The Effect of Relative Product Prices on the Optimal Management of Loblolly[1] Pine

James E. Henderson[2] and Ian A. Munn[3]

Abstract. Product prices may indicate the appropriate management regime when the landowners' primary objective is to maximize value through timber revenues. The effect of relative product prices (pulpwood and sawtimber) on the financially optimal management regime for loblolly pine (*P. taeda*) plantations was examined across a range of site indices, discount rates, and initial planting densities. Planting densities of 538 and 681 trees per acre (TPA) were included. Management scenarios included in the analysis involved sawtimber rotations (one or more thinnings) and pulpwood rotations (no thinning). Relative product prices were defined by expressing the price of pulpwood as a percentage of sawtimber price. Pulpwood rotations are not optimal at current prices. Pulpwood would have to be 44 to 84 percent of sawtimber value depending on site index and discount rate before pulpwood rotations would become optimal. This required price of pulpwood decreases with decreasing site indices and increasing discount rates. This holds true except in the case of extremely high site indices such as SI 90 and 80 (base age 25), where the required price of pulpwood rises with increasing discount rates. At current prices, LEV's are greater for planting densities of 538 TPA than planting densities of 681 TPA.

Key Words: optimal rotation, optimal management regime, relative product prices

INTRODUCTION

The profit maximizing management regime for loblolly pine depends, in part, on the relative price of pulpwood and sawtimber. For example, if the desired end product were pulpwood then a regime that maximizes pulpwood production would be applied. In contrast, if the desired end product were sawtimber then a regime that maximizes sawtimber production would be followed. If the landowners' objective is to maximize profits, optimal management regimes may well depend on relative product prices. This study sought to determine how relative product prices impact the selection of the optimal management regime for loblolly pine plantations. The effects of product price on two types of management regimes (pulpwood and sawtimber) are investigated. Pulpwood regimes are defined as management regimes that do not include thinnings and are characterized by high initial stocking. Sawtimber regimes are defined by one or more thinnings and are characterized by a lower initial stocking. For each combination of site index, planting density, and interest rate there is a combination of relative product prices at which landowners should be indifferent between sawtimber and pulpwood rotations.

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METHODOLOGY

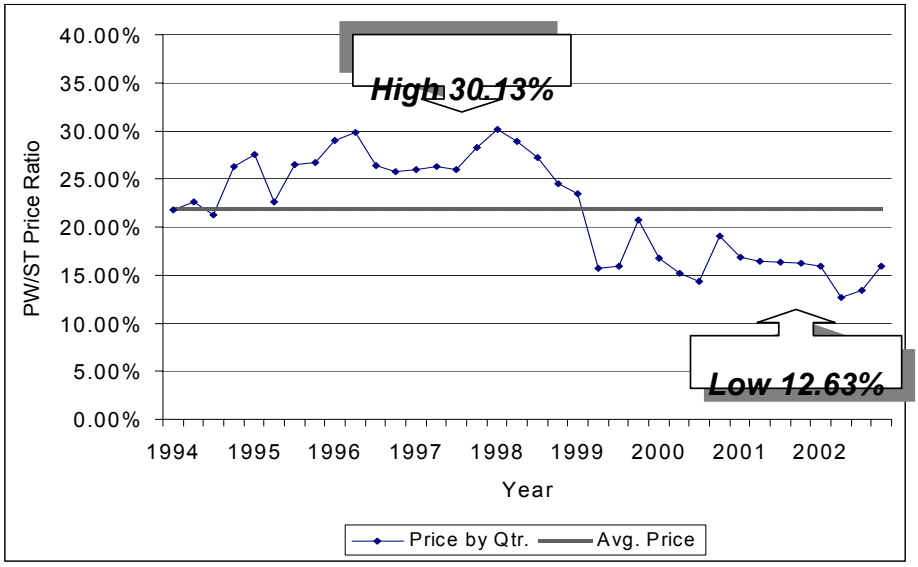
Growth and yield were projected for three management alternatives: no thinning, one thinning, and two thinnings using P-Yield (Hafley and Smith 1989). Land expectation values (LEV) were computed for all projections. Initial stand conditions included a range of site indices and two planting densities. Site indices include SI 50 through 90 base age 25, which are representative of those found in Mississippi. Two initial planting densities of 681 trees per acre and 538 trees per acre were considered. These two planting densities are used to characterize pulpwood and sawtimber regimes respectively as pulpwood rotations are characterized by higher planting densities and sawtimber rotations are characterized by lower densities (Smith et al. 1997). Survival after five years was assumed to be 80%.

End products were limited to pulpwood and sawtimber. Product specifications were eight inches small end diameter inside bark for sawtimber and four inches for pulpwood. Harvest volumes were expressed in tons to simplify comparison of product prices. Thinning ages were determined by Stand Density Index (SDI). The SDI was computed for each age, site index, and planting density using Reineke's (1933) formula for loblolly pine. When the SDI reached 55% of the maximum 450 for loblolly pine, the SDI was reduced to 35% using a low thinning. These upper and lower boundaries are consistent with profit maximizing objectives (Dean and Chang 2002). For each SI and planting density, thinning ages and amounts were held constant for all projections.

Relative product prices rather than absolute prices were used. The stumpage price of sawtimber was set equal to one and pulpwood price was expressed as a percentage of sawtimber price. For analysis purposes, pulpwood price was allowed to vary, reflecting the price variations that have occurred in Mississippi from 1994 to 2003. (See Figure 1.) A range of pulpwood prices was considered that included the high of 30.13% and the low of 12.63%.

Establishment costs were based on South-wide averages for 2000 reported by Dubois et al. (2001). Site preparation costs included chemical treatment and burning. Planting costs were $0.069 per seedling. Thus, the total cost of stand establishment was $129.36 for 681 trees per acre and $119.36 for 538 trees per acre. These costs were expressed as a percentage of the sawtimber price in Mississippi for 2000, since LEV's are based on relative rather than absolute prices.

Figure 1. Stumpage Pulpwood Price as Percentage of Sawtimber Price (1994-2002, MS)



Harvest volumes were projected over a range of rotation ages for each combination of site index and planting density for both product regimes. The range differed for each site index and interest rate, yet was large enough to capture the maximum Land Expectation Value (LEV). Thinning ages were held constant for each combination of SI and planting density, but the final harvest age varied as indicated by LEV. The rotations ages that maximized LEV for pulpwood and sawtimber regimes (i.e., no thinning versus thinning) were determined for each combination of site index, planting density, discount rate, and price.

The optimal rotation age was identified for each management regime. The regime with the highest LEV at its optimal rotation age was identified as the optimal product regime. First, historic prices were used to identify the optimal product regimes for prices likely to occur. Next, prices were varied until the price at which profit-maximizing landowners would be indifferent between sawtimber and pulpwood regimes was identified. Table 1 includes a listing of all financial and biological factors that were allowed to vary.

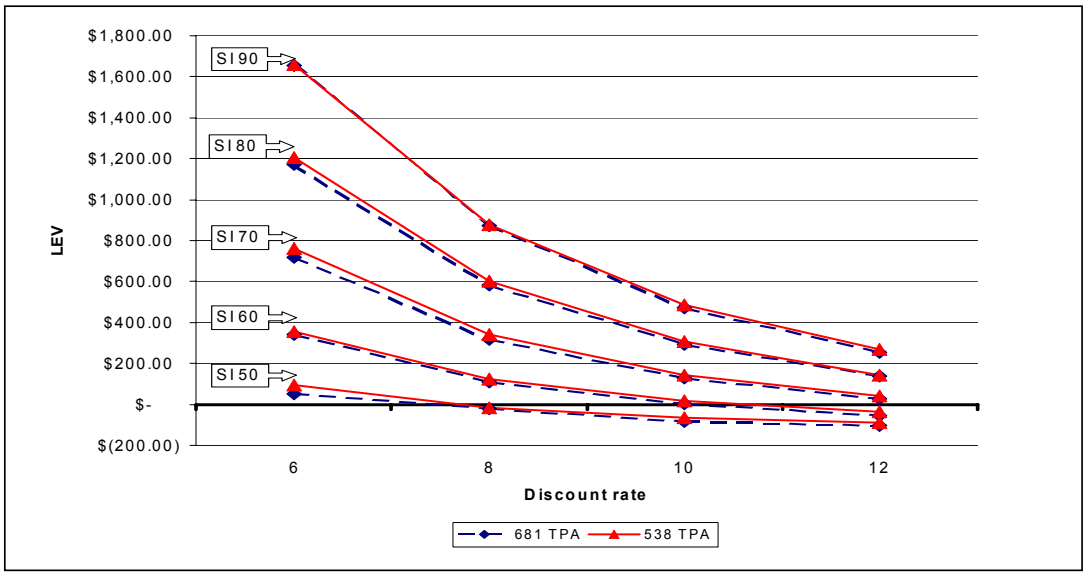
Table 1. Variable biological and financial factors included in growth projections and LEV calculations.

Site Indices	50, 60, 70 ,80, 90 (base age25)
Planting Density (TPA)	681 (9x9), 538 (8x8)
Harvest Age	Variable range
Discount Rate (%)	6, 8, 10, 12
Relative Price Ratio	12.63% to 30.13%

RESULTS

For relative pulpwood prices below 30.13%, the ten-year high for pulpwood in Mississippi, sawtimber rotations are financially optimal for all combinations of site index, planting density, and discount rate. LEV's at the mean price ratio ranged from $1,660 for SI 90 at a 6% discount rate to -$90 for SI 50 at a 12% discount (Figure 1).

Figure 1. LEV's at Mean Pulpwood Price Ratio of 21.90 Percent



the value of pulpwood is 67% of sawtimber value.

Figure 2. Price Indifference Point between PW and ST Rotations – 681 TPA

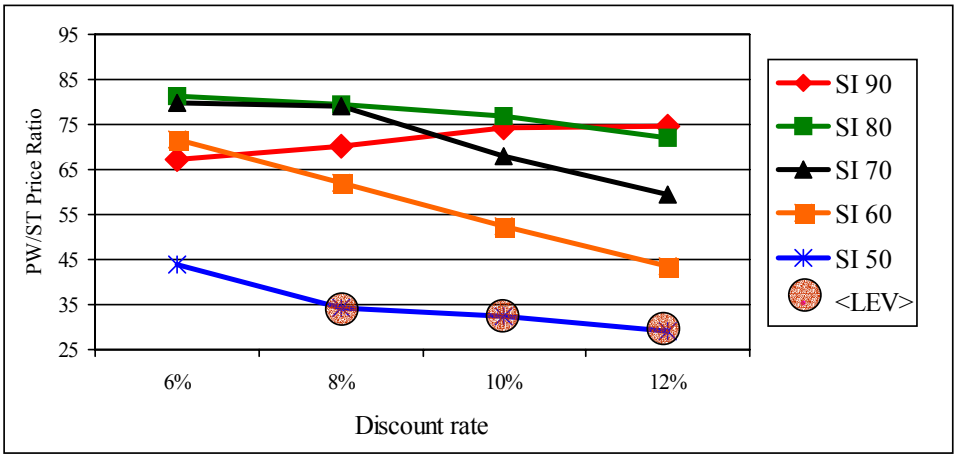
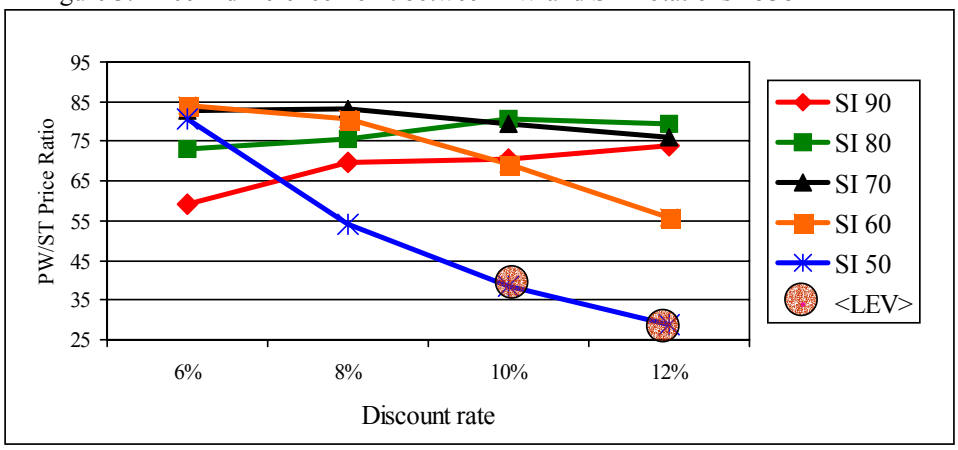
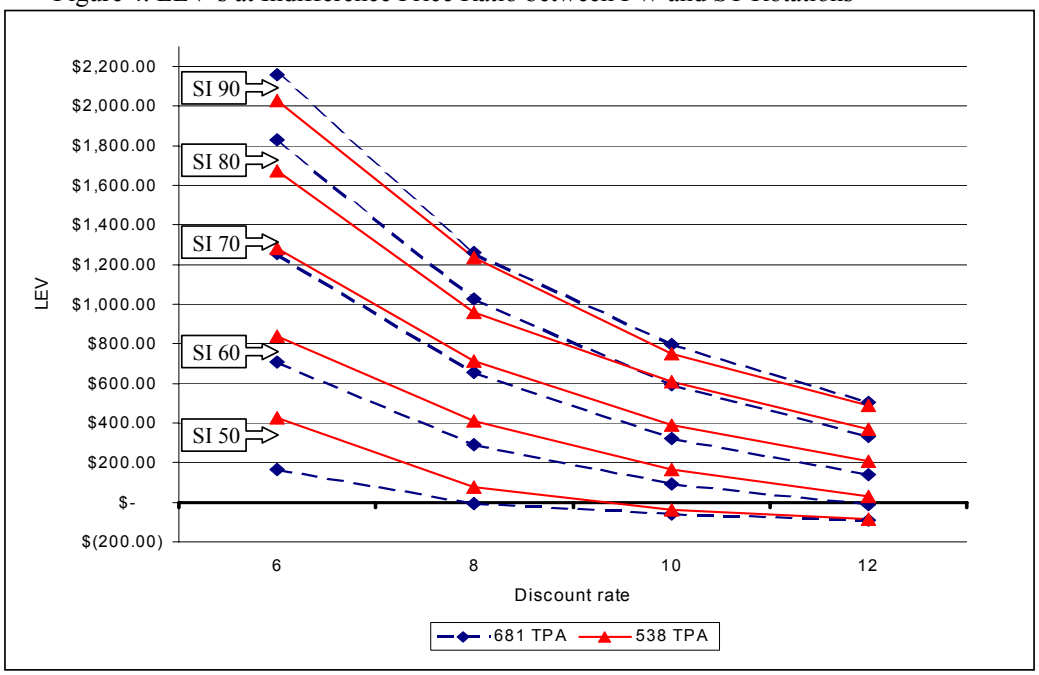


Figure 3. Price Indifference Point between PW and ST Rotations - 538 TPA



LEV's for 538 TPA were greater than 681 TPA over the range of historic prices for all site indices and discount rates considered. This trend was also observed at the indifference price between pulpwood and sawtimber rotations for SI 50, 60, and 70. LEV's at the indifference price ratio for SI 80 and 90 were greater for 681 TPA (Figure 4).

Figure 4. LEV's at Indifference Price Ratio between PW and ST Rotations



DISCUSSION

The indifference price changes with the discount rate. How the indifference price changes depends on site index. For better site indices such as SI 90 and 80, the indifference price ratio increases as discount rates increase. For SI 50, 60, and 70, the price ratio decreases with increasing discount rates. The trends are driven by the relative amount of sawtimber. As the discount rate increases, the optimal rotation age decreases. At lower rotation ages, lower site indices have proportionately less sawtimber volume relative to pulpwood volume. Thus the pulpwood price relative to sawtimber price necessary to make pulpwood regimes optimal does not have to be as high. The better site indices produce a greater proportion of sawtimber earlier in the rotation so higher pulpwood prices are necessary for pulpwood rotations to be optimal compared to lower site indices.

SUMMARY

Sawtimber rotations are optimal at current product prices. Pulpwood rotations are optimal only when pulpwood prices as a percentage of sawtimber prices are extremely high, anywhere from 44 to 84% of sawtimber prices depending on site index and the minimum acceptable rate of return. The indifference price between pulpwood and sawtimber regimes decreases with decreasing site indices and increasing discount rates, except for those involving extremely high site indices. The indifference price ratio increases with increasing discount rates for the better site indices such as SI 90 and 80. At current prices, planting densities of 538 TPA result in greater LEV's than planting densities of 681 TPA.

Considerations for future research include the addition of chip-n-saw, price adjustments for quality, e.g. lower prices for first thinning pulpwood and higher prices for larger diameter sawlogs should be addressed.

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