PINE

Biological and Economic Productivity of Mixed-Aged Loblolly Pine stands in the South

by

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Abstract

The financial performance of the 991 sample plots of uneven-aged loblolly-hardwood stands in the Central South FIA database examined in this report depend crucially on real price trends. Equivalent annual income (EAI) is the measure of economic performance. The regional market stumpage price data are from the Timber Mart-South database. For this set of prices, a higher real price level prevailed in most of the regional markets after 1993. The mean EAI was \$56/ac/yr most of which was due largely to the favorable trend in real timber prices. The mean EAI with the real price maintained at the starting price was \$1 0/ac/yr. The increasing real price trend during the study period dominated all other factors in determining financial performance. With this increasing price trend, the best performing lands are overstocked stands and the opportunity cost of conservation is negative. Constant price EAI is affected significantly by the stand basal area, total number of trees, number of hardwood trees, and number of trees near saw timber size. The effect of some factors on constant price EAI is significantly stronger on publicly held lands than on privately held lands. No difference between the financial performance of industrially owned lands and other privately held lands is apparent.

INTRODUCTION

The 104 million acres of forested land in the Central South states (Alabama, Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas) cover 58% of the land area included in the Forest Inventory and Analysis (FIA). Loblolly-shortleaf pine type occupies 26% of this forested land. Much of this loblolly-shortleaf pine forest is managed for even-aged silviculture, but a substantial portion, 5.6 million acres is instead managed as mixed-aged loblolly pine-hardwood.

With the advantages of mixed-aged silviculture potentially outweighing the disadvantages in many places (Guldin 1996), the need exists for more understanding of factors affecting the economic performance of this type of management. The purpose of this paper is to analyze recent empirical information from which financial performance can be calculated, to assess the range of this performance, and determine what factors affect financial performance and productivity. Since non-timber values of forests have a larger place in mixed-aged stands, this assessment is a useful foundation from which to consider non-timber values (Scarpa, et.al. 1998).

METHODS

To measure economic performance, we calculated equivalent annual income (EAI). EAI is a way to express the stock value, net present value (NPV), in terms of an even annual income flow. EAI allows us to compare financial performance of sample plots with data over different time periods. NPV is calculated:

$$NPV = \sum_i \frac{H_i}{(1+r)^i} + \frac{V_t}{(1+r)^t} - V_0 .$$

And from this stock value the equivalent flow value is calculated:

$$\mathrm{EAI} = \mathrm{NPV}\frac{r(1+r)^t}{(1+r)^t - 1}$$

H_i is the value of the harvest at time i, V_t and V_0 are the value of harvestable timber in the stand at time t and 0 respectively. These values are all in a real price indexed to a base year. We use 1988 as the base year for the value of money in this study. For the real guiding rate of interest, represented by r above, we use 3%. For each tree type on the stand, both stand volume and harvest data between two survey times are needed in addition to pricing data to make these calculations.

We calculated these EAI values in two different ways. First, we used the real price prevailing at the time of the first survey (time 0) as the price for all valuations. This constant price EAI is a measure of

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plot productivity and also may reflect closely the best future price information a manager has at time zero. Second, we calculated the EAI using the real price prevailing at each valuation and harvest time. This real price EAI captures both productivity and the price effect. It is the actual financial performance experienced and under a perfectly informed rational expectations assumption, these prices are the prices faced by the forest manager.

DATA SOURCES

In this study we examine the economic performance of mixed-aged loblolly-pine hardwood stands in the Central South region. The stand data were obtained from the Forest Inventory and Analysis (FIA) database. The selected plots were "mixed-age" in the sense that they had more than one age class in the dominant species. The distribution of the sample plots throughout the Central South and the survey dates are listed in Table 1. The permanent sample plots of mixed-aged loblolly-pine hardwood stands culled from the latest Forest Inventory and Analysis survey of the Central South region numbered 991 with 40,187 sample trees.

Table--l. Distribution of sample plots by region.

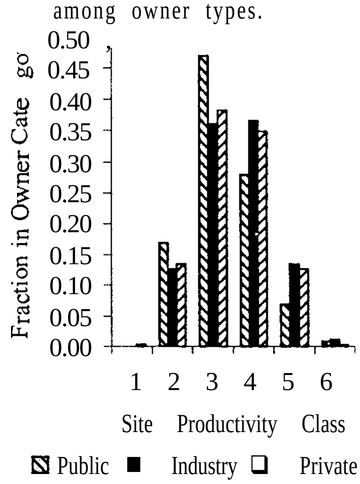
	Number of plots	Survey Years Past	Survey Years Current
Alabama			
North	114	89-90	81-82
South	178	80-82	89-90
Arkansas			
South	53	77-78	87-88
Louisiana			
North	134	83-85	91
South	109	83-85	91
Mississippi			
North	140	86-87	92-94
South	130	86-87	93-94
Oklahoma			
South	4	86	92
Tennessee			
West	1	79	88
East	1	80	89
Texas			
North	26	85	91-92
South	101	85-86	92
Total	991	77-87	87-94

As listed in Table 2, the plots are predominantly under non-industrial private ownership, but a substantial number of plots are in the public domain or owned by the forest products industry. The intrinsic site productivity is reported for each sample plot as a site productivity class, which ranges from class 1 (greater than 225 $ft^3/ac/yr$) to class 6 (less than 49 $ft^3/ac/yr$). These site classes are distributed in the same way among the plots in the three ownership categories (Figure 1).

Table--2. Ownership of sample plots

Owner	Number of Plots	
Private Individual	442	
Farmer	107	
Private Corporation	82	
Other Private	22	
	Total Private	653
Forest Industry	227	
Leased from		
• Private Individual	8	
• Private Corporation	2	
• Farmer Owned	1	
	Total Forest Industry	238
National Forest	94	
Other Federal	4	
Other Public	2	
	Total Public	100
Total in all categories		991

Figure 1. Site productivity is evenly distributed among owner types.



Using the FIA data we calculated for the previous survey, any harvest, and the current survey, the volumes of hardwood and softwood timber suitable for use as sawtimber or pulpwood.

Figure 2. Softwood Saw log. Average stumpage price in the Central South region. (Timber Mart-South)

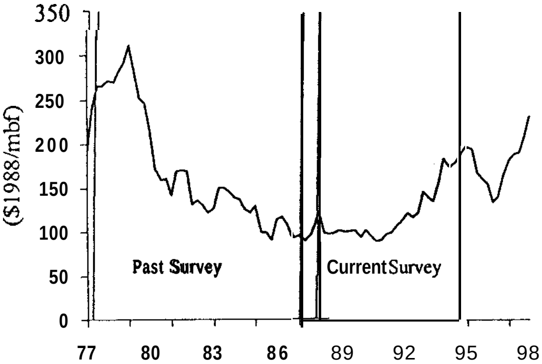


Figure 3. Softwood pulp wood. Average stumpage price in the Central South region. (Timber Mart-South)

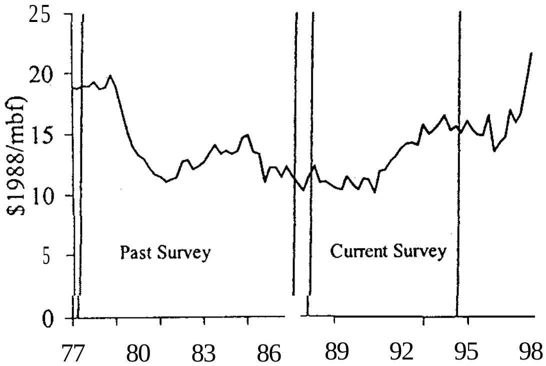
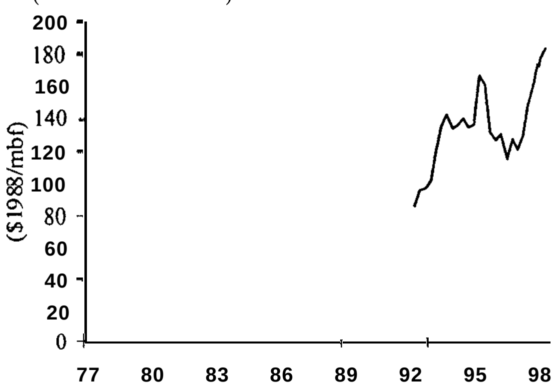


Figure 4. Hardwood saw log. Average stumpage price in the Central South region. (Timber Mart-South)



Stumpage price data for the market areas in the Central South region were obtained from the Timber Mart-South database. These prices are available for both sawtimber and pulpwood for timber classified as hardwood or softwood. Figures 2 through 5 illustrate the time series of the price average over all of the markets for the four stumpage product types. The actual change in prices between the past and current survey times is very different for the twelve sub-regions analyzed as is apparent in Table 3.

Figure 5. Hardwood pulp wood. Average stumpage price in the Central South region. (Timber Mart-South)

Table--3. Softwood Stumpage Price ($1988/mbf)

	Saw Log		Pulp Wood	
	Past Survey	Current Survey	Past Survey	Current Survey
Alabama				
North	127	123	13	16
South	148	152	19	19
Arkansas				
South	221	131	12	12
Louisiana				
North	152	128	18	17
South	152	123	16	17
Mississippi				
North	103	190	10	20
south	110	245	10	18
Oklahoma				
South	151	163	12	15
Tennessee				
West	75	55	7	7
East	64	70	6	10
Texas				
North	111	127	16	17
South	98	145	14	18/3

RESULTS

The distribution of the constant price EAI is in Figure 6 and the real price EAI in Figure 7. The $10/ac/yr average return if prices had been constant is the return from the productivity of the stand alone, while the much larger $56/ac/yr average return at actual prices represents the stand productivity and also the overall price appreciation. Comparing this to the performance of northern hardwoods, Hseu and Buongiorno (1997) use the same methods to calculate an average $13/ac/yr on industrial lands and $8.50/ac/yr on public and non-industrial private lands.

Figure--6. Real Price Equivalent Annual Income. Median $24/ac/yr. Mean $56/ac/yr.

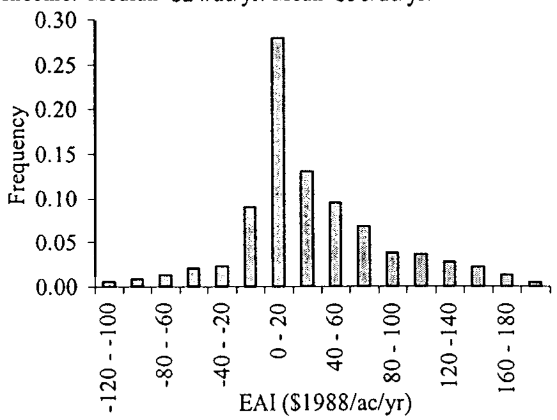
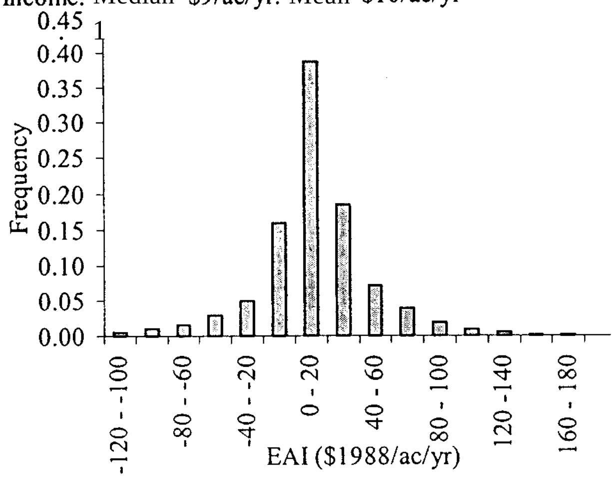


Figure--7. Constant Price Equivalent Annual Income. Median $9/ac/yr. Mean $10/ac/yr



The benefits of the price changes are not uniform as seen in the plot of real price EAI versus constant price EAI in Figure 8. This highly variable mapping between the two measures of financial performance result, from the wide local differences in price changes between the survey dates (Table 3). The differences in prices at the harvest times also contribute to the noise in the relationship. In Table 4 the financial return in the various subregions do follow the price changes in Table 3. Mississippi with the greatest appreciation in prices between the previous and the current survey times also exhibits a much higher average real price EAI compared to the constant price EAI. In contrast, Arkansas, with the greatest price drop realized a negative real price EAI which was much lower than the very good constant price EAI.

Figure--8. Real Price EAI and Constant Price EAI are only loosely related.

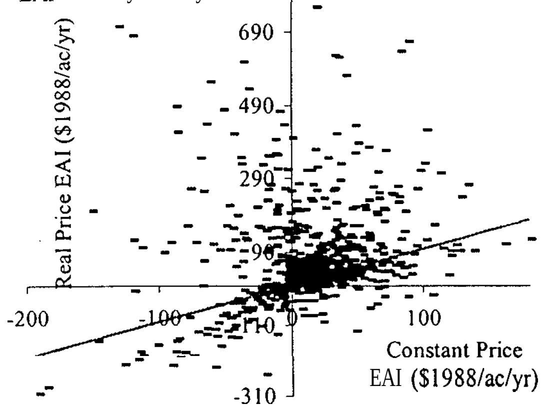


Table--4. Average equivalent annual income ($1988/ac)

	n	Real Price	Constant Price
Alabama	292	16(2)	10(2)
North	114	12(2)	6(2)
South	178	19(2)	12(2)
Arkansas	53	-35(10)	20(6)
South	53	-35(10)	20(6)
Louisiana	243	-14(4)	8(3)
North	134	-25(6)	2(4)
South	109	0(5)	15(4)
Mississippi	270	169(9)	11(2)
North	140	144(11)	11(2)
South	130	197(16)	12(3)
Oklahoma	4	188(29)	-30(50)
South	4	188(29)	-30(50)
Tennessee	2	3(5)	-2(4)
West	1	-1	-7
East	1	8	2
Texas	127	73(4)	10(4)
North	26	64(11)	24(10)
South	101	76(5)	7(4)
All	991	56(4)	10(1)

( ) Standard error.

Price behavior plays a crucial role in the real price financial performance of these plots. Buongiomo, and Hseu (1993) also find that price behavior dominate economic return in northern hardwoods during an unfavorable price trend. Planning for those price changes is very difficult. The large returns are fleeting if they are based in an appreciation in the value of standing timber and the prices drop before the timber is harvested.

DETERMINANTS OF EQUIVALENT ANNUAL INCOME

The effect of the known site characteristics on both real price EAI and constant price EAI are listed in Table 5. As noted above, the real price EAI is dominated by price changes and since these price changes are independent of the site characteristics, it is most useful to consider the effects of the site characteristics on the constant price EAI. Of the site characteristics related to the intrinsic site productivity, none are clearly related to constant price EAI. For constant prices the financial performance was not different among the different productivity classes. The estimates for the difference attributed to site productivity class are negative for all the groupings of site classes compared to site class 3, but these estimates are not significantly different from zero. Any difference that can be attributed to intrinsic site productivity is small enough that it is masked by other unknown sources of variability.

Table--5. Determinants of equivalent annual income ($1988/ac/yr).

	Constant Price EAI		Real Price EAI	
Intercept	6	(5)	-30	(18)
Site Productivity Class 1 or 2	-1	(3)	37*	(12)
Site Productivity Class 4	-4	(2)	-5	(9)
Site Productivity Class 5 or 6	-2	(3)	-11	(13)
Basal Area	-0.29*	(0.04)	0.5*	(0.2)
Fraction BA HW	18	(10)	-55	(37)
Tree Count	0.020*	(0.007)	-0.00	(0.03)
Square of Tree Count	$-2x10^{-6}$	$(3x10^{-6})$	$-1x10^{-6}$	$(1x10^{-5})$
Fraction Count HW	-18*	(5)	26	(21)
Large Soft Pulp Wood	1.04*	(0.07)	0.8*	(0.3)
Large Hard Pulp Wood	0.9*	(0.3)	2	(1)
Aspect	-0.02	(0.02)	0.17	(0.09)
Slope	-0.2	(0.3)	1	(1)
Slope x Aspect	0.001	(0.003)	-0.00	(0.01)
Xeromesic	-1	(5)	-79*	(18)
Hydromesic or Hydric	-6	(6)	-54*	(23)
Public Land				
Basal Area	-0.5”	(0.1)	1.8*	(0.4)
Fraction BA HW	68	(38)	-100	(152)
Tree Count	0.07	(0.03)	-0.4*	0.1010’
Square of Tree Count	$-2x10^{-5}$	(1x10”)	$1.4x10^{-4}$*	$(5x10^{-5})$
Fraction Count HW	-55*	(19)	182*	(76)
Large Soft Pulp Wood	0.9*	(0.2)	-1.3	(0.8)
Large Hard Pulp Wood	-1.1	(0.9)	-0	(3)
Industrial	-1	(2)	-14	(9)
R^2	0.37		0.25	

*Coefficient different from zero at 5% confidence level.

The aspect, slope, and physiography of the site are also related to the productivity and should be reflected by the site productivity class. Thus the coefficients for these factors reflect the effect of this factor in addition to that captured by the site class. None of these factors exhibited an effect on financial performance large enough to be distinguished from unattributable variability. In addition to the aspect, measured here as the absolute angle from the northeast, and the slope, we also examined the interaction between those two factors and found no detectable effect. Most of the plots were classified as mesic, but the few plots that were either more or less well drained than the mesic classification did not exhibit a substantially different financial performance.

The lands owned by forest products industry did not perform different from the non-industrial private owned lands after correcting for the other known factors. The financial performance of the publicly owned lands are different in several respects from the industrial and private lands. The effect of basal area, stocking of hardwoods, and stocking of large pulp softwood is substantially larger on the public lands.

After correcting for other known factors, the plots with smaller basal areas exhibit better constant price financial performance. Presumably, the productivity of a stand with a extremely low basal area would suffer, but this sample of stands did not include enough very low basal area plots to support this presumption. The effect of basal area on productivity is significantly more pronounced on public lands. The fraction of the total basal area consisting of hardwoods does not have a statistically distinguishable effect.

The plots with more trees were significantly more productive than the plots stocked with fewer trees. With a given basal area, more trees mean smaller, more rapidly growing trees. The coefficient of the square of the tree count is negative, which indicates that a point of diminishing returns occurs, but this coefficient is not statistically significant. On public lands, the effect of the tree count is not distinguishible from other lands. The more the number of hardwoods in the stand, the lower the productivity of the plot. This accords with the lower value and growth rate of hardwoods. The effect of hardwood- count lowering productivity is more pronounced on public lands.

Stands are more financially productive, as measured by the constant price EAI, when stocked with more softwood and hardwood just below saw timber size. This positive effect is significantly more pronounced on public lands for softwoods near saw timber size.

CONCLUSIONS

Real financial performance of mixed-aged loblolly stands depends crucially on real price trends. With the roughly increasing price trend in some important markets, the best performing lands are overstocked stands and the opportunity cost of conservation is negative. Financial productivity as measured by constant price EAI is significantly affected by the stand basal area, total number of trees, number of hardwood trees, and number of trees near saw timber size. Some stand stocking factors affect constant price EAI on publicly held lands to a more than on privately held lands. No difference between the financial performance of industrially owned lands and other privately held lands is apparent.

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