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Abstract

Mississippi's long-run softwood timber potential was estimated for three input situations under a common set of economic and biological assumptions. Economic goals for sustained pine production were estimated using the computer program GASPLY with no restrictions, with private nonindustrial upland hardwoods excluded from type conversion and with private nonindustrial lands excluded from active forest management altogether. Estimated price-quantity equilibria ranged from $301 per thousand cubic feet (MCF) and 966 million cubic feet (MMCF) in the unrestricted case, to $1,226/MCF and 479 MMCF in the example with passive private nonindustrial management. Widely differing potential goals for pine production highlight the degree to which Mississippi's future softwood availability and related economic activity can be influenced by private nonindustrial actions.

Forestry is a vital part of the Mississippi economy and way of life. Future softwood timber availability in the State is related closely to the level of management practiced by private nonindustrial forest landowners. These individuals control more than 70% of the State's 16.7 million acres of forest land and two-thirds of the total growing stock (Murphy 1978). The impacts of some extreme cases of private nonindustrial forest management on long-run softwood timber supplies are presented. These cases highlight the potential for such landowners to influence softwood supply and price in Mississippi. A discussion of methods used to analyze softwood availability in Mississippi is followed by model results and a summary of implications.

Procedure

Computer program GASPLY (Georgia Supply), developed by Robinson *et al.* (1978), was used to assess the potential influence of private nonindustrial forestry on long-run softwood timber availability in Mississippi. The program is designed to project volumes that can be produced in a state or region, given economic inputs such as prices and costs, biological inputs such as potential forest types and yields and land-base inputs that define potential acreages. The potential supply of timber from an area is projected as a function of the forest land base, the management practices applied to the land base and the per-acre costs and yields related to those practices. In the long-run, therefore potential timber availability is independent of existing timber inventories; i.e., all factors of production are variable. The long-run output from the analysis is an estimated economic growth goal---to balance the future supply and demand for forest products. The GASPLY program also estimates the total investment required to produce the output goal, the necessary management prescriptions, the location, site quality, ownership and numbers of acres involved.

In applying the growth-goal model to Mississippi conditions, many direct and indirect assumptions were necessary. Softwood demand, for example, was assumed to double by the year 2020 and was assigned a price elasticity of -0.50.[1] Management regimes were assumed for three intensities of management ---custodial, natural stand and plantation. Regimes for each intensity vary by ownership class and forest type. Other assumptions include interest rates, stumpage prices, clearing, site preparation, planting, treatment and overhead costs, property taxes, proportion of nonindustrial lands in farm ownership and rates of conversion of forest land to urban and other uses. Input values differ with site quality, ownership, forest type and subregion within the State.

The number of factors affecting the economic potential of an area to produce timber in the long run precludes a detailed sensitivity study of all inputs. Potential acreages available for different

[1] *Assumptions for aggregate demand were based on broad U.S. Forest Service projections. Price, cost and other assumptions, however, were derived from various state-specific sources.*

types of forest management were the only inputs varied, thus reflecting impacts of different actions by private landowners. The results and implications presented are, therefore, related to a single set of input assumptions. In such analyses, the relative magnitude of changes in price-quantity equilibria is more important than the absolute numbers estimated. Instead of varying all assumptions in the analysis, more effort was placed on specifying realistic values for each input assigned in describing economic and biological conditions in Mississippi.[2]

Mississippi's forest-land base was defined by aggregating 1977 forest survey plot data into 407 acreage cells. The data, supplied by the Southern Forest Experiment Station, were grouped by region, sub-region, forest type, ownership, site quality and physiographic class. GASPLY determines the present-net-worth (PNW) maximizing management plan for each acreage cell, given the economic and biological inputs assigned for Mississippi. In this manner, the program estimates the average long-run costs of producing various sustained harvests at the state level. These costs are equivalent to the stumpage prices necessary to produce the harvests through time. The equilibrium harvest level is a growth goal or economic potential, because acreage cells are assigned to management plans using the PNW criterion.

The purpose for applying GASPLY to Mississippi was to investigate potential softwood timber availability and possible impacts of different levels of private nonindustrial forest management. These objectives were accomplished using three cases as follow:

Case 1. No restrictions on the model; that is, to estimate the level of harvest that could be sustained in Mississippi in the long-run, given assumed conditions and PNW maximizing landowners.

Case 2. Private nonindustrial upland hardwood sites excluded from the model; that is, to evaluate the importance of forest type conversion on such sites to future pine production in the State.

Case 3. Private nonindustrial landowners restricted to custodial management; that is, to assess the potential impacts of such landowners on Mississippi's future softwood availability.

Cases 1 and 3 define extreme situations, because landowners maximize PNW in Case 1 while none of the State's private nonindustrial landowners practice active forest management in Case 3. Forest type conversion on private nonindustrial upland hardwood sites is excluded in Case 2. This case reflects biases against investments with high initial costs and delayed returns.

Results

The demand relationship defined for Mississippi and the timber supply relations resulting from the three cases examined are illustrated in Figure 1. Estimated supply relations for Mississippi are relatively inelastic above certain harvest levels. Similar relations were presented for the Southeast by Robinson *et al.* (1981) and for East Texas by Hickman and Jackson (1981). The estimated harvest of pine in Mississippi in 1976 was 484.3 million cubic feet (MMCF) (Murphy 1978), and the average price of pine stumpage was about $300 per thousand cubic feet (MCF).[3]

Case 1

With no restrictions on the model, 966,482 MCF of pine were estimated as the State's potential sustained harvest at a stumpage price of $301/MCF.[4] For assumed input conditions, including PNW maximization by all landowners, the Case 1 extreme shows the annual pine harvest in Mississippi could be almost doubled with virtually no long-run real price increase. This extreme could occur only with a high level of intensive pine management. Acreages necessary to sustain a 966 MMCF harvest are presented by management intensity in Table 1.

Forty three percent of Mississippi's forest land would have to

[2] *Further discussion of input assumptions and specific values assigned for the analysis are in Bullard, S. H. 1980. Potential softwood availability from Mississippi's private nonindustrial forests. Unpub. M.S. thesis, Dept. of For., Miss. St. Univ., Miss. State, Miss. 79 p.*

[3] *All results are reported in cubic feet. Conversion of price-quantity results to cords or board feet would be difficult because each total harvest is comprised of thinnings and final harvests that vary by ownership, management intensity, forest type, site quality, etc.*

[4] *Equilibrium prices and quantities are determined iteratively in the GASPLY model. For an initial price, quantity is estimated by summing annualized yields for all acreage cells. Demand price is then estimated by Price* = $EXP[-B_1(\ln Q - B_2)]$, where B_1 is the inverse of the elasticity of demand, Q is quantity, and B_2 is the natural logarithm of the constant term and the demand shifters (Robinson et al. 1978).

support pine plantations to sustain annual pine harvests of 966 MMCF (Table 1), given the biological and economic assumptions of Case 1. Plantation management would be necessary on 30% of the public, 82% of the forest industry and 32% of the private nonindustrial forest land in the State. Other acreage requirements from Table 1 are converting all longleaf-slash areas and almost all of the 3.5 million acres of upland hardwood to pine plantation management and converting almost 2.5 million acres of oak-pine to pine production. Required acreages under Case 1 are unrealistic but illustrate the commitment necessary to produce at the State's softwood potential. Based on all assumptions, the potential sustained harvest represents an economic upper boundary for pine production in the State, rather than a realistic short-term goal.

Case 2

One Case 1 result, converting 3.5 million acreas of upland hardwood forests to pine plantation, is a very unlikely acreage goal in Mississippi.

Table 1. Acreage requirements by management plan for an annual pine production of 966 MMCF in Mississippi (Case 1 -- no restrictions).

	MANAGEMENT PLAN[1]		
	Plantation	Natural Stand	Custodial
	----------Thousand Acres----------		
OWNERSHIP			
Public	463.3	899.0	173.4
Forest Industry	2,616.7	0.0	590.0
Private Nonindustrial	3,017.9	4,554.6	1,767.7
FOREST TYPE			
Longleaf-Slash	971.5	0.0	0.0
Loblolly-Shortleaf	945.2	2,956.8	0.0
Oak-Pine	661.0	2,496.8	0.0
Upland Hardwoods	3,520.2	0.0	112.3
Bottomland Hardwoods	0.0	0.0	2,418.8
SITE CLASS[2]			
High	745.9	1,116.1	658.9
medium	5,158.2	4,220.2	1,847.2
Low	183.8	117.3	25.0
TOTAL	6,097.9	5,453.6	2,531.1

[1]Plantation and natural stand management regimes were defined by ownership and forest type. The custodial option, however, includes fire control only, with property taxes the only cost.

[2]Site class definitions were:

High 120+, medium 50-120, and low <50 cubic feet per acre per year in fully stocked natural stands.

Seventy-five percent of these stands are classed as private nonindustrial, a group of owners who frequently reject conversion investments because of the high costs and long time periods involved. Case 2 evaluates the potential price-quantity results if none of the State's 2.76 million acres of private nonindustrial upland hardwoods are converted to pine production.

The Case 2 price-quantity equilibrium was estimated as $444/MCF and a sustained harvest of 796 MMCF (Figure 1). These estimates are higher than price-quantity levels in the late 1970's by almost 50% for real stumpage prices and 65% for pine harvests. Acreages required to sustain an annual cut of 796 MMCF are presented by management level in Table 2. Compared to Case 1 results, more intensive management is required in the loblolly-shortleaf forest type, and almost 2 million acres in private nonindustrial ownership are shifted from natural stand to plantation management.

Case 3

The final GASPLY application for Mississippi restricted private nonindustrial owners to custodial management. Results describe the potential price-quantity impacts of private attitudes concerning forestry investment in Mississippi. While Case 1 defined potential relations if landowners were to maximize PNW, Case 3 estimates relations if private nonindustrial landowners simply minimize costs. The estimated price-quantity equilibrium for Case 3 could not be depicted in Figure 1 due to scale. Under the input conditions, the model estimated that annual harvests of 479 MMCF could be sustained in Mississippi at a stumpage price of $1226/MCF. Without active forest management on private nonindustrial lands, a four-fold increase in real prices would not be sufficient to maintain pine harvests at 1976 levels. Results depend on the entire set of inputs, but private nonindustrial objectives clearly have a dramatic impact on future pine production in Mississippi.

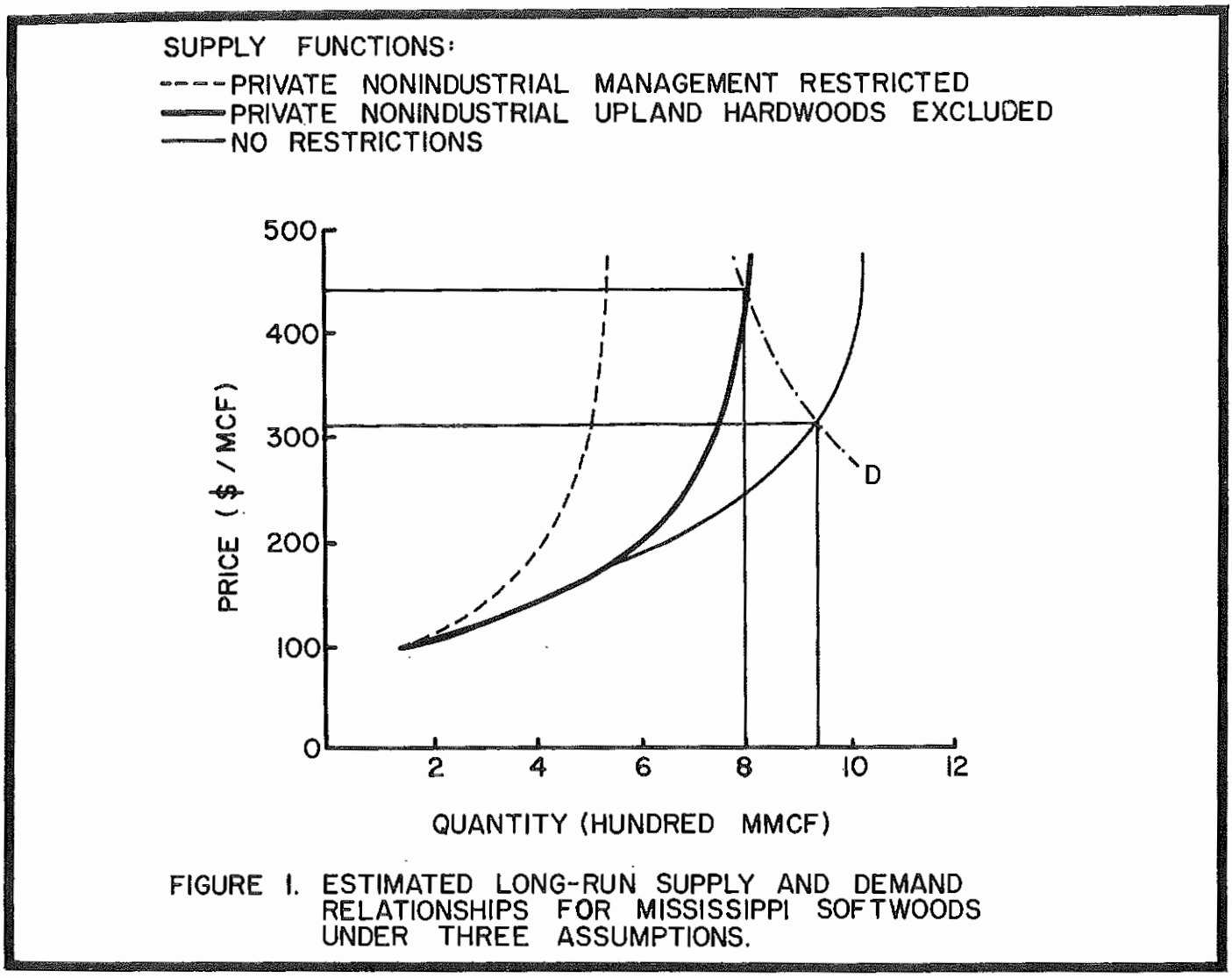

FIGURE 1. ESTIMATED LONG-RUN SUPPLY AND DEMAND RELATIONSHIPS FOR MISSISSIPPI SOFTWOODS UNDER THREE ASSUMPTIONS.

Discussion

Potential softwood timber availability in Mississippi was analyzed for three input cases, under a common set of economic, biological and resource-base assumptions. Initial assumptions were not varied for the analysis, and emphasis was placed on relative rather than absolute changes in model results for the three situations. The GASPLY program provided estimates of long-run price-quantity equilibria for each input case, and the associated acreage requirements were summarized.

If forest landowners in Mississippi maximized per-acre PNW, annual harvests could be almost doubled with no real price increases. Such a potential or goal, however, is highly impractical considering the acreages necessary for intensive pine management. The influence of private nonindustrial actions on potential production goals in Mississippi was first examined by excluding upland hardwoods from type conversion. Without such conversion, the estimated potential for softwood production dropped by 18% while potential real prices increased by 50%. The maximum potential for private nonindustrial landowner attitudes to influence long-run softwood availability was estimated by obtaining price-quantity results without active forest management on these ownerships. Four-fold increases in price and 50% reductions in annual harvests were estimated as the potential differences resulting from PNW-maximizing versus cost-minimizing private nonindustrial ownership objectives.

By influencing softwood timber

Table 2. Acreage requirements by management plan for an annual pine production of 796 MMCF in Mississippi (Case 2 -- private nonindustrial hardwood sites excluded from the model).

	MANAGEMENT PLAN[1]		
	Plantation	Natural Stand	Custodial
	M Acres		
OWNERSHIP			
Public	463.3	899.0	173.4
Forest Industry	2,616.7	0.0	590.0
Private Nonindustrial	2,338.1	2,605.0	1,640.5
FOREST TYPE			
Longleaf-Slash	971.5	0.0	0.0
Loblolly-Shortleaf	2,913.7	994.5	0.0
Oak-Pine	661.0	2,509.5	0.0
Upland Hardwoods	871.9	0.0	0.0
Bottomland Hardwoods	0.0	0.0	2,403.9
SITE CLASS[2]			
High	474.3	1,135.1	664.0
medium	4,787.6	2,296.1	1,739.7
Low	156.2	72.8	20.2
TOTAL	5,418.1	3,504.0	2,403.9

[1]Defined as in Table 1.

[2]Defined as in Table 1.

production, private nonindustrial landowners have the potential to greatly affect future economic activity in Mississippi. More intensive management of these forests could increase the State's total economic output by as much as $2.73 billion (Porterfield *et al.* 1978). In the present study, upper and lower bounds on possible price-quantity influences were estimated by assuming PNW-maximizing and cost-minimizing objectives for private nonindustrial ownerships. Future softwood availability in the State can be expected between the extreme cases, with actual conditions closely related to present and future levels of private and public investment in private nonindustrial forestry.

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