Determining Econometric Relationships between Timber Sale Notice Provisions and High Bids Received on Timber Offerings from the Alabama Department of Conservation/State Lands Division

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Abstract

An econometric analysis was conducted with the intent of discovering the relationship between contractual provisions, as specified in timber sale notices, with high bids received for those timber sales. Specifically, the goal of this study was to determine the relationship between high bids for timber tracts and certain contractual stipulations that have not previously been explored to any great extent (such as requirements of landowner assistance and performance bonds, and adherence to forestry Best Management Practices).

Data collected from 105 timber sales conducted by the Alabama State Lands Division of the Department of Conservation from 1966 through 1997 were analyzed using a simple linear regression model. The dependent variable was high bid price per acre. Independent variables included various physical characteristics, number of bidders per timber sale, and specific contractual stipulations that have not been previously examined econometrically.

The results indicate that certain contractual provisions – such as landowner assistance and bonding requirements – exhibit negative and significant relationships with high bids received for Alabama state timber sales, as expected. A dummy variable that related to forestry Best Management Practices provisions exhibited a positive and significant relationship with high bid prices per acre. This result was unexpected.

Introduction

Efficient contracting is important to the free flow of goods and services in a market economy. Well-defined property rights increase the efficiency with which contracting parties exchange goods and services (Meade 1965, Castle 1978). Contracts define the rules by which parties exchange rights to property, and ensure performance during and after the exchange.

Contracting for timber property rights most often involves two or more parties negotiating for exchange of the rights associated with a bundle of physical goods. However, contracting can be very complex, involving several parties bidding on timber offered by the landowner. The winning bidder often contracts with other parties to harvest and haul the stumpage from the land. She may even contract with mills to buy the stumpage after she harvests it. Further, the complexity of the contracts themselves can range from informal verbal agreements to elaborate arrangements for the exchange of large volumes of timber.

From the resource owner’s perspective, one critical aspect of contracting is the amount he receives for the timber. Often, when landowners are ready to sell their timber, they put their tract up for sale and solicit bids from interested parties. It is in the landowner’s best interest to provide as much accurate information as possible in order to reduce information-gathering costs faced by potential bidders. This approach creates a tendency to attract more bidders. Potential bidders will analyze the costs and revenues associated with the proffered timber tract based on the provided information and the information they gather themselves. The bid that is submitted is a reflection of the accuracy of the collected information. Physical characteristics, such as volume of pine sawtimber or pulpwood on a proffered tract, have long been perceived as important indicators of bid amounts.

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However, other timber sale or contractual characteristics may exhibit positive or negative relationships with bid prices. Contractual restrictions made by the seller may negatively impact bid prices. For example, if a seller contractually obligates the buyer to harvest only specifically marked trees instead of clearcutting the entire tract, costs per acre are likely to increase, since the buyer will face higher per-acre harvesting costs. Therefore, many types of contractual restrictions, such as requiring re-planting of harvested areas, observance of forestry Best Management Practices (BMP’s), contract lengths, and other on-site restrictions may cause the bidder to lower her bid price. This is not to say that contractual restrictions are bad. On the contrary, contractual restrictions are expressions by the seller regarding her wishes for the timber tract, and as such are attempts at utility-maximizing behavior. However, they may come at a cost, which sellers calculate and equate on the margin with the benefits that could be gained were the restrictions not in the contract. In a world of imperfect information, however, these calculations may be less than perfect and research into the costs of these restrictions in the field of forestry are few.

The purpose of this study is to analyze timber sale notices published by the State Lands Division of the Alabama Department of Conservation to determine the econometric relationships (if any) between contractual provisions contained in those notices and the high bid for the timber sale.

LITERATURE REVIEW
Bid price determinant studies have been conducted regarding public timber sales (Anderson (1969), Brannman, et. al. (1979), and Johnson (1979)), and private timber sales (Cubbage, et. al. (1985), Hubbard and Abt (1989), Munn and Rucker (1994), and Puttock, et. al. (1990)). They have determined that bid prices are a function of such determinants as the type of sale method employed, assistance from professional foresters (for private timber sales), contractual provisions such as contract length and the type of payment method chosen, and tract characteristics (volume of timber, harvesting costs, types of species on the tract, quality of timber, and ease of access. Guttenberg (1956) analyzed 334 southern pine sawtimber sales from national forests in Texas, Louisiana and Mississippi for a period of January 1949 through March 1955. His focus was in relating stumpage price variations to physical, measurable timber characteristics, such as volume sold, cut per acre, and quality. He found that purchasers tend to pay a premium for higher quality timber, that stumpage prices paid increases with the total volume offered and with its volume per acre, that stumpage prices paid decreased with increases in hardwood/pine ratios, and that stumpage prices are associated with changes in the wholesale market price for southern pine lumber. His results were consistent for all three states. There have been numerous other studies of bidding behavior in timber markets.

THEORY AND METHODS
The typical market participants involved in exchanging property rights associated with Alabama state-owned timber include the Alabama State Lands Division (on the seller side) and wood dealers, lumber mills, and paper mills (on the buyer side). The State Lands Division prepares a timber sale notice (TSN) which contains information it hopes will attract a significant number of buyers to the sale. The TSN contains such provisions as tract location, tract composition, and expected contractual arrangements. Historically, these contractual arrangements included the time period for which the contract was in effect, whether or not a security bond must be forwarded and the amount of that bond, and other basic contractual obligations.

When new economic forces arise, there exists a need and a desire to define (or re-define) property rights so that externalities are internalized (Demsetz 1967). Such is the case with the State Lands Division. In the 1980’s and 1990’s, the State—reflecting the character of a public which had evolved a higher environmental acumen—acknowledged (through their contractual provisions) there were externalities associated with its timber sales. For example, the harvesting techniques used on its timber tracts may have caused undesirable environmental damage. In some cases, the State Lands Division required winning bidders to prepare and replant a site after harvesting it. Therefore, in certain (not necessarily all) timber sale notices, the State Lands Division wrote provisions which signaled the potential bidders that they would be required to follow best management – type provisions and would have to provide landowner assistance (such as engaging in site preparation, installing firebreaks around the site, and replanting).

It is the degree of explicitness extant in a contract that determines the amount of inefficiency present. The State Lands Division, facing increasing marginal costs associated with supplying additional units of information, and decreasing marginal benefit gained from supplying marginal units of this
information, supplies its optimal amount of information in the precursor to the contract, the timber sale notice (TSN).

Bidders utilize the information provided in the TSN to prepare bids. Bidders are not, however, “information takers.” They also gather information necessary to provide what they hope to be a winning bid. This includes tract accessibility, logability, and other factors affecting both their ability to log and harvesting costs. They will also ascertain, through timber cruises, the quality and quantity of timber available. They may also contact the State Lands Division to provide them with more elaborate information regarding contractual provisions.

Perfect information rarely exists in the market economy, yet information is garnered and transferred by contracting parties in an attempt at contracting efficiency. The goal is to achieve as much information as possible at a “reasonable” cost. The public timber sale notice provided by the State Lands Division represents the method by which it conveys information regarding the timber sale to potential bidders. These bidders will adjust their bids based both on information they acquire regarding the physical characteristics of the site (usually through a first-hand site survey) and on the contractual restrictions put forth in the TSN by the State Lands Division.

The model used in this study is a hedonic model developed for analysis of consumer choice by Griliches (1971), Rosen (1974), and Freeman (1979). It relies heavily upon the theoretical framework developed by Munn and Rucker (1994) in their analysis of the role of consultants in private timber sales. The hedonic model represents the equilibrium price that is determined by supply and demand and is assumed to be exogenous to individuals.

The selling price for a given State Lands Division timber sale is dependent upon physical and contractual characteristics and is represented by the following hedonic equation:

\[ P = f(z_1, z_2, \ldots, z_n) \]  

(1)

Where \( P \) is the high bid price per acre for a proffered tract and the \( z \)'s are \( n \) levels of tract characteristics.

Bidders are the potential buyers of stumpage offered by the State Lands Division; therefore, their actions constitute the demand side of the equation. Munn and Rucker offer that bidders use stumpage as one of the inputs in the production of delivered products. Therefore, the production function for a bidder is:

\[ I(x, z, w) = 0 \]  

(2)

where \( x \) is a vector of inputs and outputs not including the timber tract, \( z \) is a vector of timber tract characteristics, and \( w \) is a vector of bidder characteristics that influence the bidder’s productive availability. However, because of the historical nature of the collected data, it is impossible to determine relevant structural information for each of the bidders that bid on State Lands Division timber sales. Therefore, for purposes of this study, it is assumed that all potential bidders are homogeneous and have equal access to State Lands Division timber sales and their productive abilities are equal. The resulting production function is, therefore:

\[ I(x, z) = 0 \]  

(3)

According to Munn and Rucker, a potential bidder will be willing to pay a certain amount for a proffered tract based upon his “gross profit,” which is the difference between total revenues and total costs, including opportunity costs of capital and time (Palmquist 1984). The bidder’s objective, then, is to maximize gross profits subject to the production function, or:

\[ \max_x \quad G \pi_B = \sum_{i=1}^n p_i x_i, \quad \text{s.t.} \quad I(x, z) \]  

(4)

where \( G\pi_B \) is the gross profit for the buyer and \( p_i \) is the price for each \( i \) netput, which are delivered prices for different outputs and prices for nontimber inputs. The net profit would be the gross profit less the bid price. Theoretically, in a perfect market with competition the actual or net profit (economic profit) would be zero. However, for purposes here it is assumed that profits can be realized and that a “desired level of profit” can be achieved (Palmquist 1989). The bidder’s bid function is, therefore:

\[ \text{Bid}(z, p, \pi^d_B) = G\pi_B - \pi^d_B \]  

(5)

where \( \pi^d_B \) is the desired profit level.
The State Lands Division in reality is not a “bid taker.” In other words, it does not have to accept the high bid for a proffered timber sale. The (TSN) states that the State Lands Division reserves the right to refuse all bids and on occasion this did happen. However, this analysis uses simple linear regression to analyze the hedonic demand function; therefore, there is an implicit assumption in the model that the State Lands Division is a “bid taker.”

It is important to understand that it is not the contract itself that provides the bidder with the information needed to make bids. The contract is written and executed after bids have been solicited and a winner announced. Rather, it is the timber sale notice that provides potential bidders with information necessary to submit a bid.

For the econometric model, high bid price is a function of a series of physical and contractual variables placed in the TSN, and takes the following general form:

\[ BP = f(\text{one}, p_1 \ldots p_n, n, x_1 \ldots x_n) \]  (6)

where \( BP \) is the high bid price per acre, \( \text{one} \) is the constant (y-intercept) for the equation, \( p_1 \ldots p_n \) is the list of independent variables associated with physical site characteristics, \( n \) is the number of bidders bidding on a sale, and \( x_1 \ldots x_n \) is a list of independent variables associated with provisions or stipulations put forth in the TSN.

The variables used in this study were based on stipulations provided in 105 Alabama State Lands Division timber sales and associated timber sale notices. The data was collected in June, 1997 in Montgomery, Alabama. The timber sales span a period of 1966 – 1997.

There are some variables that have been shown to be significant in previous studies, and therefore should be included in any study analyzing bidding behavior for stumpage. These variables include the volume of pine sawtimber per acre, the contract length, and the number of bidders per timber sale. Originally, all stipulations, as they were stated in the TSN’s, were placed into the regression equation as individual dummy variables. For example, some TSN’s contained provisions stating that the winning bidder had to repair all logging roads following completion of the harvest. Therefore, a “logging roads” dummy variable was created to account for this provision. However, correlation problems arose, mainly because of the interaction between certain dummy variables.

For example, if the TSN contained a provision stating that the winning bidder had to site prepare the land following harvest, that same TSN generally had several other “landowner assistance” provisions also, such as replanting, applying herbicides, and installing firebreaks around the site. Therefore, dummy variables of provisions that were very similar (site preparation, re-planting, and firebreak installation) were combined into one general dummy. There were two of these variables in the regression; one for landowner assistance provisions and one for best management practices provisions. The specific model is presented below with anticipated signs:

\[ \text{HIGHBID} = f(\text{TIme (+), PINSTVPA (+), HWSTVPA (+), PINEPPA (+), CULLTPA (-), NUMBIDRS (+), PBAMTREQ (-), BMPDUM (-), LADUM1 (-), DISTANCE (-)} \]

where,

- \( \text{TIme} \) = the contract length,
- \( \text{PINSTVPA} \) = the volume of pine sawtimber in board feet per acre;
- \( \text{HWSTVPA} \) = the volume of hardwood sawtimber in board feet per acre;
- \( \text{PINEPPA} \) = the volume of pine pulpwood in cords per acre;
- \( \text{CULLTPA} \) = the number of cull trees per acre;
- \( \text{NUMBIDRS} \) = number of bidders per timber sale;
- \( \text{PBAMTREQ} \) = the amount of the performance bond as a percent of the high bid per acre, when required;
- \( \text{BMPDUM} \) = a dummy variable for whether or not a best management stipulation occurred in a given TSN. The best management dummy was composed of five contractual provisions: (1) whether or not access was restricted, (2) whether or not the bidder had to repair roads used during harvesting activities, (3) whether or not a penalty was assessed for damage to residual trees, (4) whether or not the bidder had to protect streamside management zones, and (5) whether or not the bidder was responsible for logging debris. Other minor provisions were dropped because of the insignificance of their occurrences;
- \( \text{LADUM1} \) = a dummy variable for whether or not a landowner assistance stipulation occurred in a given TSN. The landowner assistance dummy variable was composed of four provisions: (1) whether or not the bidder had to replant the site, (2) whether or not the bidder had to perform a chemical site preparation, (3) whether or not the bidder had to perform a prescribed burn site preparation, and (4) whether or not the bidder had to install fire breaks.
around the site. Other minor provisions were dropped because of the insignificance of their occurrences; and DISTANCE = the distance in miles from the winning bidder’s operation to the timber tract for sale.

RESULTS

The regression results are presented in Table 1. The model was corrected for heteroscedasticity, or unequal error variances, by the Limdep econometric software program, produced by Econometric Software, Inc. Limdep uses White’s (1978) consistent estimator as part of the regression analysis to produce a robust covariance matrix. However, the correction for heteroscedasticity performed by Limdep does not change the coefficient estimates, nor does it necessarily change the standard errors (Greene 1998). The R² for this model was 0.6682.

The coefficient value for the contract length variable TIME indicates that each month added to the contract length increased the high bid per acre by $11.62. This level bolsters a hypothesis that one way in which the negative dollar effects of contractual restrictions can be offset is by allowing greater amounts of time to complete the harvest.

The coefficient value for the volume of pine sawtimber per acre (PSTVPA) indicates that each additional board foot of pine sawtimber per acre offered in a timber sale resulted in a $0.14 (real 1982 dollars) increase in high bid per acre.

The coefficient value for the volume of hardwood sawtimber per acre (HWSTVPA) indicates that each additional board foot of pine sawtimber per acre offered in a timber sale resulted in a $0.06 (real 1982 dollars) increase in high bid per acre.

The coefficient value for the volume of pine pulpwood per acre (PINEPPA) indicates that an additional cord per acre offered in a timber sale brought an additional $30.89 (real 1982 dollars) per acre by the high bidder.

The coefficient value for the number of bidders per timber sale indicates that each additional bidder attracted to a State Lands Division timber sale brought an additional $33.26 (real 1982 dollars) per acre in the high bid. More bidders theoretically mean a lower probability of success at winning the bid for each bidder, all other considerations remaining constant. With more bidders participating in the sale, the uncertainty level rises for each individual bidder. Therefore, the winning bid tends to be higher for timber sales when there are more bidders.

The coefficient for the PBAMTREQ variable indicates that for each additional percent of the high bid required in a performance bond, the high bid per acre decreased by $3.27 (real 1982 dollars) per acre. This presents a good indication of the negative dollar impact contractual provisions can have on price. In this case, the State Lands Division introduced performance bond requirements to ensure that contractual provisions regarding landowner assistance were met. If the contractual provisions were not met within the specified time, the State Lands Division could withhold the performance bond as payment against the forfeited portion of the contract. Depending upon the number of landowner assistance provisions in the contract, the performance bond rate could be very high, as much as 125% of the high bid amount in cases where there were numerous landowner assistance stipulations for large acreage.

The value for PBAMTREQ indicates that bidders were aware of the time value of money and the opportunity costs associated with giving up cash as a performance bond for a sometimes significant period of time (sometimes as long as three years). Bidders took these costs into account when calculating bid amounts for State Lands Division timber, and adjusted their bids accordingly.

The LADUM1 coefficient value of -235.70 indicates that the winning bidder reduced his bid by $235.70 per acre each time a landowner assistance provision was included in the TSN. The significant negative value for the LADUM1 variable indicates that bidders did take into account the effects these provisions have on their costs, and subtracted them from the total bid accordingly.
The coefficient value for the Best Management Practices dummy variable means that each time a TSN included a best management provision, the bid price per acre increased by $166.87 (real 1982 dollars). The variable was significant at 99%.

The CULLTPA and DISTANCE variables were not significant at 5%.

There is no easy explanation that can be grounded in theory for the unexpected sign for BMPDUM, just as there is no plausible reason for expecting bidders to bid more for a tract of timber when more best management stipulations are put into the TSN, all other considerations held constant. BMPDUM is not significantly correlated with any other explanatory variable in the model.

One hypothesis would be that an institutional change occurred at some point during the study period (1966–1997) and this structural change impacted BMPDUM adversely. For example, real stumpage prices increased markedly beginning in the late 1980’s and early 1990’s and continued through 1997. If the best management provisions had begun occurring during the same time period, there might be indications that high bid per acre was moving positively as a result of this institutional market change and was reflected in BMPDUM. However, had that been the case, the best management practice dummy variable would have been positively correlated with stumpage prices. An earlier iteration of the regression was tested using two different price series. The stumpage price variable was not significant, and no correlation existed between the stumpage price series and BMPDUM.

A more likely scenario is that BMPDUM moves with a site quality variable unaccounted for in the data. For example, the State Lands Division might have naturally required more best management provisions be followed on environmentally or ecologically sensitive sites. These sites may have also been more appealing to bidders because they (1) had better access or (2) contained higher quality timber because of inherent site characteristics such as better soils. There is no way to be certain with this particular database, given that data extends back to the mid-1960’s.

Table 1. Results of hedonic linear regression model (corrected for heteroscedasticity), with coefficient values, significance, standard errors, and t-ratios.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P[°T° • t]</th>
<th>Standard Error</th>
<th>t-ratio</th>
</tr>
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<tr>
<td>CONSTANT</td>
<td>-259.84</td>
<td>0.00457</td>
<td>89.438</td>
<td>-2.904</td>
</tr>
<tr>
<td>TIME</td>
<td>11.624</td>
<td>0.01916</td>
<td>4.8778</td>
<td>2.383</td>
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<tr>
<td>PINSTVPA</td>
<td>0.14351</td>
<td>0.00000</td>
<td>0.016292</td>
<td>8.809</td>
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<tr>
<td>HWSTVPA</td>
<td>0.061298</td>
<td>0.02027</td>
<td>0.025964</td>
<td>2.361</td>
</tr>
<tr>
<td>PINEPPA</td>
<td>30.887</td>
<td>0.00318</td>
<td>10.204</td>
<td>3.027</td>
</tr>
<tr>
<td>CULLTPA</td>
<td>-2.8214</td>
<td>0.30245</td>
<td>2.7212</td>
<td>-1.037</td>
</tr>
<tr>
<td>NUMBIDRS</td>
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<td>0.00822</td>
<td>12.320</td>
<td>2.700</td>
</tr>
<tr>
<td>PBAMTREQ</td>
<td>-3.2689</td>
<td>0.00975</td>
<td>1.2392</td>
<td>-2.638</td>
</tr>
<tr>
<td>BMPDUM</td>
<td>166.87</td>
<td>0.01032</td>
<td>63.763</td>
<td>2.617</td>
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<tr>
<td>LADUM1</td>
<td>-235.70</td>
<td>0.00118</td>
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<td>DISTANCE</td>
<td>-0.31630</td>
<td>0.15227</td>
<td>0.21917</td>
<td>-1.443</td>
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</table>

CONCLUSION
Overall, the model is useful in its ability to ascertain the relationship between contractual provisions and bid prices for State Lands Division timber sales. The values obtained for the physical site characteristic variables—PINSTVPA, HWSTVPA, and PINEPPA—indicate that the model is consistent with previous studies that attempted to model bidder behavior.

Contractual stipulations, including those specifying the amount of performance bond that had to be paid to the State Lands Division and whether or not landowner assistance provisions occurred in TSN’s, displayed negative relationships with the high bid per acre. Of those variables, only that for number of cull trees per acre was insignificant. However, all three indicated that there were costs associated with certain contractual stipulations, and these costs were...
considered and accounted for by bidders. The degree to which TSN’s provided the total amount of necessary information that bidders require to submit a bid is unknown, as is the amount of transaction costs associated with these stipulations (particularly the landowner assistance provisions). Had there not been such a high degree of correlation present between landowner assistance variables in the model, an estimation of transaction costs associated with landowner assistance provisions might have been possible. 

Other contractual stipulations, such as the contract length and whether or not best management provisions occurred in a TSN, indicated that certain contractual stipulations could be positively related with bid prices. The longer the contract length, the higher the bid price, all other considerations held constant. Increasing contract length can dampen the negative effects of other contractual stipulations such as landowner assistance. Landowners contemplating the sale of timber may wish to consider lengthening the contract period in cases where the contract will contain negative stipulations. However, care must be taken to forecast the increased bid prices brought about by longer contractual periods and balance this against possible losses (such as allowing the timber to grow beyond the optimal harvest period and therefore incurring additional opportunity costs) arising from this longer period. Increasing the number of bidders by making the timber sale more attractive can also help offset negative contractual stipulations. 

The positive and significant result for the best management dummy variable is counter to expectations and warrants further study in the future. Perhaps more research in this area through the attainment of more data could provide clues as to whether or not this variable was correctly specified in this model and whether best management provisions do indeed negatively influence bids. 

This econometric study indicates that information provided in timber sale notices is critical in helping potential bidders decide how much their bids should be, as evidenced by the significance of the variables in the model. Bidders take the information provided in the timber sale notice and calculate their bids based on their experience regarding the costs associated with various contractual provisions. In perfect stumpage markets, these calculations can form the sole basis by which bids are submitted. Of course, the markets in which the Alabama State Lands Division offered timber were not perfect, for if they were, no contract disputes would arise. However, the timber sale notices provide information that bidders use to make efficient and productive decisions, given this world of imperfect information and substantive transaction costs. 

LITERATURE CITED


