
Deriving Simple and Adjusted Financial Rates of Return on Mississippi Timber Lands by Combining Forest Inventory and Analysis and Timber Mart-South Data

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Abstract.—This study compares returns on investments in Mississippi timber lands with returns on alternative investments. The real annual rates of return from mature, undisturbed timber lands in Mississippi over a 17-year period (1977–94) were computed. Southern Research Station Forest Inventory and Analysis (FIA) timber volume data and Timber Mart-South (TMS) data on timber prices were employed. FIA trees were assigned a TMS dollar value based on species, size, and condition. The dollar value of each plot was derived by summing the per acre value of all trees on the plot. Simple and adjusted financial maturity concepts are investigated and compared. Simple financial maturity reflects the value of the timber only, while adjusted financial maturity reflects the implicit costs of holding timber. Average annual rates of change in monetary value and volume change were computed and compared for three distinct time periods: 1977–87, 1987–94, and 1977–94. These rates of return are compared to those for alternative investments such as stocks, bonds, certificates of deposit, and treasury bills. The effects of various plot- and condition-level strata such as ownership, forest type, survey unit, and ecoregion on financial rates of return are investigated.

Methods and Procedures

This study investigates biological and financial growth rates of undisturbed stands in Mississippi by applying Timber Mart-South (TMS) stumpage prices to Forest Inventory and Analysis (FIA) sample trees. Each FIA sample tree was assigned a dollar

value based on species, size, and condition. Saw-log trees were divided into multiple products (saw log and topwood) and rough cull trees were treated as pulpwood. The tree values were summed for each plot to derive the total plot value in dollars per acre.

Study Area

The study area consists of the 82 counties of Mississippi, with the emphasis on timber lands. Timber land is defined as land that is at least 10 percent stocked by trees of any size, or formerly having such tree cover, and not currently developed for nonforest uses. Minimum area considered for FIA classification and measurement is 1 acre.

Time Periods

Three distinct time periods were investigated. These time periods coincide with FIA surveys of Mississippi. These three time periods are 1977–87, 1987–94, and 1977–94.

Plot Selection

Value change computations require input from two points in time. For this study, the earlier time period will be referred to as time 1. The later time period is time 2. Therefore, when the 1987–94 period is discussed, 1977–87 is time 1 while 1987–94 is time 2.

All plots must be classified as forested for all survey periods in question. All time 2 plots must be classified as saw-log-size stands, while time 1 plots may be either poletimber-size or sawtimber-size stands. Stands classified as seedling/sapling

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in either survey are omitted. All time 2 stands must have at least 5,000 board feet of timber per acre. Several plots were classified as having elm-ash-cottonwood forest. These were excluded because sample size was inadequate (< 10 plots for each survey period). All stands with evidence of management, disturbance, or harvesting for the survey periods in question, as well as the previous survey period, were excluded.

Tree Selection

All live trees ≥ 5.0 inches in diameter at breast height (d.b.h.) were included in the sample set, except rotten cull trees. Rough cull tree volumes were given pulpwood value. No cull trees were used in sawtimber computations. Tree selection was performed by variable radius sampling (37.5 basal area factor). Since tree selection was performed by variable radius sampling, new trees appear over time. These new trees were included in all computations and therefore affect growth and value changes. Trees that died between survey periods were included only in the survey year(s) in which they were alive. This factor has the potential to create negative biological and economic value growth between surveys.

Timber Mart-South Data

This study uses TMS price data to calculate individual tree values. TMS has been collecting delivered prices and stumpage prices for 11 Southern States since December 1976. All TMS price data are nominal. Real prices were calculated using the U.S. Bureau of Labor and Statistics all commodities Producer Price Index. As 1986 was the midpoint of the study period, all TMS prices were inflated or deflated to 1986 levels.

Tree Products and Tree Values

The following logic was used for determining tree products: (1) all poletimber-size trees are used for pulpwood; (2) the entire volume of rough cull trees, even sawtimber-size trees, is used for pulpwood; (3) the saw-log section of sawtimber-size

trees is used for sawtimber; and (4) the section between the saw-log top and 4-inch diameter outside bark pole top is used for pulp and often referred to as topwood.

In 1981, TMS began to report Southern pine chip-n-saw prices. Therefore, the two survey periods after this time included a third product, Southern pine chip-n-saw. Chip-n-saw trees are Southern pines 9.0 to 12.9 inches d.b.h. All trees < 9.0 inches d.b.h. are still treated as pulpwood, and trees ≥ 13.0 inches d.b.h. are treated as sawtimber trees. This modification was made for the 1987 and 1994 survey periods.

FIA traditionally computes all board-foot volumes by international 1/4-inch log rule. Most of the TMS price data is in Doyle log rule. To accommodate the price data, all FIA tree volumes were recalculated using the Doyle formula. In a few instances, prices are reported in Scribner log rule. To accommodate this, the Doyle prices for these few instances were converted to Scribner prices by multiplying the Doyle price by 0.75 (Timber Mart-South 1996).

The TMS reports include a low, high, and average price for standing timber for various products. This report does not consider peeler logs or poles and piling as possible products because determining these products from FIA data is questionable. Omitting these classes allows for a slightly conservative approach to estimating tree and stand value. FIA data has information on species, product size (poletimber or sawtimber), and quality (tree class and tree grade). Prices for each section of the tree were assigned based on these factors. These prices were then applied to the different sections of a tree. Table 1 details how TMS prices were assigned to individual trees.

Growth Models

Timber volumes and values are summed for each plot. These totals are then used as inputs for the growth models. Three growth models were used in this study. Each is based on the formula used in determining average annual change.

Table 1.— *Logic used in assigning TMS prices to FIA sample trees.*

Tree characteristic	Price assignment
Growing-stock pine poletimber	Average pine pulpwood price
Nongrowing-stock pines	Low pine pulpwood price
Hardwood growing-stock poletimber	Average hardwood pulp price
Hardwood nongrowing-stock, nonoak trees	Low hardwood pulp price
Pine sawtimber topwood	Low pine pulpwood price
Hardwood sawtimber topwood	Low hardwood pulp price
Southern pine chip-n-saw	Average chip-n-saw price ^a
Tree grades 1 and 2 oaks ^b	High oak sawtimber price
Tree grade 3 oaks ^b	Average oak sawtimber price
All other growing-stock, sawtimber-size oaks ^b	Low oak sawtimber price
Post oak, Delta post oak, and black oak	Low mixed sawtimber price
Tree grades 1 and 2 Southern pine	High pine sawtimber price
Tree grade 3 Southern pine	Average pine sawtimber price
All other pine sawtimber—growing-stock	Low pine sawtimber price
All nonoak tree grade 1 hardwoods	High mixed sawtimber price
All other nonoak tree grade 2 and 3 hardwoods	Average mixed sawtimber price
Any remaining growing-stock hardwoods	Low mixed hardwood price

^a Except for the 1977 survey, in which this category does not exist. For 1977, all Southern pines < 9.0 inches d.b.h. are treated as pulpwood, larger trees as sawtimber.

^b Except for the following species: post oak, Delta post oak, and black oak.

Timber Value Growth (TVG) is a simple financial maturity model that considers only the actual change in value for a plot for the survey period in question. Incomes derived from future stands are ignored. The basic formula for TVG is:

$$\text{TVG} = [(\text{TVF}/\text{TVP})^{1/t} - 1] * 100 \quad (1)$$

where

TVG = timber value growth percent.

TVF = ending sum of tree value on the plot at time 2.

TVP = beginning sum of tree value on the plot at time 1.

t = number of years between surveys.

Forest Value Growth (FVG) includes the value of land in the computation of economic value change. The formula for FVG is:

$$\text{FVG} = [((\text{TVF} + \text{LVF}) / (\text{TVP} + \text{LVP}))^{1/t} - 1] * 100 \quad (2)$$

where:

FVG = forest value growth percent.

TVF = ending sum of tree value on the plot at time 2.

LVF = ending land value.

TVP = beginning sum of tree value on the plot at time 1.

LVP = beginning land value.

t = number of years between surveys.

FVG is an adjusted financial maturity model. Adjusted financial maturity concepts account for all implicit costs associated with holding timber. These implicit costs are sometimes referred to as opportunity costs. Thus, adjusted financial maturity concepts account for revenues from future stands. One method of adjusting the model is to include bare land value (LV) in the equation, because LV accounts for future incomes and the inclusion of LV adjusts the simple financial maturity model. This study computes multiple FVGs using LVs ranging from \$50 per acre to \$550 per acre in \$50 increments.

Biological Growth Percent (BGP) is similar to TVG, except it uses timber volumes instead of timber values. The BGP model accounts for the actual annual change in tree volume for a plot over a survey period. The BGP model is the same as the TVG model, except it uses the sum of tree volumes on the plot instead of the sum of tree values.

Results

Initial investigations analyzed value growth based on various plot strata such as county, ownership, and forest type. Table 2 details the sample size, BGP, TVG, and FVG of Mississippi timber lands by forest type for the 1977–94 period. FVG is computed in \$250 increments ranging from \$250 to \$1500. This sample set is more likely to represent the true trend for the extended period as it contains only plots that met the selection criteria for all three surveys. All financial rates of return are real. Table 2 reveals that pine stands outperformed all other stands in terms of biological and economic growth. Average pine stand volume increased 5.2 percent per year, while average pine stands earned more than 16 percent per year using the simple model. The adjusted rates of return for mature pine stands ranged from 4.9 percent to 10.9 percent per year depending on land value. While stands consisting primarily of pine outperformed other types, they did not do so to the degree that many would expect. A common perception in the South is that loblolly pine is the only economically viable species. This may not be the case, as even oak-gum-cypress stands, the weakest performers in this study, had TVG greater than 12 percent per year and FVG ranging from 3.5 to 8.25 percent per year.

Figure 1 illustrates the FVG estimates from table 2. If landowners know the value of their land, or the value of nearby lands, then they can use this graph as a guide to the rates of return they might expect to earn on their holdings. This graph clearly shows the effect that land value has on rates of return. As LV increases, rates of return decrease. There will be a point at which land value plays a greater role in determining land use than do timber values.

Another avenue is to investigate value change spatially and temporally to determine if there are any regional patterns or shifts in value change over time. This is accomplished by mapping out rates of return across the State and comparing these rates to ecological strata such as forest type and ecoregion, or comparing these distributions over time. To accomplish the first, an ecological benchmark is needed. Figure 2 shows the distribution of plots by 1994 forest type. Pine stands dominate the southern/southeastern portion of the State, while hardwoods form the plurality along major waterways. The northern part of the State is almost an even mix of the three types. Traditional wisdom dictates that the greatest rates of return would occur in the southern part of the State, due to the high frequency of yellow pine. The following queries tested this idea as well as looking for any spatial/temporal patterns.

Figure 1.—Forest value growth percent by forest type and land value, Mississippi, 1977–94.

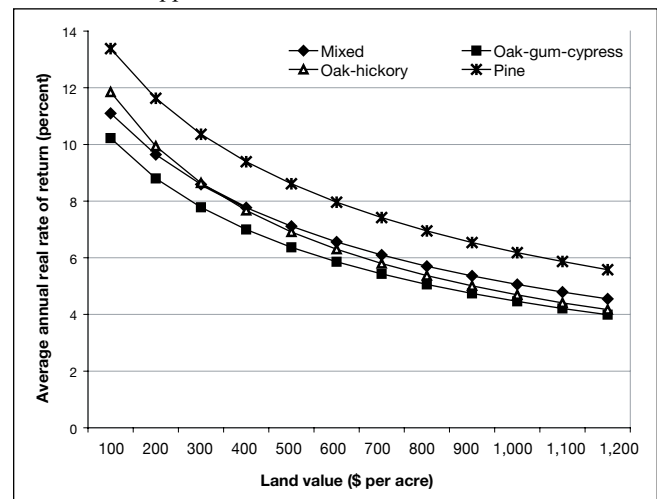


Table 2.—Average annual growth percent, real timber value growth percent, and real forest value growth percent by forest type, Mississippi, 1977–94.

Forest type	Plots	BGP (%)	TVG (%)	FVG 250 (%)	FVG 500 (%)	FVG 750 (%)	FVG 1000 (%)	FV 1250 (%)	FVG 1500 (%)
Pine	25	5.22	16.14	10.95	8.61	7.18	6.18	5.45	4.88
Mixed	26	3.63	13.36	9.08	7.11	5.89	5.06	4.44	3.96
Oak-hickory	38	4.35	15.14	9.23	6.91	5.57	4.69	4.06	3.58
Oak-gum-cypress	70	3.16	12.43	8.25	6.37	5.23	4.46	3.89	3.46
Total	159	3.84	13.82	9.05	6.97	5.73	4.88	4.27	3.79

Interesting patterns emerge when each plot's forest value growth (LV = \$750 per acre) by survey period is mapped. The southern portion of the State tended to have slightly higher rates of return for 1977–87. It is interesting that 11 plots scattered across the State experienced negative value-growth, even in the southern portion. While rates of return were slightly higher in the south, the degree to which they outperformed the rest of the State was relatively small along with the certainty that they would “earn money” (fig. 3).

Conversely, the majority of the highest earning plots in the 1987–94 survey occur outside of the southern region and in areas of the State that are dominated by hardwood and mixed stands. This result is due to increases in hardwood stumpage prices that occurred in this time frame. Another interesting point is that no negative value-growth plots were in this data set

and all plots “earned money,” with the majority of the highest earning plots occurring in the northern and central regions of the State (fig. 4).

The true long-term economic trend is best ascertained by combining inventories and using the plots that meet selection criteria in both surveys. The results of the extended 1977–94 period are similar to those for the 1987–94 period in that no plots lost money and the majority of the highest earning plots occurred outside the southern portion of the State. The moderating effect of time, along with the first inventory's lower rates of return, produce overall lower rates of return (fig. 5).

Figure 2.—Distribution of plots by major forest type, Mississippi, 1994.

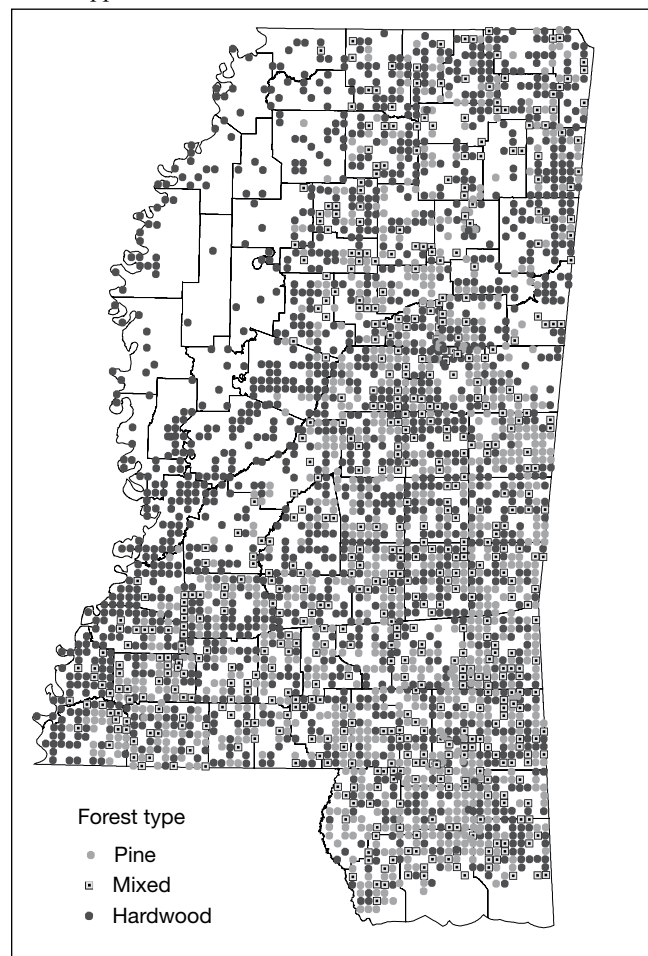


Figure 3.—Distribution of plots by forest value growth, land value = \$750 per acre, Mississippi, 1977–87.

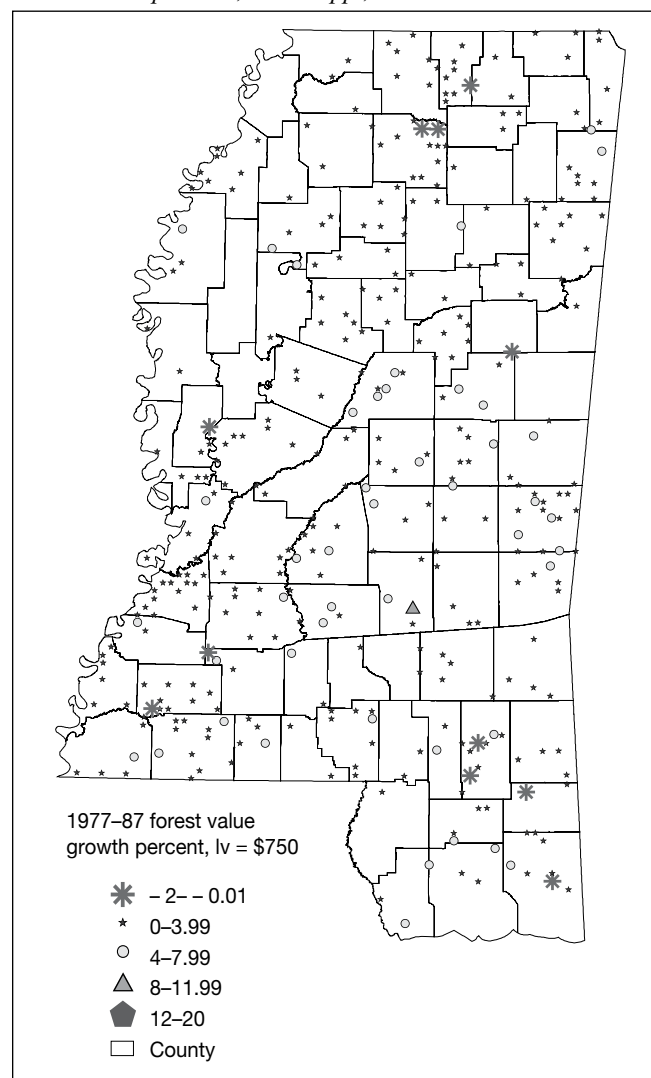


Figure 4.—Distribution of plots by forest value growth, land value = \$750 per acre, Mississippi, 1987–94.

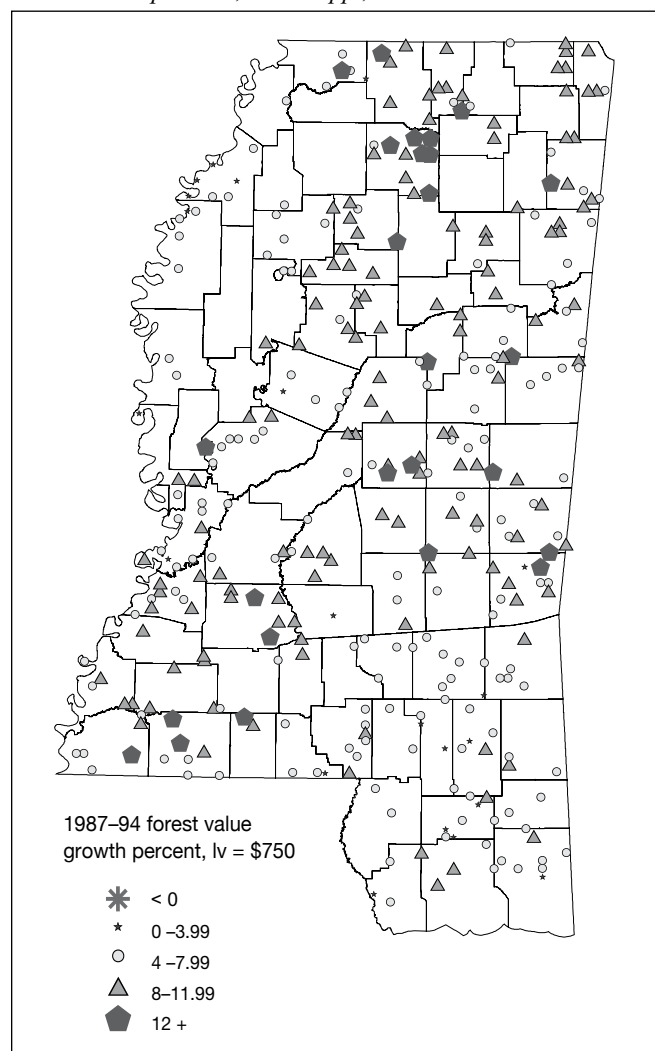
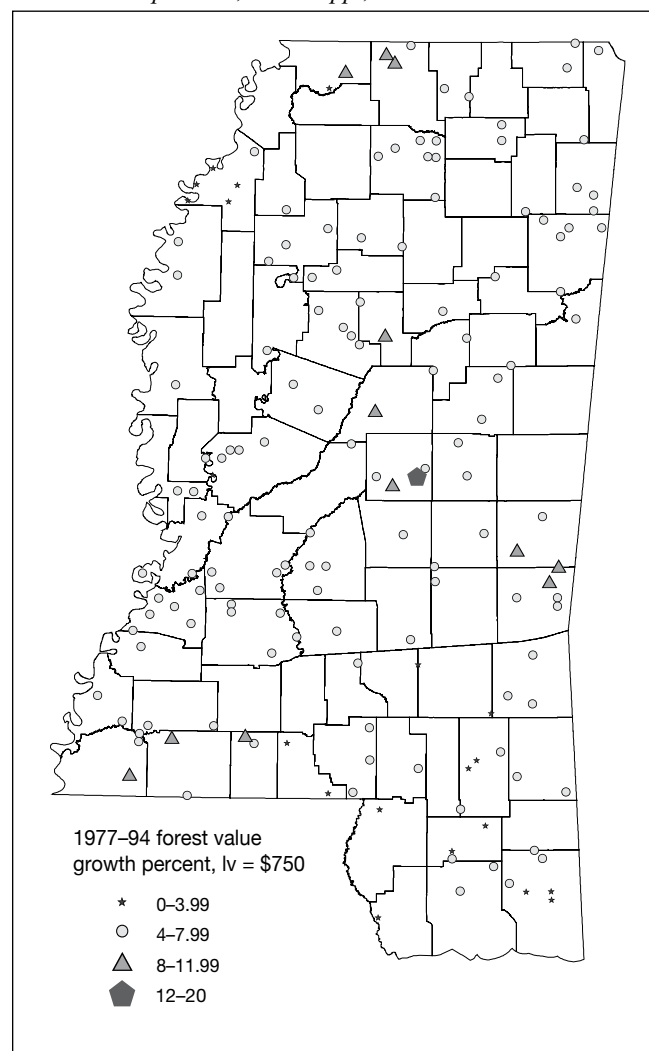


Figure 5.—Distribution of plots by forest value growth, land value = \$750 per acre, Mississippi, 1977–94.



Another avenue of investigation involves stratifying value change not on a plot- or condition-level variable such as ownership or forest type, but on ecoregion. Figure 6 combines Bailey's ecoregions with the data from figure 4. There is an apparent correlation between ecoregion and economic value change for the State, as the majority of the highest earning plots occur in the Coastal Plains middle section. Indeed, the plots in this section averaged more than 9 percent per year real rate of growth for the period. This rate of return is significantly higher than those for the other sections (table 3).

Comparing the rates of return from timber lands to those for other investment options yields interesting results (table 4). The simple financial maturity model (TVG) outperforms all other investment options for all survey periods. The results differ, however, when using the adjusted model. Between 1977 and 1987, certificates of deposit, AAA corporate bonds, and the S&P Stock Index (S&P 500) rank higher than FVG. During this survey, the adjusted model's rates of return compare favorably with the Dow Jones Industrial Average and Treasury Bills. The outcome is better for both the next time frame (1987–94) and the extended period (1977–94). In both instances FVG outperforms all other investment options except the S&P 500.

Figure 6.—Distribution of plots by forest value growth, land value = \$750 per acre, by ecological section, Mississippi, 1977–94.

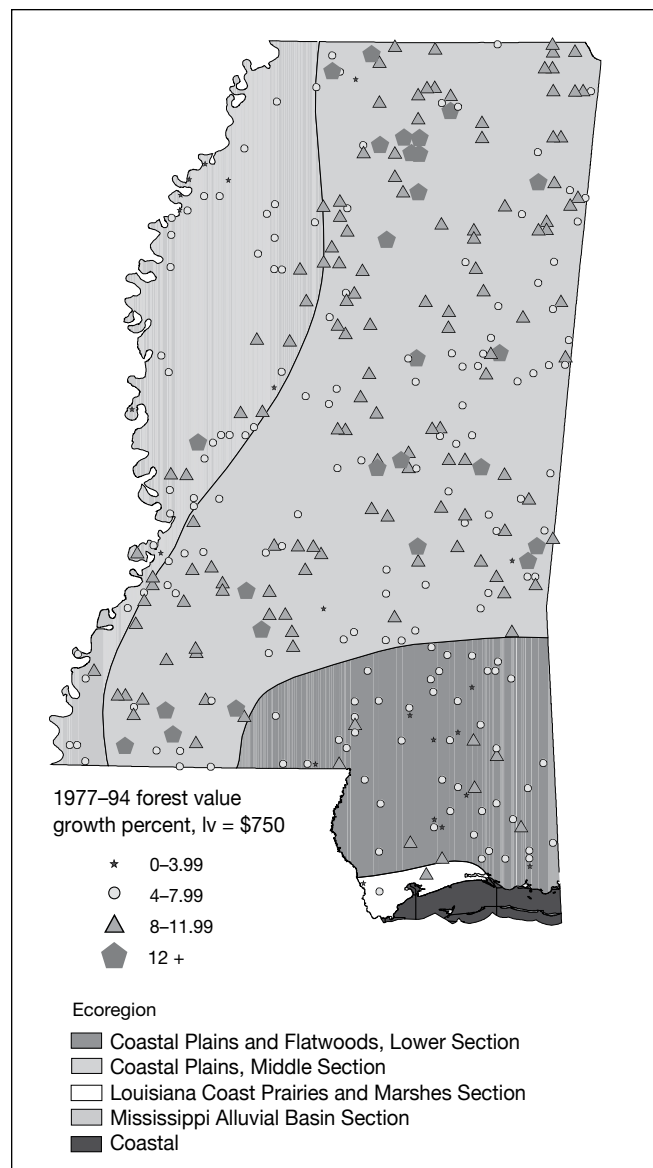


Table 3.—Average annual forest value growth percent by ecoregion, Mississippi, 1987–94.

Bailey's ecological section	N	Average forest value growth ^a
Coastal Plains and Flatwoods Lower Section	62	6.25
Coastal Plains Middle Section	221	9.05
Louisiana Coast Prairies and Marshes Section	3	6.08
Mississippi Alluvial Basin Section	56	4.45

^a Forest value growth percent calculated using bare land value = \$750 per acre.

Table 4.—Average annual real rates of return, expressed as a percentage, for Mississippi timber lands and alternative investment options by survey period.

Investment options	1977–87	1987–94	1977–94
TVG	8.05	18.58	13.82
FVG ^a	2.40	8.09	5.73
1-month certificate of deposit	2.93	2.11	3.32
3-month certificate of deposit	3.06	2.18	2.75
6-month certificate of deposit	3.22	2.30	2.89
3-month Treasury Bill	2.11	1.61	1.96
6-month Treasury Bill	2.24	1.73	2.09
1-year Treasury Bill	2.18	1.86	2.11
AAA corporate bonds	4.23	4.67	4.43
Dow Jones Industrial Average	0.10	5.13	2.21
S&P 500 Stock Index	6.84	8.48	7.92

FVG = Forest Value Growth.

TVG = Timber Value Growth.

^a FVG calculated using bare land value = \$750 per acre.

Key Points

This study did not consider the effects of taxes. The impacts of taxes paid or tax exemptions for the various investment options were not taken into account. These have the potential to affect the final rates of return. The stands must be completely liquidated to meet the specified rate of return. The landowner maintains possession of the land. Income from selling the land is not included. LV change over time is not considered. Regeneration costs, and other silvicultural practices, are excluded from the analysis as well. Returns from intermediate harvests, thinning, and costs of land improvements are not included. Therefore, foresters and land managers have the potential to improve on these rates through species selection, intermediate practices, and final products the stands produce.

Conclusions

Economic studies such as this have the potential to increase FIA's user base while informing landowners of the value of their holdings. This could lead to a higher awareness of all the management options available to them, and open the doors to new ones. For example, hardwood management may now be a viable management option to many landowners who previously ignored this resource. In addition, investment institutions such as banks and timber management organizations would find this type of product useful, increasing the demand for FIA data and products.

Literature Cited

Timber Mart-South. 1996. Stumpage price mart: standing timber, Mississippi 1st quarter 1996. Athens, GA: University of Georgia, Daniel B. Warnell School of Forest Resources. 4 p.