Forest Policy and Economics 96 (2018) 9–18

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Timber selling policies using bundle-based auction: The case of public forests in Québec

Mikael Rönnqvist[a], Sophie D'Amours[a], Marc-André Carle[a,b], Riadh Azouzi[a,*]

[a] FORAC Research Consortium, Université Laval, Québec, QC G1V 0A6, Canada
[b] TÉLUQ, Québec, QC G1K 9H6, Canada

ARTICLE INFO

Keywords:
Forest industry
Auctions
Natural resources
Québec

ABSTRACT

In the province of Québec, the government provides 25% of the volume of timber that is annually cut in crown forests through sealed-bid one-winner auctions. It was noted that many offers are made for some areas but few or none are made for many other areas. As such, a significant number of the timber volumes remains unsold. However, the combination of areas to form bundles can provide economy of scale that is not seen otherwise. We highlight some issues regarding the current allocation system and we analyse the effectiveness of different bundling systems in maximizing government revenues and enhancing bidders' competitiveness. We use actual forest data to evaluate different rules and strategies for the creation and allocation of partial and full bundles. Our results suggest that the use of the option of bundling forests areas makes the auction process more beneficial to the majority of stakeholders: Government revenues are increased; the bidding companies are more likely to obtain the desired volumes and pay less for harvesting and equipment relocation; and greenhouse gas emissions are reduced.

1. Introduction

In the province of Québec, located in eastern Canada, a new forest regime has been in force since 2013. This regime fosters a competitive timber market for some of the wood available in public forests accounting for more than 90% of the forests in the province. So, the Québec Timber Marketing Board (TMB) was entrusted the responsibility to sell this wood through auctions. During the last five years, the TMB organized several rounds of auctions. At each auction, bidders can bid on as many items as they want, with one bid for each single item. Unfortunately, these rounds of auctions did not prove to be satisfactorily because the number of unsold timber volumes at the end of each round was too high. Therefore, in this article, we aim at improving the methodology for Québec timber sales on the open market using the concept of combinatorial auctions. This is expected to provide economy of scale and an increase in timber sales.

Combinatorial auctions allow bidders to form bundles of multiple heterogeneous items and bid on them. They are an extension to single-item bids, and should be considered when complementarities, indivisibilities, or other complications exist between the different items in a bundle (Jones and Koehler, 2002). They promote efficient pricing and allocation of bundles to bidders with respect to their budgets constraints (de Vries and Vohra, 2003; Zhou et al., 2015; Humphreys et al., 2007). Since the first model proposed by Rassenti et al. (1982), combinatorial auctions have received much attention as an allocation technique with different applications, such as airport landing slots, truckload transportation, and industrial procurement. Yet, less literature can be found on their application for natural resources. It is however known that combinatorial auctions have two challenging problems: (1) the bid generation problem, and (2) the winner determination problem. The resolution of these problems needs to be tailored to the specific details of the situation, and reflect the wider economic circumstances (Wang and Xia, 2005; Klemperer, 2002). In the context of a timber-selling system, it is necessary to consider the spatial nature of the problems. The sawmills and the forest areas are typically located in different regions. Resource constraints on some bidders usually limit the number of combinations bids that they will submit. For his part, the auctioneer needs to establish a true market value for the items sold in bundles. He could restrict the collection of bundles on which bidders might bid in order to overcome the bid generation intricacy, especially as the problem instance gets large. In fact, in mathematical terms, the problem becomes NP-hard, that is the problem cannot be solved in a short (polynomial) period of time (Rothkopf et al., 1998). It may however be solved efficiently by a mixed-integer

* Corresponding author.
E-mail addresses: mikael.ronnqvist@gmc.ulaval.ca (M. Rönnqvist), sophie.damours@gmc.ulaval.ca (S. D'Amours), mcarle@teluq.ca (M.-A. Carle), riadh.azouzi.1@ulaval.ca (R. Azouzi).

https://doi.org/10.1016/j.forpol.2018.07.016
Received 28 February 2018; Received in revised form 29 July 2018; Accepted 31 July 2018

programming (MIP) formulation. Such formulation (most often) only guarantee an optimal solution within some tolerances, i.e., by using bounds on the gap between current solution and a relaxed version of the problem (typically the LP-relaxation; a related linear programming problem that is solvable in polynomial time).

The paper studies two bundle-based bidding systems where companies are allowed to form their own bundles under certain constraints. In “full bundling”, the bidder needs to bid on combinations of stands so that the total volume of the bundled stands covers the bidder's required wood supply through the auctioning system. However, this constraint is relaxed in “partial bundling” where several bundles of smaller volumes are allowed. We analyse the effectiveness of partial and full bundling systems in maximizing government revenues and enhancing bidders competitively. We use actual forest data to simulate and compare the rules that would most likely be put into practice by the TMB for bundles creation along with the auctioning strategies that can be employed by the forest products companies to within the limits of these rules. The remainder of the paper is as follows. In section 2, we present a background on auction systems for natural resources, and explain the current auction system implemented in Québec. Section 3 describes our methodological framework and includes an illustrative example. The case study is described in section 4 while the results are presented in section 5. Finally, section 6 concludes and provides directions for future research.

2. Background

2.1. Auction systems for natural resources allocation

Auctions are defined as market techniques with predetermined set of rules in which bidders compete for the right of resource allocation and for prices (McAfee et al., 1987). The literature identifies four types of auction, two open and two sealed, with First-price-sealed-bid (FPSB) auctions being the most widely used. Governments use them under different forms to transfer natural resources property rights from public to private control (Hendricks et al., 1993; Crowley and O'Connor, 1993). For example, FPSB has been extensively used for allocation problems in the mineral industry (Milgrom, 1979; Milgrom and Weber, 1982) and the oil and gas sectors in the U.S. (Griffin, 2013).

Auction systems for timber allocation are used in many countries. In the United States, several state governments have historically employed both open and sealed bid auctions to sell timber from public forests. Also, an intricate debate on the design of federal timber auctions was early faced. After Mead (1967) published a study arguing that open auctions generate less revenue, the U. S. government proposed the use of sealed-bid auctions. However, forest managers were allowed to use open auctions if they could justify the choice. As a result, different systems were applied in different areas; however, sealed-bid auctions have attracted more small bidders. Recently, the decline in the U.S. stumpage prices has raised questions about the impact of state policies on the price paid for stumpage. According to Brown et al. (2012), more than 60% of the problem refers to state allocation strategies, including the auction method. Moreover, several market-based systems were introduced in Canada following a trade agreement with the U.S. in 2006. Farnia et al. (2013) designed and simulated a sealed first-price multiple round auction. More recently, Farnia et al. (2015) proposed a time-based combinatorial auction that takes in consideration the expected delivery period when allocating products to auction winners. According to the authors, this coordination among auction winners would improve the economic value obtained. Very recently, Boukherroub et al. (2017) proposed a sustainable framework for Canada timber allocation problem. The authors highlighted the importance of allocation strategy to guarantee fairness between forest companies in order to develop a sustainable public resource allocation. Empirical evidence on how the choice of auction conditions affect bidders' competition is scarce. In fact, many auction markets operate under a given set of rules rather than experimenting with alternative designs. Generally, revenue differs among auction types because of differences in the ability to observe market signals. Theoretical models predict that the English auction is more vulnerable to collusion than sealed biddings (Miller, 2014). This effect arises because, under sealed auctions, bidders cannot observe market signals, and thus they overbid. All of the contributions reviewed above on forest allocation problem has developed models based upon the timber auction systems actually in use. In contrast, the design of bundle-based auction system in natural resource markets has not been studied extensively.

2.2. Québec timber auction system

In the previous regulatory regime in Québec, which was effective from 1987 to 2013, the government used to allocate all the volume of timber that can be harvested from public forests to sawmills through timber licenses. In the new regime, the government estimates that at least 25% of the timber that can be harvested from public forests should be sold on the open market (Government of Québec, 2008). The government determines the residual needs of the mills based on the total need of the mills for roundwood (a consultation of timber licenses holders was carried out by the government to obtain information about their timber needs in the next five-year period), and the volumes that are typically consumed from other supply sources (such private forests and other provinces). The mills are then guaranteed to only obtain up to 75% of these residual needs from public forests, and the missing volumes could be obtained from public forests through auctions or procured additionally from other sources. This measure aims at ensuring that market prices can be found or estimated properly for the wood. These prices can then be used to set the prices for wood sold through timber licenses. In order to obtain the best possible and fairest prices, the TMB has to make timber available to as many buyers as possible across all regions of Québec. Mill owners, contractors, cooperatives, forestry groups and log dealers are all permitted to take part in the auctions organized by the TMB. Each year, at least three auctions must be conducted (TMB/BMMB, 2015). Information on the calls for tenders and related forest areas are made available to all parties interested on the TMB website.

Fig. 1 depicts the auctioning process. An auction starts with the posting of a public tender document (DAO) by the TMB. This document provides information about the goods offered in the bid including the volume of timber estimated by species (or groups of species), the geospatial location and the quality of timber, and the time limits. It contains also a rough description of the work related to road and harvest operations. The winner of an auction is selected based on the highest amount submitted for a bid. This amount has to be greater than the reserve price, i.e., the lowest price the TMB is willing to accept for a bid. To avoid bidders' collusion, the TMB has the authority to cancel any auction that received less than three bids. In addition, the TMB does not allow mills that belong to the same company to submit separate bids. In case of ties between two bids, the winner is determined by drawing. Afterwards, the winner has to harvest from the land assigned. The winner can also sell part of the wood harvested to another company.

During the last five years, the TMB offered 1437 forest areas for auction, representing a total of 483,717 thousand hectares of land and near 46 million cubic meters of roundwood (see Table 1). Out of these, only 956 offers were sold, or just over the half of the lots offered each year (66% in average), thus the total auction actual sales were much less than initially expected (the achievement rate was 84% in average). In certain cases, the areas comprise some volumes that are not required to be harvested under the silviculture prescription and are added to the volume permitted, and the winner is free to harvest the additional volumes or not. Most of the offers were accepted as is, but in some cases, the TMB needed to combine certain areas that were very close to each another so that they become attractive, and the companies bid on