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FUTURES MARKETS AND THE RESERVATION PRICE OF STUMPAGE

by

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1. Introduction

The Forest Service and other landowners appraise stumpage before it is sold to establish a minimum or reservation price. Establishing a minimum price for a sale is protection against both a less-than-competitive market and poor sale timing. It is also a method of projecting operating revenues. The Forest Service's method-of-sale appraisal is based upon an engineering economic estimate of harvest costs, a cruise of the timber volume and a prediction of timber price based upon a moving average of timber prices of previous years. With the inflation rates of the late 1960s, the 1970s, and the first year of the 1980s, these projections of stumpage prices have been much lower than the actual bid prices for stumpage. This large difference between reservation price and bid price, called an overbid, defeats the purposes of establishing a reservation price: insuring a competitive return and projecting revenues.

The examination of overbid as evidence of collusion dates to Mead's allegation of oligopsony in the purchase of Douglas fir stumpage. Mead took the sale of timber at its appraised value as evidence of a less-than-competitive market, a view that was not by any means generally accepted. Bentley, for instance, believed that overbid or its lack could be explained by market conditions. Essentially, in a down market, operators would operate between average variable cost and average cost, while in a hot market they would make pure profits. This, Bentley believed, explained why some sales went for appraisal and others did not. Haynes, writing a decade later and arguing from a time series of sales in the

Pacific Northwest, redefined overbid as the high bid less the appraisal, as opposed to Mead's ratio formulation. Haynes regressed overbid on sale characteristics and number of bidders and concluded that sales with low or no overbid were less desirable sales. In other words, failure of the appraisal--over appraisal--and not collusion caused the seemingly non-competitive bids. Haynes discovered one more thing of interest here: the size of the real overbid shows no time trend in his sample period. This observation makes it easy to provide an estimate of the high bid given the appraisal: multiply by about 2.

Haynes regression technique is an hedonic regression, the regression of a price on a set of characteristics. The technique seems to have been first discovered by Waugh and was popularized by Griliches and Adelman. Rosen, however, provides the first rigorous theoretical backing for its use. This technique was used by Jackson and McQuillan to predict high bid. They adjusted for log size in a novel fashion--the relative value of a tree was $a + b \ln(\text{diameter})$ where a and b were coefficients in the regression. Their regression statistics and signs were all appropriate, and they were able to explain a large part of the variance in high bid. The magnitude of their coefficients, however, implies that doubling the product price will not be anywhere near double the bid, which is silly.

All these previous studies and the Forest Service's appraisal methods have in common a reliance on current or past prices to explain a bid for the right to cut timber in the future. The use of current prices is one reason why reservation prices are so poor a prediction of market

price. This paper uses futures prices to construct a very simple estimate of the actual price, and, using data from the Siuslaw National Forest, it tests the new method against several variants of the Forest Service's method. Finally, the new prediction equation is used to show how inability to make accurate predictions can account for bids on some sales at or near the minimum bid.

2. The Current Appraisal Method

Before describing a new method for valuing timber, we will outline the current Forest Service procedure for preparing a sale and point out how these procedures result in large overbids. The Forest Service appraises timber at the value that a middle cost mill would willingly pay (see Bentley). To get this appraisal, they subtract conversion costs (stump to log) and manufacturing costs (log to product-from-product selling price).

The process begins with the derivation of log values by grade and diameter. These values come from mill studies; logs are tracked through the milling process and their breakdown is noted; the products are priced at market giving the value for the products in the log. The cost of manufacturing, including a profit allowance, is subtracted from the value of the product, and the resultant number is the value of the log. (These numbers are tabulated in Appendix section 414.22 of the Timber Appraisal Handbook.) The problem with this part of the appraisal is two-fold: (1) The mill study happens long before the sale so that the selling prices are out of date. The Forest Service uses an index of general lumber and plywood prices to adjust these values which provides an

imperfect but workable solution. (2) The Forest Service, by design, has not chosen to collect the costs of the most efficient producer--presumably to give other producers the opportunity to bid. Without a statistical sample of mill costs across mills, the choice of a middle-cost mill is just a well-educated guess.

The second part of the appraisal process models the stump-to-log conversion. From a timber cruise, the Forest Service estimates the volume by log grade, diameter, and species of the timber. They price this volume using log prices developed from the mill studies. From this value they subtract an engineering economic estimate of the stump to mill costs. The result is what some hypothetical middle efficiency producer could pay for the timber.

Thus, the intent of the Forest Service is to produce, as an appraisal, a reservation price based on what a middling producer could pay. Part of the overbid certainly results from this decision, but, in an inflationary era, part of the overbid must also result from the pricing of the timber for immediate harvest, when in fact, the purchaser has several (often five) years to cut the timber. For instance, with a three-year contract and 10 percent inflation, the value of the stumpage will have increased 30 percent before it is cut. In a competitive market this anticipated value increase is reflected in the futures markets and in the high overbids but not in the appraisal.

3. Using Futures to Price Stumpage

The futures market provides prices for two widely traded wood products futures. These prices contain information about the price traders expect for wood products in the near term future--up to 18 months from the current date. Using standard econometric methods, one can use these prices to estimate a price for standing timber 5 years forward.

The quoted prices in Chicago diverge from the expected price in several ways. First, the futures market price is likely to be a biased predictor of the spot price in the delivery month, e.g., the price of a March future in January is not unbiased for the price of a March future in March. This proposition, usually attributed to Keynes, is because futures are useful to traders. In Keynes's view, hedgers--in this case the forest industry--are able to reduce the risk of doing business by selling futures and therefore are willing to pay money, in the sense that they sell futures contracts for less than what they expect the price will be, to hold futures. Their risk reduction comes about because they have contracted to buy stumpage at a fixed price but are facing an uncertain market and price for the timber products. By selling a futures contract, they make that sale price certain and lock in an operating margin of the futures price less the stumpage price. For this valuable service of making their return much more certain, Keynes holds that hedgers would be willing to pay a price and, in fact, do pay a price. To say the least, the empirical evidence on the existence of this price, or risk premium, is shaky (see Telser and Cootner in Peck). A more modern view recognizes that the other actors in the futures markets may also

derive benefits from the contract. Hirshleifer explains how futures markets allow agents who do not agree on the price of a good in the future to do business—they agree with each other on what should be delivered and when and how much more than the futures price should be paid, and they both go into the futures market or not as they please to indulge their notions of what price the commodity should sell for. Many authors (for instance, Bucola) show that buying commodities, say, by a cereal company, can also be a form of hedging. And Grauer and Litzenberger and Berck and Cecchetti show how ordinary investors would be willing to pay for the risk-reducing attributes of futures contracts in an inflationary era. The sum of all these theories is that there are many actors in the futures markets that would be willing to pay for the right to take either a long or short position in the futures market. Thus, it is not known whether the futures market will understate or overstate the expected spot price; the question must be settled empirically.

The second problem with using a future price is that it is a price that is relatively near term, between one and two years away. The subject timber likely will not be cut for four years. The easiest way to account for this change in time period is to assume that the price of stumpage is a random walk with a drift equal to the anticipated rise per unit time in the price of timber. That is, assume that the price of timber will rise at the rate of expected spot less current spot divided by the number of months between these prices. There are problems with this approach which are best illustrated with an example. Suppose that

the current timber market is depressed (which it is) and that housing a timber market revival is expected in one year's time (which we are not so sure it is). Then the expected spot for a year from now would be much larger than the spot now. What about two years from now. Between one and two years from now the market cannot again be expected to make the jump from depressed to excited, so one would not expect the price to go up as much the second year as it did the first year. More technically, the timber market can be viewed as being the sum of two processes: one process depends on millions of small decisions and acts of nature--sale decisions by firms, shipping costs, tariffs, exchange rates, long-term trends in housing choice, etc.; and the other process depends upon the decisions of the Federal Reserve Board. The first process can reasonably be viewed as a random walk, while the second process is more a matter of turning on and off the flow of mortgage money. It might be modeled as a Markovian jump process, but it does not have the property that it drifts upwards, subject of course to large variance. The mortgage process is more likely to go down once it is up, and this distinguishes it from the random walk that is equally likely to go up whether it started down or up. The preliminary statistical evaluation at the end of this paper does not make use of this second process.

The third problem faced in using the futures market is called the basis. The futures contract calls for a specific commodity, a boxcar full of random length 2x4 lumber (or 1/2" CDX plywood for the plywood contract) delivered in a specific place, f.o.b., a rail car in the Pacific Northwest. Stumpage is not that commodity. The value of

stumpage less the value of the contract commodity is the basis. Since that difference includes all the costs of the conversion process, it will be large and negative. The difference will also include the difference in product mix--stumpage produces a mix of chips, plywood, and grades of dimension lumber and the contracts are for a single grade of dimension lumber or plywood. These differences are accounted for by the Forest Service's estimate of conversion costs and grade differential.

4. An Empirical Test of the Futures Price

Appraisal methods based upon an estimate of the spot price of timber on the date of the timber sale fail both because the spot price is not indicative of traders' expectations of trend in the price of wood products and because it does not account for the long time span between the formation of expectations and the conversion of the stumpage to wood products. Using data from the Siuslaw National forest, we show that the Forest Service's appraisal based on current price does not add to an estimate of the high bid for stumpage based upon a futures market price.

When the high bid was regressed against the Forest Service's appraisal, the following equation results for 104 nonsmall business set-aside sales in the period 1976-1979:

$$\begin{array}{rcll} \text{high bid} & = & 41,804 & + 1.98 \text{ appraisal} \\ & & (121,000) & (.111) \\ & & (.346) & (17.88) \end{array}$$

The numbers in parentheses are the standard errors and t ratios; R^2 was .75 and the Durbin-Watson statistic was 1.80. This equation shows that, on average, the appraisal is about half of the high bid, much what one would expect in an era of high inflation. The regression statistics are not notable—all variables are of the right sign and significant—except that the prediction error is large; a 95 percent prediction confidence interval about a large sale—\$4,000,000 bid—would be +/- \$1,759,000. Adding the ratio of either of the futures prices to the spot price reduces the prediction interval very little, but a t-test on this new variable shows that futures prices are a statistically (.01) significant explanatory variable.

By recasting the equation slightly, it is possible to show a stronger point: spot prices are not a significant determinant of futures bid. Construct a new variable, newapr, which is the Forest Service's appraisal divided by the spot price for Douglas fir and multiplied by the average of the plywood and lumber futures prices for a future maturing closest to eight months from the sale date. When high bid is regressed on this new variable, it gives

$$\begin{array}{rcll} \text{high bid} & = & 35,152 & + & 1.98 \text{ newapr} \\ & & (119,024) & & (.108) \\ & & (.295) & & (18.18) \end{array}$$

which has essentially the same regression statistics as the previous appraisal, $R^2 = .76$, Durbin-Watson = 1.82, although it does have a slightly smaller prediction error confidence interval. When the previous appraisal is added to this equation, the previous, or Forest Service, appraisal is not statistically significant—in fact, its t-ratio is .2.

Other forms of this same experiment were also tried. Instead of simply multiplying the whole Forest Service appraisal by the ratio of futures to spot, it is also possible to break the appraisal into its component parts and regress high bid on the costs, value of minor species, and value of Douglas fir and Hemlock adjusted by the ratio of futures to spot. Although this approach seemed promising, the values of the coefficients were not believable. Costs always appeared with the wrong sign.

From this econometric exercise, one can conclude that spot prices play no role in the determination of the high bid, as evidenced by the t-test of their significance, and that using a nearby future captures the trend in prices but not the magnitude of the move that can be expected over the life of a timber contract. The latter results from the newapr regression still having a coefficient on newapr that is closer to two than to one. Many things may contribute to the size of this regression coefficient. The difference in the maturity date of the future and the end time of the contract is certainly one of them. The Forest Service's choice of a mill of middle efficiency as the basis for its evaluation and its allowance for "normal profit" of about 11 percent on materials are other possible explanations. As mentioned earlier, the biased nature of

the futures price as a predictor of the closing spot is another possible reason. Finally, there exists the very real possibility of some other systematic bias in the appraisal system. Despite these problems, these regressions show the definite superiority of a futures price over the spot price as a predictor of the high bid for stumpage.

5. Estimated and Reservation Price

Although the price estimated by the procedure outlined in this paper could serve for the purposes of predicting revenues, it should not be used as a reservation price. The purpose of a reservation price for Forest Service timber is to assure that the government gets the same revenue from its timber that a knowledgeable private seller would get. When collusion among bidders causes all the bidders to bid the same minimum price (or close to it), setting a reservation price limits the seller's loss. In such circumstances, one wants the reservation and market prices to be the same, but this strategy has a very poor side effect. Since the reservation price is but an estimate, other bidders will have other estimates. If all parties have the same information and more or less the same methods, these estimates will be near each other, and there is no reason to believe that any one of them should be higher or lower than any other. Since these estimates come from considering thousands of independent factors, they are likely to be normally distributed about their mean. Thus, with a small number of serious bids—which is very common in the best of circumstances—there is a large possibility the reservation price will be the highest bid and the sale preparation will simply have to be repeated.

The optimal reservation price balances the losses from possible collusion against the losses from not making a sale. If the likelihood of collusion is B , then its expected loss is $B (EP - \text{reserve})$ where EP is the expected price from the regression equation and reserve is the reservation price. Let $L(\text{reserve})$ be the probability that the sale is not consummated--the realization of P is greater than reserve, and let M be the costs of not making the sale (sale preparation, interest, etc.); then, $M L(\text{reserve})$ is the expected loss from not having the sale go through. Minimizing the sum of the two expected losses gives

$$L'(\text{reserve}) = B/M$$

which is the equation for the optimal reservation price.

For example, a sale estimated to be worth \$4,000,000 with a probability of collusion of 3 percent and a readvertising cost of \$100,000 would have $L'(\text{reservation}) = 3 \times 10^{-7}$. To find L' , we tabled the values of the function L . Since the difference between the expected price and the reservation price divided by the prediction error is distributed as t , we tabled L by the following procedure. Take an L , such as .05, and find t_L from a table,

$$\text{reserve} = 4 \times 10^6 - (888,615) t_L.$$

The optimal reservation price calculated by this method is \$3,000,000. For the Forest Service appraisal, which would be approximately \$2,000,000, to be the optimal reservation price would require a ratio of B to M of $.5 \times 10^{-7}$. Two ways such a ratio could come about are to have the probability of collusion at 50 percent and all other facts the same or to have the loss from failure to consummate the sale be \$600,000 and all other facts the same. Neither of these cases seem to fit the facts nor do any intermediate ones; it is unlikely that deterring collusion requires reservation prices as low as the Forest Service currently sets them.

There is one further thing the Forest Service could do to protect against collusion: not announce the reservation price. As things now stand, the Forest Service announces in advance that any bids above the reservation price will admit the bidder to oral auction. All potential colluders can bid the minimum and attend the oral auction. If a member of the coalition defects, all the other bidders are present, and that member will be forced to pay at least market price for his timber. If the reservation price were not announced, each bidder would be forced to make a serious sealed bid before attending the auction. Enforcement is more difficult in this situation because the defector may be the only bid above the reservation bid. Of course, the system has the glaring deficiency that the timber industry might try to corrupt the official that chooses the secret reservation price, and the Forest Service may not consider the pressure placed on their responsible officials to be at all worth heading off future putative collusion.

