (Pelleri & Sulli, 1997), that has led to the abandonment of large areas of agricultural land and actively managed forests, allowing secondary woodlands to proliferate (Bätzing et al., 1996; Coppini & Hermanin, 2007). These phenomena, occurring mainly in the Alpine areas, consequently caused a decrease of the ability of forests to cope with natural hazards (Vogt et al., 2006) and reduced the quality and quantity of the harvested timber (Fonti & Giudici, 2001), which is still not sufficient to satisfy national demand (Secco et al., 2017).

In order to support the development of the forestry sector in Italy, many political efforts have been undertaken on both national and regional scales (Marchetti, 2018; Quatrini et al., 2017), with several measures focusing on coppices (Mairota et al., 2016). In addition to these policy measures, the scientific community produced several works addressing this topic, including among others: the benefits deriving from the sustainable active management of coppices studied from the perspective of biodiversity (Mattioli et al., 2016; Müllerová et al., 2015), natural risk reduction (Vogt et al., 2006), logging impacts (Venanzi et al., 2016) and policy solutions (Fabbio, 2016). Nonetheless, this current discussion seems lacking in the evaluation of economic aspects: for this reason, this paper is an attempt to rectify this shortcoming, by establishing a model to analyse the harvesting operations in

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a coppice forest, in order to define the main factors influencing their economic results.

The selected study area is a chestnut (*Castanea sativa* Mill.) coppice located in the Piedmont Region, in the Western Italian Alps. In Italy, this typology of coppice covers almost 1 M ha, equal to 27% of all Italian coppices (Angelini et al., 2013) and represents a valuable example of the effects of the different societal trends that influenced forest management over the last decades. In the past, thanks to the many different products that chestnut stands were able to provide (Mariotti et al., 2008), society favoured their presence throughout all the mountainous areas in the country, generating a veritable "Chestnut culture" (Conedera et al., 2004). Then, from the Seventies onwards, the spread of some virulent pathogens, such as Ink Disease (*Phytophthora cambivora* (Petri) Buisman) and Chestnut Blight (*Cryphonectria parasitica* (Murrill) Barr.) (Turchetti & Maresi, 2006; Turchetti et al., 2008), and the related physiological problems, such as Ring Shake, limited their use (Fonti et al., 2002; Macchioni & Pividori, 1996). Consequently, these limitations provoked a clear change in their management, shifting from coppice to high forest, or frequently to abandonment (Arnaud et al., 1997; Conedera et al., 2001). From an economic perspective, this change also influenced the profitability of these stands: in fact, the lower value of the achievable wood products, made the economic return of their exploitation uncertain. Currently, chestnut stands are the most common forest type in the Piedmont Region, covering an area of 205,000 ha, equal to 23% of the forests covering the regional territory (Gottero et al., 2007), and also one of the most common in Italy, but their fate is still uncertain. Therefore, the framework we developed aims to illustrate the potential revenues that can be achieved through a return to the active management of these stands, by providing a reliable economic analysis of the forest harvesting process, taking into consideration both the revenues that can be obtained from the different timber products and the costs associated with logging operations.

To reach this goal, we i) set up a model to evaluate, from an economic perspective, the most likely timber value of a harvest and then tested it on a representative case study located in the Western Italian Alps; ii) assessed the effect and intensity of the variation of the economic and technical factors on the results of the model, through a sensitivity analysis of its parameters and the evaluation of their elasticity; iii) proved the robustness of the results, by applying a reiterative probabilistic analysis based on a Monte Carlo simulation model; and finally, iv) built a scenario analysis with the standard features of the two most common types of private logging companies in the study area, whose characteristics are also well suited to the Italian context. This set of analysis is intended to be employed to compare and analyse the drivers which most profoundly affect the profitability of a harvest in different areas and when adopting different work methods. Moreover, its application with real data from the standard logging companies in the area will also be relevant for entrepreneurs, in order for them to evaluate the management of their logging operations from an economic perspective and to support the definition of the most suitable business strategies to implement their company performance.

2. Materials and method

2.1. Case study

The data needed to build the timber value (TV) model was obtained from a case study conducted in the Ormea territory of the Piedmont Region, a small municipality in the Western Italian Alps, 800 m above sea level. The analysed chestnut stand is an over-mature coppice stand, with sporadic sycamore (*Acer pseudoplatanus* L.), European ash (*Fraxinus excelsior* L.) and rowan (*Sorbus aucuparia* L.) trees, covering a total area of 0.42 ha. A forest road, suitable for use as a bunching site, where the timber can be collected before its extraction, constitutes the lower boundary of the stand. This area, whose features are consistent with most of the privately-owned coppice forests of the Region (Gottero et al., 2007), can also be considered as an example of the most common state of Italian coppices, where the lack of management has negatively influenced the profitability of the harvest (Moscatelli et al., 2007). In Piedmont, at least 30% of chestnut stands are either abandoned (Manetti et al., 2006) or over-aged and under-exploited (Gasparini & Tabacchi, 2011). Moreover, 89% of these stands in this Region are privately-owned (Gottero et al., 2007), and generally affected by a fragmentation of ownership that negatively influences harvesting activities (Brun et al., 2009). This phenomenon is clearly evident in the statistical data collected from the Italian Statistics Institute (ISTAT), which states that the average harvest area in the Western Alps is equal to 0.46 ha (ISTAT, 2015), while the area of forest operations in coppice forests, referring to the Piedmont Region, varies from 0.43 to 0.78 ha (Brun et al., 2014a). Therefore, this study can be considered representative of the current forestry situation in the area, securing validity to the results.

The dendrometric data was collected through field surveys with complete callipering of the trees and measurement of a relevant number of tree heights. This data allowed us to employ the Italian Forest National Inventory (IFNI) log rules (Castellani et al., 1984) to estimate the total wood volume of the area, equal to 494 m^3/ha.

The stand is an over-aged chestnut coppice stand; since the production of new sprouts for this species is only marginally influenced by the age of the stump (Conedera et al., 2001), the current Regional Forest Law defines specific rules for its management (art. 56; Law 8/r – 2011). In particular, for chestnut stands, no maximum rotation period is defined by law, but a minimum crown cover percentage after harvesting, equal to the 10% of the initial volume, is required. Moreover, it should be noted that pathogens such as ink disease and chestnut blight resulted to be widespread in the stand, negatively influencing the quality of the products.

2.2. Timber value model

To understand how the structural and logistic features of logging companies operating in the Piedmont Region influence the TV of a forestry operation, a model capable of describing and analysing the whole process was developed. TV is the most common measure used to estimate the value of a mature forest stand (Chang & Gadow, 2010; Faustmann, 1995; Navarrete & Bustos, 2013) and is defined as the value of standing timber, as determined from the sales price at the landing location, minus all harvesting costs (Amacher et al., 2009; Armitage, 1998; Nieuwenhuis, 2000). The model we created examines all the positive and negative items in the economics of the logging operation. Regarding timber revenues, the quantities and market values of the assortments were estimated. As for costs, all the segments of the logging operations needed to perform the harvest were analytically considered, and subsequently formalized into a framework able to take into account different harvest types. The TV per cubic meter was then obtained by dividing this value by the extracted wood volume: this value was used as the reference value in this study and in the following analyses. The data acquisition of all the information necessary to build the TV model, e.g. wood volume, achievable products, hourly yields, machinery costs, manpower costs and market prices, is a complex and accurate operation. In fact, all technical and economic data was collected both in the field or by means of a literature review of relevant studies (Brun & Blanc, 2017; Picchio et al., 2011). This data can be divided into three categories: a) ordinary objective data, namely the organization of the logging operations; b) complex objective data, such as the collected and elaborated dendrometric data; c) estimated information, such as the hourly yield and the opportunity costs from the logging company internal data.

2.2.1. Revenues

The main data source concerning timber revenues is the timber