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Identifying the Factors Distinguishing Timber Sales on Industrial and Non-industrial Private Forest Lands in Arkansas

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Abstract

Although forests provide a wide variety of products and services, timber still continues to be the most valued forest product in the marketplace. More than two-third of the nation's forests are under private control, some are owned by industries (about 10%) while a much larger portion (about 59%) is owned by individuals. This study investigates the differences between timber sales offered by industrial and non-industrial ownerships. A test of means revealed that there is a significant difference between per hectare bid for these 2 types of sales. A logistic regression model was then estimated to identify important factors characterizing this difference. Results indicated that industrial forests were more likely to obtain higher bids. They were also more likely to have shorter contract lengths. Industrial ownerships were found to be more likely to have clearcuts. However, they had a higher likelihood of restricting harvesting during wet-weather conditions. Forest industries were also found to be less likely to have pulpwood for sale than non-industrial private owners.

Introduction

Appropriately called the "Natural State," Arkansas has approximately 7.6 million hectares of forests within her borders. These resources, along with the associated forest sector industries, provide significant contributions to the state's economy. In 2002, these forests produced 21 million cubic meters of industrial roundwood (U.S. Forest Service, 2004). In addition to these tangible economic benefits, Arkansas' forests also provide various recreational and environmental services. Some of these services, such as camping, fishing, and hunting, also provide economic benefits to the state's economy (Williams and Kluender, 1997).

The study of economics is primarily concerned with efficient allocation of goods and services to competing demands within the society. In a market-based economy, this allocation is achieved through the operation of the market. The market operates through numerous transactions that reflect the exchange of goods and services available within the marketplace. This transfer of goods and services is also a transfer of property rights. The "bundle of rights" to a good is relinquished through its sale in the marketplace, resulting in a market transaction. Market transactions, however, often involve costs known as transaction costs, which include items such as the costs of contracting.

An estimated 159 million ha of forests in the U.S. are privately owned. About 59% of all non-government forest owners are non-industrial private forest (NIPF) landowners (Birch, 1996). NIPF lands currently supply about half of the country's demand for wood fiber. This number is expected to rise to about 60% by the year 2030 (Haines, 1995; Harrell, 1989). This increase is primarily due to a sharp decline in supply from public forests caused by a general shift in public forest management due to environmental concerns and production of amenity goods (Smith et al., 2001; Mehmood and Zhang, 2001; Mehmood and Zhang, 2002). In Arkansas, the proportion of NIPF landowners within total number of forest landowners has traditionally been very similar to the national average. Additionally, about a quarter of the state's forests are owned by the forest products industry (Birch, 1996).

These two types of private forest ownerships, namely NIPF and industrial, have significantly different characteristics. Industrial forests are usually owned by public companies and are therefore intensively managed for wood products in order to maximize profit for the shareholders. This focus on profit maximization leads to management efficiency and minimization of waste. Non-industrial forests, however, are owned by numerous individuals and occur in a wide variety of parcel sizes ranging from a few ha to thousands of hectares. These owners also have a wide variety of management objectives including timber, recreation, and aesthetics. Due to this diversity of objectives and a widespread lack of knowledge regarding forest management, the level of efficiency in the management of NIPF forests is low. This low level of efficiency leads to waste of scarce resources. Existing literature in NIPF management is a testament to this fact.

Our objective was to investigate the differences between timber sales on private industry-owned and non-industry-owned forest lands in Arkansas. In order to achieve this objective, we identified the significant factors distinguishing timber sales from these two types of private ownerships. Knowledge of such factors may provide some insights on possible efforts toward gaining economic efficiency in NIPF forest management.

Materials and Methods

For this study, sealed-bid, timber-sale data from the state of Arkansas were used. The data were collected from a variety of sources across the state including private consultants, the Arkansas Forestry Commission, and the U.S. Forest Service. The materials collected from these sources included bid abstracts, prospectus, and timber-sale contracts. Once these materials were collected, the necessary information contained within these documents was identified and compiled in a spreadsheet. The final data set contained information on 625 timber sales that occurred in 38 counties around the state (Dahal and Mehmood, 2005). For this study, however, only the data from industrial and NIPF lands were used, resulting in a sample size of 436 observations.

A two-sample test of means (t-test) was first performed on the data to determine if there is a significant difference in per hectare bid price for timber sold on these two types of ownerships. The data were then used in a binomial logistic regression model in order to identify the important distinguishing factors of timber sales on industrial and non-industrial private forest ownerships.

The specific model estimated through logistic regression was as follows:

OWN = *f* (BIDPERHA, CLENGTH, NOOFBIDS, HVSTTYPE, WETWEATH, PSTPERHA, PPWPERHA, HSTPERHA, HPWPERHA)

The dependent variable, OWN, represents the type of ownership. This is a binary variable that takes the value of one when the sale is on industry-owned land, and is zero otherwise. The first independent variable, BIDPERHA, represents bid price per hectare of forest from the winning bid. Since industrial forests are relatively more intensively and efficiently managed, we expect this variable to have a positive sign. CLENGTH is the length of the contract for harvesting timber, expressed in number of days. Again, since the level of efficiency on industrial ownerships is high, the length of the contract in those cases is expected to be short. Therefore, we expect this variable to have a negative sign.

The next explanatory variable, NOOFBIDS, represent the number of bids received for the sale. It is difficult to form an *a priori* expectation for this variable since number of bids could be a function of any number of other factors. However, conventional wisdom would suggest that since timber from industrial forests may be perceived as high quality due to intensive management, these sales are likely to receive a higher number of bids. HVSTTYPE represents the method of harvesting employed in each timber sale. This is a dummy variable that takes the value of one if any type of selection harvest is employed and zero when the stands are clearcut. Since selection harvest imposes a cost on the timber buyer due to the extra time and effort required in harvesting and because of the relative difficulty of moving logging equipment around the tract, industrial owners are more likely to opt for clearcuts. Therefore, we expect this variable to have a negative sign.

The variable WETWEATH represents whether or not the timber sale has a restriction on logging during wet weather conditions. Logging during wet conditions has a higher likelihood of causing soil erosion and impairment of water quality. If timber is not harvested during wet weather, it imposes a cost on the buyer. This would imply that strictly on the basis of economic efficiency, industrial owners would be more likely to allow wet-weather logging. However, there are voluntary policies in place to prevent such damage, known as the Best Management Practices (BMPs). Due to their commitment to the Sustainable Forestry Initiative (SFI), forest products industries adhere to strict guidelines regarding logging in wet weather conditions and implement BMPs to prevent soil and water damage. Therefore, we expect industrial timber sales to forbid wet weather logging. Consequently, we expect a negative sign for this variable.

The following four variables, PSTPERHA, PPWPERHA, HSTPERHA, and HPWPERHA represent the amount of pine sawtimber, pulpwood, hardwood sawtimber, and pulpwood in the sale, respectively. These variables are included to determine if the types of primary wood products available for sale are different by ownership. These variables also have quality implications for forest products from different types of ownerships. In general, because of aforementioned management efficiency reasons, products from industrial ownerships are more likely to be of higher quality. This implies that industrial ownerships are more likely to have a larger amount of sawtimber for sale rather than pulpwood since sawtimber is the higher valued product. Additionally, the market for pulpwood thinnings in Arkansas is not as well developed as some states in the Southeast such as Georgia and Alabama. Therefore, we expect the two sawtimber variables to have positive signs and the two pulpwood variables to have negative signs.

Since the dependent variable is binary, a logistic regression procedure is used to estimate the model. In binomial logit models, probabilities are assigned for each of the two possible outcomes for the dependent variable (i.e. industrial and non-industrial ownerships).

In this case, these probabilities are:

$$P(Y_i = 1) = P_i = \frac{e^{X_i\beta}}{1+e^{X_i\beta}} \quad \text{and}$$

$$P(Y_i = 0) = 1 - P_i = \frac{1}{1+e^{X_i\beta}}.$$

Where P_i represents the probability that a timber sale took place on industrial land, and $X_{i\_}$ is a standard regression notation representing the right side of a regression model in matrix terms. Unlike ordinary least squares (OLS) regression, the logistic procedure involves estimating the regression parameters by maximizing a likelihood function. The likelihood function that is maximized can be expressed as

$$L = \prod_{i=1}^{n} P_i^{y_i} (1 - P_i)^{(1-y_i)}.$$

The coefficient estimates in logistic regression do not have the same implication of per unit impact by each individual independent variable on the dependent variable as in the OLS case. In order to draw such implications parallel to the OLS case, marginal effects for each independent variable are calculated as follows,

$$\frac{\delta P_i}{\delta X_i} = P_i(1 - P_i)\beta.$$

Results and Discussion

The t-test of mean bid price per ha was performed using SAS version 8.2. Results of this test along with some descriptive statistics are presented in Table 1. T-test results revealed that there indeed is significant difference between winning bid prices per hectare for timber sales on industrial and non-industrial private forest ownerships. The t-test was performed assuming that the variances of these two samples were not equal.

Table 2, on the other hand, presents the estimates of the logistic regression model. The log-likelihood test (analogous to F-test in the OLS case) was significant at the 99% confidence level. There were no large correlations among the variables in the model. Standard tests for specification errors did not reveal the presence of such errors. Most of the variables had expected signs. The only exceptions were the two sawtimber volume variables. Contrary to our *a priori* expectations, these variables had negative signs. However, they were not significant; therefore no statistical implications could be drawn for these two variables. Additionally, the variable representing the number of bids received in each sale was also not significant.

The variable representing winning bid price per hectare was positive and significant at the 99% confidence level. This implied that industrial landowners have a higher probability of receiving a higher bid price for their timber. As mentioned earlier, forests under industrial ownership are likely to be comparatively more efficiently managed with the help of the best available knowledge on forest management techniques. Management of these forests is optimized for timber production. Therefore, these forests are more likely to have better quality products. Additionally, industrial landowners have up-to-date market information and have better access to the market. Because of these advantages over non-industrial ownerships, it is not a surprise that industrial owners would be able to obtain higher revenues from timber sales.

The variable contract length was negative and significant at 99% confidence level implying that industrial ownerships are more likely to have a shorter contract length for timber removal. This result is also a function of the higher efficiency on industrial lands. Industrial owners, due to their expertise and current information on the forest products market, are better able to negotiate with timber buyers so that the timber can be harvested in the shortest possible length of time.

The method-of-harvest variable was significant at 99% and had a negative sign. Since this variable took a value of one if some type of selection harvest was employed, the sign indicated that industrial landowners were more likely to employ clearcutting rather than selection harvests. Selection harvesting has significant cost implications associated with it. For instance, it is more time consuming to selectively harvest a site. It is also difficult to move harvesting equipment in such a site. Therefore, selection harvest requires additional time in planning and execution and a considerable amount of additional resources, thereby contributing to the cost of harvesting. Therefore, it is expected that a profit maximizing firm would minimize cost by employing clearcuts where possible. It should be noted here, however, that by the inclusion of this choice of harvest method variable we do not intend to make any implication regarding the health and soundness of forest management. Rather, the only intended implication is purely economic in nature. Our basic argument is that since clearcutting is the least-cost method of harvest, profit-maximizing firms are more likely to choose clearcutting over other methods. The nature of management (even or uneven aged), however, could have some impact on the choice of harvesting method.

As expected, industrial landowners were more likely to minimize logging during wet weather conditions. The variable was significant at the 99% confidence level. This is indicative of the forest products industry's (at least those that are members of the American Forest and Paper Association, which include almost all of the large forest products firms) commitment to the Sustainable Forestry Initiative that they would strictly adhere to state BMP prescriptions. We weather logging also increases the cost of road maintenance. Therefore, profit-maximizing firms are likely to avoid such costs. Both pine and hardwood pulpwood volumes were negative and were significant at the 95% confidence level. These variables represent the amount of pulpwood that was being offered for sale. The results indicated that industrial landowners were less likely to have a large amount of pulpwood for sale. Pulpwood is a significantly lower-valued product compared to sawtimber. Profit maximizing firms are therefore expected to opt for the higher valued product. Additionally, pulpwood prices have been very low in the recent years. This result, therefore, may also be indicative of forest landowners' response to market conditions.

Conclusions

Results from the logistic regression estimates identified the important factors distinguishing timber sales on industrial forest lands from non-industrial private forest lands. The results indicated that efficiency, both in forest management and business decisions, was the key factor. Due to this efficient management, industrial landowners are more likely to minimize costs and make better economic decisions regarding product and timing. Information is an important component in this regard. Providing better information on forest management techniques and market conditions to non-industrial private forest landowners would be an important step in making these lands more productive and efficiently managed. While NIPF landowners would still have to overcome a host of other obstacles such as differences in financial investment, and access to markets; this could still help in reducing the waste of natural resources and in opening more land to non-timber uses and services from forests.

Table 1. Descriptive statistics and t-test results.

Group	N	Mean bid/ha	St. Dev.	St. Error
Non-indus.	211	2918.18	1978.80	136.23
Indus	225	6881.61	2411.50	160.77

<u>Hypotheses</u>

Null: $_{\text{Non-indus}} - \mu_{\text{Indus}} = 0$

Alternative: $_{\text{Non-indus}} - \mu_{\text{Indus}} \neq 0$

***t*-statistic**	**DF**	***P*-value**
-18.81	426	< 0.0001

Table 2. Estimates of the binomial logistic regression.

Variable	Coefficient (*t*-statistic)	Marginal effect (st. error)	Mean of variable
Constant	-1.20*** (-5.04)		
BIDPERHA	0.0004*** (2.98)	0.00009 (0.00003)	4963.52
CLENGTH	-0.004*** (-6.03)	-0.008 (0.001)	533.71
NOOFBIDS	-0.02 (-0.19)	-0.004 (0.02)	6.82
HVSTTYPE	-3.06*** (-3.66)	-0.73 (0.19)	0.35
WETWEATH	-2.48*** (-3.89)	-0.59 (0.15)	0.38
PSTPERHA	-0.000008 (-0.32)	-0.000002 (0.000006)	13438.65
PPWPERHA	-0.0006** (-2.56)	-0.0002 (0.00006)	420.05
HSTPERHA	-0.00009 (-0.51)	-0.00002 (0.00004)	797.44
HPWPERHA	-0.0006** (-2.46)	-0.0001 (0.00006)	805.83
Log-likelihood		-50.15	
Restrict. log-likelihood		-301.99	
Chi-square		503.67***	
No. of Observations		436	

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