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SOUTHERN FOREST ECONOMICS WORKERS

Proceedings of the Southern Forest Economics Workers Annual Meeting

Forest Land Ownership in the South: Implications for Management, Production, and Conservation

March 9-11, 2008
Savannah, Georgia

Editors:

J. Siry, B. Izlar, P. Bettinger,
T. Harris, T. Tye,
S. Baldwin, and
K. Merry

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The University of Georgia's Center for Forest Business integrates pioneering academic research and sound financial methods to provide education and service to forest industry, investors and landowners throughout the world.

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The Center for Forest Business was established in 1997 to provide national leadership in education, research, and service to forest industry, private landowners, and Georgia in:

- The integration of sound forest business principles and practices with contemporary biological and quantitative methods to achieve sustainable forest production
- The investigation of forest resources and forest industry alternatives that are economically competitive in the global marketplace.
- The proposal of market-based solutions to forest resource problems and opportunities.

Guiding Principles

- Provide an outstanding forest business educational program focusing on the economic and financial aspects of the resources, markets, businesses, and policies associated with managed forests.
- Serve all those who own, manage, serve, or use resources from managed forests.
- Anticipate challenges and formulate options to keep the forest business sector competitive.
- Communicate work to constituents, keeping them informed about its accomplishments.
- Enhance the economic performance and environmental sustainability of resources associated with managed forests.
- Focus on the southern U.S. in the context of the national and global economy.
- Base research on the best available data.
- Rely on synergistic collaboration with all academic programs in the Warnell School of Forestry and Natural Resources and with selected other programs in the university.

Center for Forest Business
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Athens, Georgia 30602

PREFACE

The Southern Forest Economics Workers 2008 Annual Meeting convened professionals from the forest economics community to discuss developments in forest land ownership change as well as other areas of forest economics in the U.S. South and beyond. The three-day meeting was held in Savannah, Georgia and was attended by a broad array of forest resource professionals from universities, forest industries, consulting firms, federal and state governments, and non-governmental organizations. Our intent was to examine the crucial role that forest economics plays in understanding and managing forest resources.

Keynote speakers included Dr. Mike Clutter of the University of Georgia, Mr. Fred Haeussler of Union Camp Corporation (retired), and Dr. Jack Lutz of Four Winds Capital Management. Dr. Clutter provided an overview of timberland ownership change, while Mr. Haeussler spoke on historical trends in industrial forest operations for the last 50 years. Dr. Lutz addressed the buyer's perspective (both institutional and non-institutional investors) regarding forestland investment. Technical sessions included those related to forest land ownership change, forest management, timberland investment, wood product manufacturing, forest policy, timber inventory, forest carbon, timber trade and markets, international forestry, biofuels, and markets for ecosystem services. In total, there were more than 50 presentations during the meeting. We would like to express our thanks to all individuals who participated in the meeting.

The conference was sponsored by Cellfor, F&W Forestry Services, Plum Creek, Rayonier, Southern Regional Extension Forestry, Timber Mart-South, USDA Forest Service Southern Research Station, Weyerhaeuser, and the Center for Forest Business at the University of Georgia. In addition, the meeting coordinating team included representatives from Mississippi State University and the USDA Forest Service Southern Region. The support of other organizations, including vendors and exhibitors, is gratefully acknowledged. We also would like to thank Steve Grado, Don Grebner, Ian Munn, and Steverson Moffat for planning and conference advice.

Sincerely,

Jacek Siry
Bob Izlar
Pete Bettinger
Tom Harris
Tommy Tye
Sara Baldwin
Krista Merry

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OVERVIEW OF TIMBERLAND OWNERSHIP CHANGE

Michael Clutter
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Research done at the University of Georgia Center for Forest Business has investigated the rapid disintegration of traditional forest products firms in the late 1990s and early 2000s. Since 1995, over 40 million acres of forest products industry timberland holdings have been sold. This “sea change” in land ownership was only seen before in Dust Bowl times when some 60 million acres of cotton land changed hands.

What caused this? Who owns the land now? How is it being managed? What does that management mean for the future of the forest products industry and forest cover? These are some of the research questions being asked by the Center for Forest Business.

[Abstract Only]

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THE SELLER'S PERSPECTIVE

Fred Haeussler
Union Camp
Society of American Foresters National President
(Retired)

The forest products industry underwent tremendous change from the early 1950s to 2008. Productivity of forest land and harvesting increased dramatically through improved seedlings, better silvicultural techniques, fertilization and mechanization. Mill efficiency also increased during the period, and the U.S. South became the world's woodbasket.

The perfection of the wood dealer system, woodlands safety and loss control and the concept of economic rotations all greatly enhanced industry procurement systems. Forest owners and woodlands production systems adapted to new requirements of the Clean Water Act, Endangered Species Act, BMPs and local logging ordinances.

In the early 1980s, corporate raiders typified by Sir James Goldsmith understood the extremely low book value of timberlands on many traditional forest industry firms' balance sheets in relation to their true fair market value. They quickly found a way to unlock that value and this quickly led to a two decade long flurry of mergers, acquisitions, poison pills and declines in shareholder value which continues to this day.

[Abstract Only]

Fred Haeussler was Land Acquisition Manager for Union Camp Corporation in Savannah, Georgia until its merger with International Paper Company. He received his BSF from the University of Georgia and MF from Duke University. He worked for forest industry in positions of increasing responsibility in Alabama, Mississippi and Georgia. He was Society of American Foresters National President in 1986 and was elected a Fellow of SAF. He is also a member of the Georgia Foresters Hall of Fame.

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THE BUYER'S PERSPECTIVE

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Abstract

Most of the timberland formerly held by the large, publicly-traded forest products companies in the United States has been sold or transferred to large institutional investors or timberland real estate investments trusts (REITs). Why are the institutional investors interested in buying timberland? What are the factors that cause individuals to buy timberland?

Keywords: Timberland, investment

Introduction

The publicly-traded US forest products companies have transferred or sold most of their timberlands to real estate investment trusts and institutional investors. What is driving these investors to buy that land? What factors cause individuals to buy timberland?

Institutional Investors

Institutional investors, such as pension funds and endowments, are driven primarily by returns — they need the money. Biodiversity, carbon sequestration, wildlife and scenic beauty have little value for them because those "forest products" currently provide little in the way of financial returns. Why are they so focused on the money?

In the case of pension funds, they are responsible for keeping the roofs over the heads of, and food on the table of, their retirees. Any reduction in financial returns, whether to increase biodiversity or improve recreation opportunities, means that the there will be less money available for the pension beneficiaries. These beneficiaries include retired teachers in Ontario, New York and Arkansas, retired police officers in Colorado and San Antonio, retired college professors everywhere, and retired state employees in Pennsylvania and Oregon. All these pension funds have (or have had) investments in timberland.

Endowments are responsible for the financial foundation of colleges and universities. They contribute to the upkeep of the buildings and provide financial aid. Harvard, Yale and Chicago all have (or have had) significant investments in timberland. Reducing financial returns to promote other forest attributes will mean less money available for scholarships and building maintenance.

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But, while the financial returns are the primary concern, these institutional investors want no environmental surprises. They ***do not*** want to see their name in the headline above a picture that is identified as a forest they own and described as, or implied to be, an environmental disaster. They do not want bad press, even if the activity on their timberland is absolutely legal, ethical, and scientifically sound.

Institutional investors have been buying timberland as a way to diversify their investment portfolios. Timberland is poorly correlated with many other asset classes, such as stocks and bonds, and has performed well against many of them (Figure 1). Timberland often improves the performance of the portfolio (Figure 2).

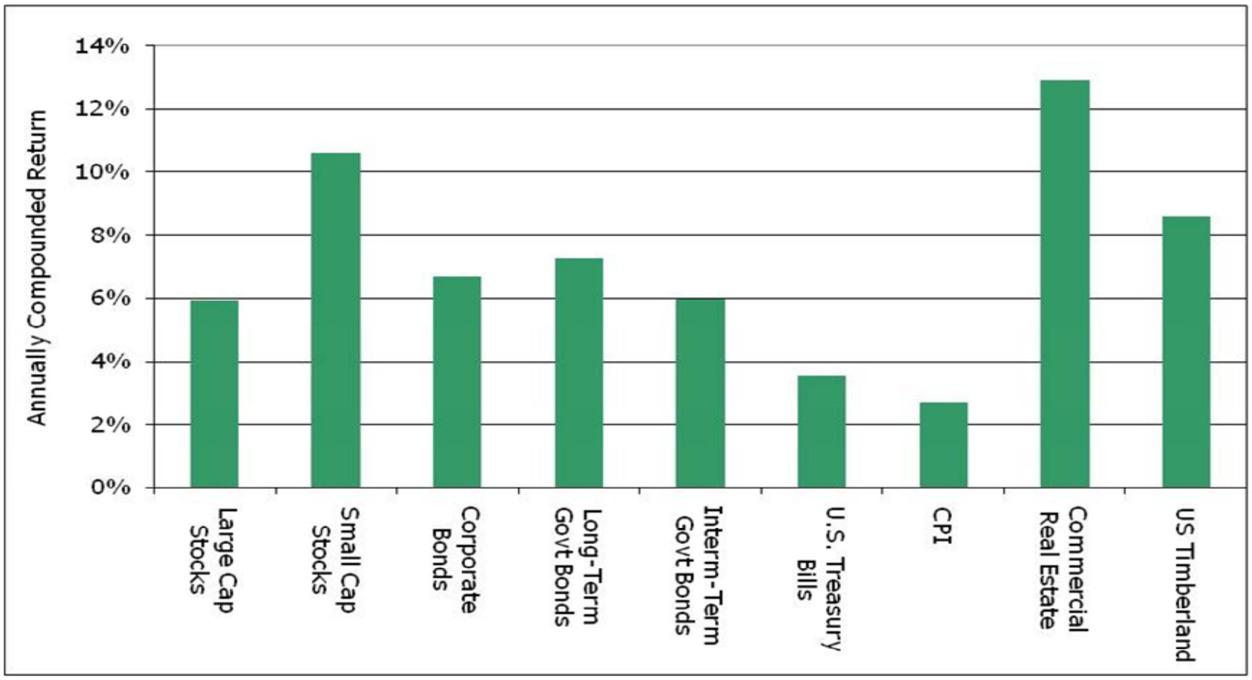

Figure 1. Returns for various asset classes, 1998-2007
Sources: National Council of Real Estate Investment Fiduciaries and Morningstar

<u>Individual Investors</u>

Individuals and families have invested in timberland for centuries and, in fact, own more US timberland than industry did or institutional investors do. Individual and family ownerships are usually smaller than institutional ownerships.

Individual investors are mixed in terms of their investment objectives. While many are concerned primarily with financial returns, many are also in a position to realize non-financial returns as well.

These non-financial returns can include such values as recreation, scenery and wildlife (all in one place in Figure 3).

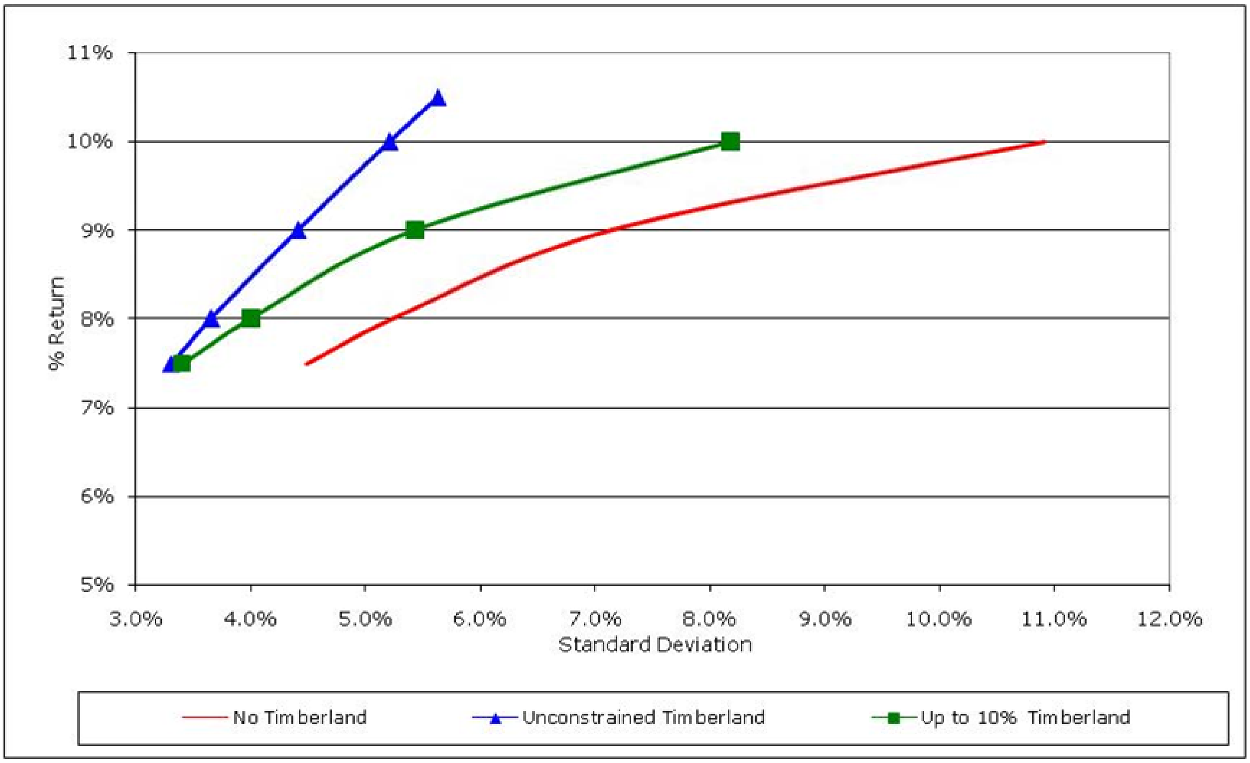

Figure 2. Efficient frontiers for a portfolio with and without timberland

Figure 3. Multiple forest values near Invercargill in New Zealand

Summary

Large institutional investors buy timberland primarily for the money. Their properties are often managed to high standards because they do not want to be identified with environmental problems. Individual investors are more able to focus on non-financial returns because they may not necessarily have to maximize the financial returns from their timberland.

THE IMPERATIVE OF POLICY MANAGEMENT

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Abstract

In order for forests to remain a profitable investment, private forest landowners, both old and new, must develop an effective means to represent their interests on policy issues. This presentation, "The Imperative of Policy Management," gave an overview of the shift in land ownership in the southeastern U.S., how population growth will affect land use, and the potential impact this will have from a policy standpoint as described above. My intention was to demonstrate that policy has the potential to have as much or a greater economic impact on the future of our forests than any force of change. If we do not pay the proper attention to this risk, we as a forest community stand to lose more than an important industry; we could lose our way of life.

Keywords: Investment, landownership change, population growth, risk, southeastern U.S.

Discussion

With the sustained changes in forestland ownership and the massive influx of population predicted for the southeastern U.S., forest landowners are already facing, and will continue to face, new challenges with fewer resources. When traditional forest industries owned large amounts of productive forestlands, they employed policy advocates and analysts to protect their investments against risks associated with policy. With the turnover of the ownership of those lands, the new forest landowners find themselves in the same position as the traditional private forest landowners: a large investment in land with little or no political representation. When policy is set without forest landowner input, the result has the potential of impacting the future of our forests through a reduction of land being managed for forest. This, in turn, has the potential to affect the overall economic health of those states that enjoy a significant economic impact from working forests.

In order for forests to remain a profitable investment, private forest landowners, both old and new, must develop an effective means to represent their interests on policy issues. "The Imperative of Policy Management," is created by the shift in land ownership in the southeastern U.S. and population growth. From a management standpoint and a policy standpoint, these have the potential to seriously impact private landowners.

America's private, non-industrial landowner now owns and manages nearly 60% of our nation's forest resources. With this ownership comes a great responsibility to provide fiber for our

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growing nation and now to provide ecosystem services to our growing population. With the emergence of the ecosystem service interest in our forests, new “stakeholders” have showed up to the policy table with the hope to maintain the current state of our forests. This non-scientific, emotional approach often resonates with policy makers and has increased the pressure on forestry groups to ramp up their efforts to highlight the good work our nation’s forest landowners do on their forests. However, as our population continues to grow we will see more stakeholders and additional regulatory attempts made on these productive forestlands.

In the recent Southern Forest Resource Assessment, Wear and Greis (2002) suggest that “Urbanization will have the most direct, immediate and permanent effects on southern forests — of all forces of change.” By the year 2030, the U.S. is estimated to add an additional 82 million people, a 30% increase, to its population. In the timber rich southeastern U.S., we expect the population to increase by 80% in Florida and nearly 50% in Georgia. This will increase the amount of services in these growing regions and will in turn lead to fragmentation of our productive forestlands. Studies have shown that with increased fragmentation we will see decreased opportunities for traditional forestry practices, wildlife habitat and large scale conversation projects. Along with this we expect to see an increased amount of forest land converted to other uses. The end result being more landowners managing smaller tracts of land that have less potential for traditional forestry and greater potential for development. If we do not pay the proper attention to this risk this creates, then we as a forest community stand to lose more than an important industry, we could lose our way of life.

Landowners have always been aware that there are risks associated with owning and managing forestland, and for the most part, we have always done a good job of managing to reduce the physical risk on our property: fire lines can be plowed, boundaries marked, overstocked stands can be thinned, and routine inspections can alert us to any problems that might be evolving. However, this is one area for which landowners have not so vigilantly managed to protect their property. Much more devastating than a fire or storm, from which landowners can eventually recover, adverse legislation or misguided regulation can interfere with landowners’ abilities to continue managing their forests for today and the future. The good news is that these risks can be managed just as well as physical risks.

Landowners no longer can depend on someone else to mind the shop in Washington, D.C. on their behalf. The paper company lobbyists no longer have forestland on their agenda and instead are focusing their efforts on manufacturing issues. This leaves the responsibility of working with congressional leaders to protect private property rights and encourage new markets for forest products up to the largest ownership group of forests in the country: the private forest landowners. However, landowners cannot abandon their day-to-day jobs to work on all the legislation and regulation that is proposed each year that affects their property, but they can join and financially support the organizations that do this work on their behalf. They can also serve as boots on the ground, when necessary, to stand up and advocate on behalf of their property, their legacy and, for some, their livelihood.

Landowners are under more pressure than ever to become more active on the issues that they face today and indefinitely into the future. As our population continues to increase, we will have more parties at the policy table hoping to influence how private land is managed, and without a strong voice, private landowners are sure to see their rights whittled away. The time to play offense is now, and you can do your part by continuing to participate and support those organizations that support your ideals. The Forest Landowners Association is doing all it can in Washington D.C. to ensure private forestlands are successful. All we need is landowners and those interested in the future of America's private forestlands to respond to when called upon to act on behalf of private forest landowners around the country.

Literature Cited

Wear DN, Greis JG, editors. 2002. Southern forest resource assessment. Asheville, (NC): USDA Forest Service Southern Research Station. General Technical Report No.: SRS-54. 635 p.

TIMBERLAND OWNERSHIP IN THE SOUTHERN UNITED STATES: URBANIZATION AND SOCIO-ECONOMIC FACTORS

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Abstract

This paper applies a multinomial logit approach to examine the determinants of timberland use by ownership using data for eleven states in the Southern United States between 1964 and 2003. With a balanced sample of cross-sectional and time series data at county level, we model timberland use by private industry ownership and non-industrial private ownership, in addition to agriculture, and urban and other land uses, the using maximum likelihood method with multiplicative heteroskedastic correction. We include several urban-related and socio-economic variables, in addition to returns, demographics, and land quality measures, to infer the impact of different variables on timberland use by industrial and non-industrial ownership. The results indicate that significant differences exist in the magnitude of the effect of different variables on timberland use by ownership.

Keywords: Forest industry, non-industrial private forest (NIPF) landowners, land use, modified multinomial logit model, multiplicative heteroskedastic correction

Introduction

Changes in forest ownership reflect different motivations of owning forestland and hence could imply changes in forest management. Accordingly, the services provided by forests will be different under differing ownerships. Therefore, predictions on land use changes by ownership are needed to better understand the implications of various factors for the future of timberland use.

Twenty-seven years ago, based on the subjective opinion of experts, Wall (1981) projected that commercial timberland acreage in the 11 states of the U.S. South (i.e., excluding Kentucky and Oklahoma) would be 167.21 million acres by the year 2000, giving a break-down of timberland ownership under public, forest industry, and non-industrial private forest (NIPF) land owners (farm & miscellaneous private) at 16.74, 38.58, and 111.89 million acres respectively. However,

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the latest data show that there is a large gap between the projections and actual numbers (Table 1). Total timberland in these 11 states increased to 184.09 million acres. In 2002, public and forest industry owned 19.64 and 34.66 million acres between them, while timberland owned by NIPF increased to 129.79 million acres— a gap of 17.9 million acres or 16% between the projected and actual numbers (Smith et al. 2004).

Table 1. Timberland by ownership in 11 states of U.S. South, 1953-2002 (1,000 acres)

Ownership/Use	1953	1977	1987	1997	2002	1953 to 2002	
						Diff.	%
Public	16,225	17,093	18,448	19,213	19,639	3,414	21.0
Forest Industry	30,598	35,596	36,737	35,784	34,664	4,066	13.3
NIPF	141,152	129,505	124,088	127,422	129,787	-11,365	-8.1
Timberland	187,975	182,194	179,273	182,419	184,090	-3,885	-2.1
Agriculture	218,309	220,466	223,484	213,953	208,994	-9,315	-4.3
Urban & Other	23,933	36,759	43,079	46,984	45,514	21,581	90.2

Source: Smith et al. (2004), and Lubowski et al. (2006).

Over the last two decades, a number of studies (e.g., Alig 1986; Mauldin et al. 1999; Hardie et al. 2000; Ahn et al. 2002; Alig et al. 2003; Lubowski et al. 2003) have dealt with modeling land use changes among aggregated groups such as forestry, agriculture, and urban. However, there has been little effort in modeling land use with respect to more disaggregated use groups such as timberland by ownership. By pooling timberland across all ownerships, earlier studies may have assumed that various factors have equal effects on timber land use for all ownerships with an implicit restriction — all forest ownerships respond in the same way and magnitude. Some aspects of timberland by ownership have been studied by previous researchers (e.g., Alig 1986; Plantinga et al. 1990; Ahn et al. 2001), but detailed analysis of the impact of urbanization and socioeconomic factors on timberland use by ownership has not been undertaken.

In this study, we attempt to fill in this gap by developing a model of timberland use by ownership. We apply a modified multinomial logit model using county-level data in the U.S. South. The next section presents the analytical framework used in the study, followed by a description of data. The remaining sections present the results by major land use category and by ownership and draw some conclusions.

Methods

Modern land use theory builds on the contributions of Ricardo, who developed the concept of land rent in rural land use, and von Thünen, who developed a location rent model for urban land use. Miller and Plantinga (1999), and Hardie et al. (2000) develop a theory of land use change by combining Ricardian and von Thünen models. The resulting model depicts landowners' decision problem of allocating a fixed amount of land to alternative uses.

Details of the model specification can be found in Nagubadi and Zhang (2005). The logarithmic transformation and use of cross sectional data induce heteroskedasticity problems from one or more explanatory variables. As a correction to this problem, maximum likelihood estimates are obtained by using the multiplicative heteroskedastic regression method (Harvey 1976; Greene 1993).

Since the dependent variable is the log of the ratio of the proportion of land uses, it is difficult to interpret the coefficients directly, and hence marginal effects (Greene 1993, p666) are estimated at mean levels of continuous explanatory variables, and a value one for dummy variables. The standard errors for marginal effects are computed using the delta method (Greene 1993, p297).

Data

For the purpose of this analysis, county land area is defined as the sum of acreage under timberland, crop, pasture, urban/other uses and excludes water area, unproductive forests, and productive reserve forests. Timberland area by ownership is obtained from Forest Inventory and Analysis (FIA) surveys conducted in different years. To conform to FIA data years, agricultural and other data are linearly interpolated. We exclude public timberland from our analysis since changes in public timberland are not subject to market forces but governed entirely by a different decision making process.

We divide the timberland into two groups by ownership. While private industry timberland includes timberland owned by companies or individuals operating commercial wood-using plants, NIPF timberland includes timberland owned by institutional investors such as TIMOs, REITs, and other tax-advantaged pension funds, individuals or companies, such as private individuals, private corporations, and farmer ranchers, who do not operate any commercial wood-using plants. Land in agricultural use includes cropland, pastureland, and rangeland reported in various agricultural censuses. Land in the urban and other category includes urban land and land devoted to roads, rural transportation, and other special uses, estimated as a residual by subtracting timberland and agricultural area from the total land area in each county (excluding water area).

During 1972-2000, timberland and agricultural land declined while land in urban and other categories increased dramatically (Table 1). However, changes in timberland across ownerships are not identical; timberland under the NIPF ownership group declined, while that under public and industry ownership increased. Within the NIPF ownership group, the share of private corporations comprising large corporate owners such as Timber Investment and Management Organizations (TIMOs), Real Estate Investment Trusts (REITs), and pension funds increased dramatically, while that of farmers declined, whereas that of individuals increased marginally.

To represent the returns to timberland use, we use a weighted sawtimber stumpage price of pine and oak sawtimber weighted by their respective removals. As county level prices are not available, we use prices for two Timber Mart-South (TMS) regions in the state (Norris Foundation). These prices are deflated using the producer price index (PPI) for all commodities (1982=100). As a proxy for agricultural returns, we use county-level net agricultural returns obtained from the National Agricultural Statistics Service (NASS). Net agricultural returns are computed as the total cash receipts from all crops and livestock and total government payments minus total production expenses. Economic returns are expected to help explain timberland, agricultural or urban land use.

Population density is estimated as the number of persons per thousand acres of land in a county using the mid-year population estimates by the Census Bureau's Regional Economic Information System (REIS). As population density increases, we expect a negative impact towards all ownerships of timberland, and a positive impact towards agriculture and urban land use. County-level per capita personal income is also obtained from REIS. The income and median house value data are deflated using the consumer price index (CPI) for urban areas (1982-84=100). We hypothesize that per capita income would negatively affect timberland (including all ownerships) use and agricultural land use relative to urban/other land use.

Ratings on land quality are obtained from the United States Department of Agriculture which range from land capability class (LCC) 1 to 8 where 1 is the most productive and 8 is the least productive (Klingebiel and Montgomery 1961). The proportion of LCC 1 and 2 in the total land area was used in the analysis. The values of the land quality variable for each county are the same for all years. We expect that a high proportion of good quality land leads to more agricultural land use and less timberland use relative to urban/other land use.

Four variables represent the urbanization process and real estate markets in the southern U.S., whether a county has or is close to a metropolitan statistical area (MSA), median housing values (MHVAL), rural-urban continuum (CONTI). MSA is a dummy variable representing counties that include both central and outlying areas of MSAs with a population of 50,000 or more. Data on MHVAL are obtained from the Census Bureau. Since the data pertains to different census years, interpolations are used. CONTI is coded from 1 to 9 for counties that include or lie adjacent to highest to lowest populated metro areas. We expect these urbanization variables would be negatively related to all ownerships of timberland use.

Socioeconomic factors are represented by two variables, the percentage of high school graduates in a county (HEDU) and the ratio of people below the poverty level in a county (POVERTY). These data are obtained from County and City Data Books (U.S. Census Bureau, various years). Higher educational attainment signals higher knowledge level and higher learning attitudes which may influence agricultural land use negatively since knowledge of improved practices would help produce the same quantity of output from lesser area of land. On the other hand, higher educational attainment may also indicate those who have higher educational degrees pursuing employment in urban areas thus leaving agricultural land to be converted to timberland use because of declining real agricultural returns relative to timberland returns, and also inducing higher ownership of timberland as part of an investment portfolio.

Results and Discussion

The estimated results, presented in Table 2, show the impact of urbanization and socioeconomic variables in addition to the returns, demographic and land quality variables. Overall, the model explained 35%, 29%, and 40% of the variation in the proportions of private industry owned, NIPF owned timberlands, and agricultural land use respectively. The results indicate that higher forestry returns (WTDSTPR) have a significant positive effect of increasing timberlands under both forest industry and NIPF ownerships. However, the significant positive and negative effects of forestry and agricultural returns (NETAGRET), respectively, have been counter-intuitive on the agricultural land use.

Table 2. Estimated results of timberland use by ownership (n=2847)[a]

Variable	Forest Industry	NIPF	Agriculture
	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)
WTDSTPR	0.004 (0.001)***	0.003 (0.0003)***	0.001 (0.0004)***
NETAGRET	-0.000 (0.00)	0.000 (0.00)	-0.0002 (0.00005)***
PD	-0.002 (0.001)*	0.000 (0.00)	0.001 (0.00)
PCINC	-0.100 (0.02)***	-0.035 (0.01)***	0.042 (0.01)***
AVLCC	-0.084 (0.06)	0.071 (0.03)**	-0.192 (0.03)***
LCC1N2	-0.591 (0.30)*	-0.079 (0.16)	0.559 (0.18)***
MSA	0.073 (0.09)	0.021 (0.04)	-0.102 (0.05)*
HULAND	-0.001 (0.00)	-0.004 (0.002)**	-0.006 (0.002)***
MHVAL	-0.034 (0.004)***	-0.007 (0.002)***	0.004 (0.002)*
CONTI	0.062 (0.02)***	0.018 (0.01)*	0.004 (0.01)
HEDU	0.013 (0.004)***	-0.009 (0.002)***	-0.017 (0.002)***
POVERTY	-0.004 (0.00)	0.000 (0.00)	0.030 (0.003)***
Adj. R-Sq.[b]	0.35	0.29	0.40
Pred. Share:	0.10	0.54	0.22
Act. Share:	0.15	0.48	0.23

[a] The coefficients for intercept and state dummy variables are excluded here; S.E.=standard error.
[b] Conventional.
* P< 0.10, ** P< 0.05, *** P< 0.01.

Higher population density (PD) has the expected negative impact on forest industry ownership of timberlands, whereas it has no significant effect on both NIPF ownership and agricultural land use. As per capita income (PCINC) of a county increases, the proportion of timberland owned by the forest industry and the NIPF declines significantly, while that of the agricultural land use increases significantly.

As average land quality (AVLCC) deteriorates, as expected, the proportion of timberland under NIPF ownership increases, while the proportion of land under agricultural use decreases significantly. Also as expected, as the proportion of the two higher land quality classes (LCC1N2) increases the proportion of forest industry owned timberland declines significantly, while that under agricultural land use increases significantly.

Among the urbanization variables, while the metropolitan statistical areas (MSAs) have affected the proportion of land under agricultural use negatively, it appears that the MSAs have no influence on the proportion of timberland under forest industry and NIPF ownerships. Housing density (HULAND) has significant negative effect on the proportions of NIPF timberland ownership and agriculture land use, while it has no effect on the proportion of forest industry timberland ownership. Higher housing values (MHVAL) have the expected significant negative effects on the proportion of both timberland ownerships and agricultural land use. As the urban-rural continuity (CONTI) increases towards rural areas, the proportion of timberland ownership by both forest industry and NIPF increases significantly, while it appears to have no effect on the proportion of agricultural land use.

Out of the two socioeconomic factors examined in the model, as the ratio of high school graduates (HEDU) in a county's population increases, the proportion of timberland under NIPF ownership and under agricultural land use declines significantly, while that of timberland ownership under forest industry ownership increases significantly.

The estimated marginal effects are produced in Table 3. The signs of these marginal effects are not always the same as those of the respective coefficients since the complex equations for marginal effects involve the values of several coefficients, means of independent variables, and land use proportions. The sign of the marginal effect for forestry returns on agriculture land use changed to negative, which is appropriate. The marginal effects of the poverty ratio variable turned negative and significant for both forest industry and NIPF timberland ownerships.

The predicted proportions of land use from the above model are 10%, 54%, 22%, and 14% for forest industry, NIPF timberland ownerships, agriculture, and urban and other land uses, respectively, as against the actual shares of 15%, 48%, 23%, and 14%. However a similar analysis that included major uses only, timberland, agriculture, and urban and other uses, gave the predicted proportions of 70% for total timberland use, 17% for agricultural land use, and 13% for urban and other land use as against the actual shares of 63%, 23%, and 14% for the same land uses. As such the model results analyzed along the lines of timberland by ownership are considerably superior to and are closer to the actual proportions of land use than those analyzed by major land uses.

Conclusions

This study uses balanced county data of eleven states in the Southern United States between 1964 and 2003 to examine the determinants of timberland use by ownership. We examine the impact of several urban-related and socio-economic variables, in addition to returns, demographics, and land quality measures, to infer their impact on timberland use by industrial and non-industrial ownership. The results reveal that the analysis by timberland ownership (such as forest industry and NIPF ownerships, and agricultural land use) gave better results compared to the analysis by major land uses (such as timberland and agriculture land uses). Further, our analysis indicates the importance of including the urbanization and socioeconomic factors in the land use analysis.

However, these results should be viewed with caution for several reasons. First, the number of data points for all states is not the same resulting in bias towards states with more data points. Second, the number of counties within each state is also not the same which may result in bias towards states with more counties than others; finally, due to lack of separate data for timberland owned by NIPF for some states the latest timberland ownership data is extrapolated based on proportions in the previous FIA year.

Table 3. Marginal effects by timberland use by ownership [a]

Variable	Forest Industry	NIPF	Agriculture
	Margi. Effects (S.E)	**Margi. Effects (S.E)**	**Margi. Effects (S.E)**
WTDSTPR	0.0002 (0.00006)***	0.0004 (0.0001)***	-0.0003 (0.00007)***
NETAGRET	-0.000 (0.00)	0.00004 (0.00002)***	-0.00005 (0.00001)***
PD	-0.000 (0.0001)**	0.000 (0.00)	0.000 (0.00)
PCINC	-0.008 (0.002)***	-0.008 (0.00)**	0.013 (0.00)***
AVLCC	-0.007 (0.005)	0.044 (0.01)***	-0.039 (0.01)***
LCC1N2	-0.060 (0.03)**	-0.053 (0.05)	0.116 (0.04)***
MSA	0.007 (0.01)	0.013 (0.01)	-0.021 (0.01)**
HULAND	0.000 (0.00)	-0.000 (0.00)	-0.000 (0.00)
MHVAL	-0.003 (0.0004)***	-0.000 (0.00)	0.002 (0.0005)***
CONTI	0.004 (0.002)***	0.001 (0.00)	-0.003 (0.00)
HEDU	0.002 (0.0003)***	-0.001 (0.001)*	-0.002 (0.0004)***
POVERTY	-0.001 (0.0004)**	-0.003 (0.001)***	0.005 (0.001)***

[a] The marginal effects are computed at means of the variables. The marginal effects for the dummy variables are excluded here.
* P< 0.10, ** P< 0.05, *** P< 0.01.

Future research could expand this analysis by demarcating a separate category of large institutional investors such as TIMOs, REITs, pension funds, and such other non-industrial corporate/institutional timberland owners whose objectives may be completely different from those of the other NIPF timberland individual owners or farmers/ranchers with whom these corporate owners are included at present. However, the FIA has recently discontinued reporting timberland data by various categories of ownership within the NIPF owners, rather reporting all private timberland ownerships under just one category "private."

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BEYOND THE FORESTLAND OWNERSHIP: A CHALLENGE OF SUSTAINABLE FOREST MANAGEMENT IN THE SOUTH

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Abstract

Increases in the forest land base and volumes in the South during the past 20 years, due to changes in forestland ownership and other factors, may guarantee the sustainability of timber, but not all forest values. Under the perspective of sustainable forest management (SFM), this paper will discuss the economics of SFM, with specific attention to the South. Due to several pressures on southern forests, applying SFM to the region is challenging. For example, stakeholders and landowners need to build consensus and find solutions that provide incentives for landowners to keep the land in forests. Promoting non-timber product markets increases forestland owners' benefit. The challenge for policy makers and landowners is to address all forest and related components rather than simply timber production.

Keywords: Forest economics, multiple forest values, southern forests, sustainable forest management

Introduction

Forests are natural resources of critical economic importance. They are analyzed separately from other renewable resources due to their importance to the economy and natural environment. In addition, forests possess characteristics of both renewable and nonrenewable resources. Therefore, economic problems relating to forest management and sustainability are complicated. Based on the Samuelson's seminal paper (1976), the conclusions of many great economists in the nineteenth century regarding forest management, in particular the forest rotation, are questionable (Kant 2003). Fortunately, the conventional wisdom in forest economics, which provides the correct solution of optimal economic forest rotation, is based on the work of Faustmann (1849). This paper explains the maximization of timber value as forest value with forest rotation, and is concerned with the assessment of the most advantageous silvicultural system. Faustmann (1849) is a starting point of the neo-classical framework in the area of forest economics that relates to sustained yield timber management (SYTM). Generally, the forest economic model is based on the neo-classical framework that assumes static preferences, social preferences derived from a representative agent, and market signaling with the lack of any institution roles other than market.

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However, practicing only SYTM is insufficient for promoting sustainable forests. "Sustainable," in the forestry context, has been extended beyond timber management. The new and evolving paradigm of forest management, known as Sustainable Forest Management (SFM), is based on the principle of sustainable development and also sustainability of forests (Kant 2004). SFM requires more than the successful regeneration of timber trees after harvest and its silviculture. The concept of SFM incorporates human preferences for timber and non-timber products. It is an outcome of dynamic conditions in the human value system (present and future generations), biodiversity, and a reflection of social, cultural, economic, and environmental conditions (Wang 2004).

The characteristics of forest products and services assist economists to better understand the basic framework of SFM but few related literature have discussed them. Wood grown in plantation forests are private goods, and mostly renewable resources, while wood and measures of biodiversity located on public natural forests are public goods (or "commons"), and mostly exhaustible resources. Forests have different spillover effects to local and global communities (e.g. environmental services, ecological services, and climate change protection). In addition, forests provide positive externalities at the local level due to flood prevention and reduced soil erosion. At the global level, because of their role in carbon sequestration, deforestation could generate horizontal and vertical welfare losses. We can identify some characteristics of forest products and services using the concept of property rights. However, we should not exclude the case of non-market products.

Because forests provide different positive externalities at the local level and global level, forest management should adopt these characteristics as well. At the local level, forest management will differ based on the ownership of those forests. Natural forests at the local level could be seen as local public goods. Based on the concept of SFM, any decision making should be made from the locale with full information of their common assets. At the global level, international agreements in order to facilitate SFM are required. Institution economics, or theory of second best, could be applied to the economics of SFM.

U.S. southern forests serve not only as an important source of timber, but also as the most diverse and complex forest ecosystems in the country. Containing 13 southern states, the southern forestland is estimated about 215 million acres, representing 29 percent of the nation’s forest area (Conner and Hartsell 2002). The majority of the southern forestland is timberlands, which hold about 201 million acres, or more than 93 percent of total forestland in the South. Timberlands in the U.S. South are owned by a diverse group of landowners with varying objectives: industrial, Timberland Investment Management Organizations (TIMOs), Timberland Real Estate Investment Trusts (REITs), non-industrial private forests (NIPFs), and state and local forest landowners. However, applying SFM to the U.S. southern forests is challenging because there are a lot of pressures on the forestry sector and the diverse and complex structures of forest ownership.

The objectives of this paper are to discuss economic perspectives of sustainable forest management and to analyze SFM using facts related to U.S. southern forests. The analysis will be conceptualized by using a comprehensive approach which summarizes the literature relating to SFM, analyzes the trends in SFM, elaborates on the possible economic model for SFM, and suggests economic instruments in order to obtain SFM. By taking a comprehensive approach to this analysis, this article includes a broad variety of issues related to forest management. The analysis aims to contribute to the current debate on SFM by clarifying major issues of common concern. Consequently, the analysis aims to support policymakers in formulating forest policies that encourage sustainable forest management with specific attention to the South.

The study starts by defining sustainable forest management, and tracing the evolution in understanding of the concept. Then, the paper will identify a number of distinctive properties associated with SFM, propose an alternative approach for examining some economic aspects of SFM, and discuss several problems in implementing SFM principles.

Defining Sustainable Forest Management

The beginning of SFM was derived primarily from the concept of sustainable development relating the changes in societal values. SFM has evolved from several international events in global development, including the 1992 United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, the Intergovernmental Panel on Forests (IPF) during 1995–1997, the Intergovernmental Forum on Forests (IFF) during 1997–2000, and the United Nations Forum on Forests (UNFF) in 2001 (Wang 2004). The broad concept of Sustainable Forest Management from UNCED generally called "Forest Principles." The guiding objective of the principles is to contribute to the management, conservation, and sustainable development of all types of forests, and to provide for their multiple and complementary functions and uses. It is worth noting Principle 2b which identifies that “Forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural, and spiritual needs of present and future generations” (FAO 2003a). In addition, Principle 2b discusses "forest resources" as forest products and services, including wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitat for wildlife, landscape diversity, carbon sinks and reservoirs, and other forest products (FAO 2003a).

There is a globally agreed-upon definition of SFM that combines economic values, social values, and ecological values. From the International Conference on the Contribution of Criteria and Indicators for Sustainable Forest Management (CICI-2003) in Guatemala, SFM comprises the following seven common thematic areas: (1) extent of forest resources, (2) biological diversity, (3) forest health and vitality, (4) productive functions of forest resources, (5) protective functions of forest resources, (6) socio-economic functions, and (7) legal, policy and institutional framework (FAO 2003b). Although the degree of implementation of criteria and indicators at the national level varies considerably, the concept of SFM has influenced many initiatives at various levels. It has led to the revision of forest policies and legislation and has been mainstreamed by local, national, regional, and international forestry organizations (FAO 2003a). Therefore, the concept of SFM incorporates the involvement of multiple stakeholders at the multiple levels, from local to global scales (FAO 2003a, 2003b; Wang and Wilson 2007).

The development of sustainability approaches has, for some landowners, transformed forest management from timber management to forest ecosystem management. In addition, it encourages the change from sustained timber yield management (STYM) to sustainable forest management (SFM). Therefore, SFM generally incorporates human preferences for timber and non-timber products no matter what products are in the market (Kant 2003, 2004). This refers to the ways and means of managing forest resources to meet a variety of societal needs, today and tomorrow, without compromising the ecological capacity and the renewal potential of the forest resource base (Wang 2004).

Economic Characteristics of Forests

Forests are important because they provide benefits that include a range of ecosystem services, biodiversity reserves, climate change protection or carbon sequestration, outdoor recreation, and most obviously, sale or use of timber products (Hanley et al. 2007, Kant and Nautiyal 1996). In addition, forests are seen as the homes of diverse species that may be hunted or fished. This implies that forests provide positive externalities at the local level due to, for example, preventing flooding, soil erosion, and soil amelioration. At the global level, forests provide positive externalities because of their role in carbon sequestration or climate change protection (Kant and Berry 2005). Forests around the world are diverse and complex. They range from plantation forests operating like agricultural crops to natural forests holding several interdependent species of trees, plants, and animals. In terms of natural resources, forests could be seen as having mixed characteristics, from a renewable resource like plantation forests to a nonrenewable resource like natural forests (Hanley et al. 2007). Therefore, a single forest management model cannot be globally applied to all forests.

Forests produce market (timber and forest products) and non-market goods (e.g., ecosystem and environmental services, outdoor recreation, etc.). The mixed characteristics of forests create difficulties in policy implementation, especially when we are talking about sustainability. Among that literature, Wang (2007) discussed the public goods characteristic of forest while Price (2007) discussed pecuniary externalities. Hence, this article will contribute to the literature in term of clarifying SFM and proposing an alternative view of economics of sustainable forest management.

In general, markets use prices to communicate both the law of nature (production side) and the law of humans (consumption side). Prices send signals to coordinate efficiently decentralized economic decisions. Markets succeed when prices accurately define the trade-offs we face such that resources are allocated to their highest-valued use in society (Hanley et al. 2001). This economic concept includes not only markets but also market mechanisms. If people constantly rely on timber yield as a forest management objective, natural forests and their related ecosystems would be destroyed and may be exhaustible because a lot of forest related impacts are not internalized into the product prices and the trade-off and scarcity concepts are violated. It is consistent to the discussion that market prices are not an absolute signal or not the only signal of scarcity (Kant 2007), particularly when a resource like forests has mixed economic components or market failure. What are those characteristics of forests?

Forests hold special characteristics of market failure: externalities, public goods, common property resources, and hidden information. Economists make use of the term "pure" and "impure" public goods. The difference is that a pure public good is both non-excludability and non-rivalness in consumption. An impure public good contains either non-excludability or non-rivalness in consumption but not both. Climate change protection, ozone layer conditions, biodiversity, and the high seas are examples of a pure public good in which the benefits accrue to all those around the globe. Common property and club goods, for example, rivers, local parks, lakes, are impure public goods because the benefits can be excluded from non-members of the group who owns the resource. The inefficiently managed common property would make it tragedy (Crowe 1969, Gordon 1954, Hardin 1968). Because of free-riding, common property can end up being the classic and well-known case of the prisoner's dilemma, the social trap or the tragedy of the commons (Hanley et al. 2001, Hanley et al. 2007, Hardin 1968). The dilemma exists when people find that their individual incentives lead them to the worst outcome possible for themselves and society.

In the last two decades, people have realized that "trees are not forests and forests are much more than trees" (Kant 2004). This simple sentence contains at least three economic implications. First, it means that forests are not only timber and forest products; therefore SYTM is economically inefficient because it lacks consideration of biodiversity and other ecosystem aspects. In addition, timber and forest products could be sustained (in timber yield) only in plantation forests, but not natural forests. Under SYTM, natural forests might be valued only by land, timber, and forest products. Those forest areas would be changed into forest plantations as a worse case, but could be changed into agricultural areas or residential areas as the very worst case, and therefore biodiversity and ecosystem services would be forever destroyed.

Second, forests possess special characteristics of externalities, public goods, common property, and hidden information, which are discussed in the economic theory of market failure. In general, market failure comes about (1) when people cannot define property rights clearly; (2) when we cannot transfer rights freely; (3) when we cannot exclude others from using the good; or (4) when we cannot protect our rights to use the good (Hanley et al. 2001, Hanley et al. 2007). Under these conditions, free exchange does not lead to a socially desirable outcome. Because everyone "owns" the right to clean air and good climate and biodiversity, nobody owns the right (Gordon 1954). Therefore, it is impossible for a market to exist so people can trade freely. The market system is incomplete, and we have the problem of missing markets. Therefore by relying only on the market without correcting those problems, we could end up with economic inefficiency. These economic characteristics of forests are also different between plantation forests and natural forests.

Third, not only different levels in terms of local and global forests, but also different areas with the same levels have different impacts on communities. SFM and its policy should incorporate these issues. The ownerships or property rights are the key to alternative solutions of some market failure components, particular in externalities and public goods (Coase 1960). However, due to the difficulties of revealing market failure components and of well-defined property rights, sustainable forest management may end up with the second best theory requiring both horizontal and vertical bargaining and institutional aspects. We will discuss this in the next section.

Economics of Sustainable Forest Management: An Alternative View

The goals of this alternative view of economics of SFM are to correct market failures or incorporate the true forest values (both timber and non timber values) into the market.

Governments or institutions could assist the success of SFM by using transfers, legal requirements, incentives, and information revelation. In addition, as the characteristics of forests change from the local to the global scale, decision making may change due to the different levels of government, different existing forest stocks, and different needs of the people. For example, state governments or other levels of government may or may not have the same objectives under SFM.

Currently, there is a need to distinguish between the expectations of success in SFM for public lands and private lands. The distinction could be made using the discussion in the Nobel literature of Coase (1960), as the well-defined property rights. If some plantation forests belong to private ownerships, those owners have full rights to manage their land and products. In this case, forest managers may choose the SYTM rather than SFM if there is no incentive. If some plantation forests belong to the government, binding agreements or moving forest management toward SFM should be included in the current forest policies. International carbon credit market and forest certification would assist the SFM practice. The carbon credit is an attempt to internalize positive externalities at the global level market and transfer those benefits to the local level market. Forest certification (if binding) will deter illegal logging or deforestation, and support the practice of SFM.

If the ownership belongs to private owners, natural forests and their biodiversity may or may not be conserved. Government transfers, stringent government policies, and forest taxation policies should be implemented. These policies would change the objective function of the owners from deforestation toward conservation. Preserving natural forests, in fact, has more meaning than to maintaining forest areas or timber and forest products. However, implementing these policies requires participation from interest groups and institutions. Conflict of interest may present itself during the process of policy implementation. In contrast, if governments possess natural forests, governments or agencies could require full implementation of policies. In addition, for both cases, information about natural forest values (multiple forest values) should be revealed to interest groups and people as much as possible.

Using this alternative view, SFM could be better applied when certain characteristics of forests are known. This alternative view confirms that SFM containing multiple equilibria due to bargaining and benefit transfers at the forest level. In addition, SFM has multiple dimensions and multiple levels, thus forest management may be viewed as a socio-economic and ecological planning problem for multiple purposes and subject to multiple criteria (Kangas et al. 2005, Wang and Wilson 2007).

Natural forests should be separated from plantation monocultures based on ecosystem management. In addition, major forest products such as pulpwood or sawlog could be explicitly designed using plantation forests and may have mixed forest management on farms. Currently, "with the rapid depletion of offfarm resources, many farmers have responded by planting or maintaining trees on farms" (Arnold and Dewees 1997, FAO 2003a).

The other important question for this alternative view of SFM relates to who makes the decisions. These allocation decisions may be made explicitly by the government or may reflect the interaction of independent decisions by many individual consumers and firms based on ownership. In a 1992 seminar, Solow pointed out that sustainability has been mainly an occasion for the expression of emotions and attitudes, with very little formal analysis of sustainability or of sustainable paths for a modern industrial economy (Solow 1993). In addition, Chichilnisky (1997) found that there exist sustainable preferences which satisfy axioms that suggest neither the present nor the future should play a dictatorial role in society's choices over time. Solow's work implies that there could be solutions for sustainable development and also sustainable forest management without relying on monopolies that maximizes people profits.

A Challenge of Sustainable Forest Management in the South

The U.S. southern forests are an important natural resource with multiple forest values and indirect benefits. Southern forest cover contains 215 million acres, which represents 29 percent of forest area in the U.S. The majority of the southern forestland is considered timberlands, accounting for about 201 million acres or more than 93 percent of total forestland in the South (Conner and Hartsell 2002). Considering the value and volume of timber, the southern forests produce more timber harvest than any single country in the world, producing a highly significant of national income and more than 1.5 million jobs (Wear and Greis 2002). For example, forestry in Georgia has a total direct and indirect economic impact of $20.2 billion supporting a total of over 136,000 jobs. Timberlands in the South are owned by a diverse group of landowners with varying objectives: industrial, Timberland Investment Management Organizations (TIMOs), Timberland Real Estate Investment Trusts (REITs), Non-industrial Private Forests (NIPFs), and state and local forest landowners. The majority of timberland, about 89 percent, is owned by private landowners, a group estimated to be about over 5 million in size (Conner and Hartsell 2002, Wear and Greis 2002). With diverse objectives of non-industrial private (about 80 percent of the forestland owned by private landowners), ranging from timber production to recreational opportunities, a dynamic patchwork of land uses and land conditions has resulted. Industrial landowners, who own about 20 percent of the forestland, remain centered on economics and commodity production (Zhu and Bettinger 2008).

Forests serve not only as an important source of timber, but also as non timber products, wildlife habitat, forest ecosystems, etc. Applying SFM to the U.S. southern forests is therefore challenging. Although many industrial forestry organizations in the southern U.S. have adopted the Sustainable Forestry Initiative (SFIs) to show a commitment to social responsibility, and to demonstrate that their forests are managed in a sustainable manner (Zhu and Bettinger 2008), forest management in this region is more likely to consider timber and forestland by its economic value. In addition, existing non-timber products are not usually valued, and there are no markets for some non-timber values.

There are several pressures on sustainable forests and management specific to the South. First, due to population growth and migration, forestlands have diversified to agriculture and urbanization (Wear et al. 2007, Wear and Greis 2002). Since the 1970s, most of the southern states have experienced a net migration of people and an increase in the conversion of forests for living space, transportation infrastructure, and industrial sites (Alig et al. 2003). If the trend continues, forestland owners will sell more land to developers. As a result, forests are being permanently converted to non-forest uses at an alarming rate. By 2050, an estimated additional 4 million acres will be converted to non-forest uses (Alig et al. 2003). Second, average size of private forest holding has shrunk or fragmented, where the size of adjacent forest patches has decreased (Wear and Greis 2002, Zhu and Bettinger 2008). This fragmentation of forestland makes it more difficult to manage and maintain forest values especially for wildlife habitat, clean water, and air. As stated in Connor and Hartsell (2002), “the practicality of management declines as forested tract size decreases, and those landowners with the fewest acres of forestland have the fewest management options.” Third, large restructuring in paper companies and wood mills since 1997 has resulted in the selling industry forestland either to TIMOs or to private individuals. Fourth, due to ineffective tax policies and assistance programs, family forestland owners find it more costly and difficult to keep forestland, and to pass it down to their next generations. For example, “the amount of forest land that must be harvested each year to pay the tax appears to be on the order of 2.6 million acres, and the amount of forest land that must be sold each year to pay the Federal estate tax appears to be on the order of 1.4 million acres” (Granskog et al. 2002). Government cost-share programs have assisted a small percentage of the total NIPF owner population (Wicker 2002). In addition, there are a large number of forest landowners who are not being adequately served by other assistance programs or are not actively involved in managing their forestland (Blinn et al. 2007). Finally, the diverse groups of landowners may end up losing forestland, especially given the objectives of REITs and NIPFs.

With all these pressures on forests, public participation is needed for a discussion of their future in order to have sustainable forests in the South. State and local governments may provide differential tax to favor forest industry under the positive externalities scheme. Non-timber products market should be promoted, which would increase the economic value of ecosystems.

Conclusions

This paper is an attempt to provide alternative viewpoint about economics of sustainable forest management. Using the concept of market failure, the main discussion in this paper is about how to correct these distortions: externalities, public goods, common property resources, and hidden information. One option to correct the problems is to internalize those externalities, provide information of multiple forest values, and implement some effective policies. Some policies could be seen as another distortion. However, with the welfare economics perspective, double distortion may result in no distortion. Our discussion confirms that timber and forest products are not the full value of forests, therefore SYTM is economically inefficient. Because forests hold special characteristics of externalities, public goods, and hidden information, without correcting those problems (and only relying on commodity markets to value forests), we could end up with economic inefficiency. This paper proposes some requirements in order to promote SFM. However, the process of internalizing externalities may not reflect the full picture of multiple forests values due to some limitations. Therefore, sustainable forest management may result in the second best option, requiring public participation, bargaining, legal requirements, and institutional agreements.

The southern forests are important to the region due to multiple forest and forest related values. Fiscal instruments, such as incentives and disincentives, may help forestland owners hold their lands among land use problems. Government policies should encourage reflecting the true costs and benefits of forest. In addition, all stakeholders can help support non-timber product markets in order to increase the currently non-valued values of forest.

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THE IMPORTANCE OF TIMBER HARVESTING FOR NONINDUSTRIAL PRIVATE FOREST LANDOWNERS IN THE CUMBERLAND PLATEAU OF TENNESSEE

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Abstract

The Cumberland Plateau in Tennessee currently is experiencing widespread forest fragmentation and changes in species composition as a result of land use change. These changes can be attributed partially to industrial forest land divestiture and the lingering effects of the 1998 – 2002 Southern Pine Beetle (SPB) epidemic. The region has recently become a focus of debate concerning land management practices and its effects on biodiversity. Nonindustrial Private Forest Landowners (NIPF) are caught in the crossfire as they control the majority of the forestland on the Plateau that both the forest industry and society need and value.

This study was conducted to evaluate the opinions of NIPF landowners on the importance of timber harvesting objectives relative to other non-consumptive activities and to assess their willingness to sell timber. Preliminary research findings indicate that perception levels concerning timber harvesting and land clearing on the Cumberland Plateau were ranked as being on the high side by respondents. The top three non-consumptive objectives were: to enjoy scenery (m = 3.98), for peacefulness (m = 3.94), or to preserve nature (m = 3.83). Timber management was ranked as only moderately important (m = 2.60). About 45% of all respondents indicated that they had previously sold or harvested timber from their forest land, but only 30% indicated they intended to sell timber in the future.

[Abstract Only]

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FOREST MANAGEMENT INTENSITY OF NONINDUSTRIAL PRIVATE FOREST LANDOWNERS IN MISSISSIPPI: 1998-2006 DATA

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Abstract

Mississippi's nonindustrial private forest (NIPF) landowners who owned at least 20 acres of forestland were surveyed annually from 1998 to 2006 to ascertain how intensively NIPF landowners managed their lands. Specifically, landowners were asked to report the number of acres treated and treatment costs for two broad categories of activities: (1) capital expenditures, which included site preparation, fertilization, regeneration, and road construction; and (2) expensed expenditures, which included property taxes, timber management costs, fees for professional services, routine expenses, hunting management costs and timber sale expenses. For each activity, the data were summarized in four ways: mean cost per acre treated; percentage of landowners engaged in the activity; mean cost per acre owned for all respondents and mean per acre owned for only those respondents who engaged in each activity. Analysis of variance (ANOVA) and regression analysis were used to study changes in forest management intensity over time. The results provided benchmark information on the costs and activities of NIPF landowners and can be particularly useful in the policy arena.

Keywords: NIPF landowners, forest management intensity, management expenditures, Mississippi

Introduction

Forest landowners in the U.S. South play a vital role in satisfying the nation's increasing demand for timber. Growing international and national demands for timber, coupled with the decline in available timber inventory in the western U.S. due to federal and state regulations that restricted harvest, has shifted a large portion of the U.S. demand for softwood to the South (Arano et al. 2002). Southern forests supply half of the timber harvested in the U.S. and this share is rising (Smith et al. 2004). Accurate timber supply projections of southern areas are essential for policy and planning purposes in light of this increasing demand.

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Southern forests make up 28.7% of U.S. forestlands (Smith et al. 1999). Nearly 70% of these are owned by nonindustrial private forest (NIPF) landowners (Powell et al. 1994). Therefore, the accuracy of timber supply projections largely depends on assumptions made about NIPF landowner forest management behavior. The objectives and decisions of these landowners are critical to future timber supply. Forest management intensity and investment behavior by these landowners constitute major impacts on projected timber supply (Adams et al. 1982). In Mississippi, forests cover 18.6 million acres or 62 % of the state's land area and NIPF landowners own nearly 69% of these forests (Figure 1).

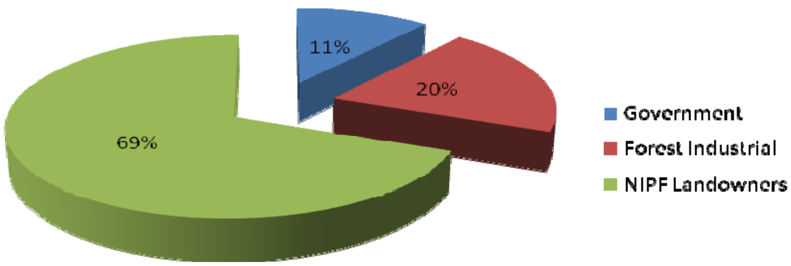

Figure 1. Mississippi forestland by type of ownership

There is limited information concerning NIPF landowner activities and expenditures over time. Various approaches for estimating forest management intensity have been used. See, for example, Adams et al. (1982) and Moffat et al. (1998). A series of articles reported south-wide costs for various silvicultural activities (Dubois et al. 1995, 1997, 1999, 2001). Recently, several studies have addressed the forest management activities of NIPF landowners, focusing on total expenditures for each activity (Arano et al. 2002), treatment costs per acre and total acres treated by timber investment management organizations (TIMOs) and industrial landowners (Rogers and Munn 2003). To our knowledge, however, no comprehensive study has been conducted that examines NIPF activities and expenditures over time.

NIPF landowner behavior is different than forest industry behavior due to the multi-objective nature of NIPF ownership. NIPF landowners may not always respond to prices in the same way that forest industry does, and this makes predicting timber supply from NIPF land quite difficult (Amacher et al. 2003). Detailed information about forest management expenditures and activities incurred by NIPF landowners annually provide a wealth of information about expenses associated with forestland ownership, management practices implemented by NIPF landowners, and changes in management intensity over time. Landowners' expenditures on forest management activities reflect landowners' willingness to invest in timber production and can be used to measure management intensity. Changes in these expenditures over time reflect changes in management intensity and thus may prove useful in many different ways. Landowners need information about the distribution and magnitude of expenditures for various activities as benchmarks for their own management decisions. Timber supply modelers may use such data as inputs to conduct future timber supply projections. Policy makers utilize information concerning practices being implemented, on how many acres, by whom, at what cost, and how often, in order to develop appropriate policies and legislation (Rogers and Munn 2003).

This study investigated forest management intensity of NIPF landowners in Mississippi from 1998 to 2006. The same sampling procedures and survey instruments and questionnaires were used each year. The objectives of the study were to determine:

1) amount of land owned and its composition by forest type;
2) mean cost per acre treated for silvicultural activities;
3) mean expenditures per acre owned annually (costs for silvicultural activities and overhead) for all respondents by activity groups and for those who engaged the activities; and,
4) changes in management intensity over time, trends by activity, and factors which contributed to the changes.

Methods

Data Collection

The survey instrument was designed by the Social Science Research Center, Mississippi State University, using Dillman's (1978) total design method. During the nine years, Mississippi NIPF landowners were surveyed to determine the intensity of their forestry management practices for the previous year. Samples were drawn annually from landowner address lists obtained from tax assessors' records for about 70 of 82 Mississippi counties. The number of available counties varied slightly from year to year. To eliminate as many non-forestry holdings as possible, the survey was limited to landowners who owned at least 20 acres of forestland. Although landowners who own less than 20 acres represent 59% of all forest landowners, they only account for 8.5% of the total forest area in Mississippi (Doolittle 1996).

The survey was designed to determine three types of information: (1) property data, (2) forest management activity data, and (3) expenditure data. Property data included acres owned, in total and by forest type, and ad valorem taxes. Information on forest management activities included activities implemented and the number of acres treated for each activity. Expenditure information was obtained for forest management activities and routine expenses associated with timberland ownership. Activities included mechanical site preparation, chemical site preparation, site preparation burning, fertilization, regeneration, road construction, and timber stand management. Routine expenses included property line maintenance, protection against fire, insects and diseases, road maintenance, animal damage control, as well as supervision and administration, fees for professional service (consulting foresters, accounts, attorneys, and surveyors), hunting management expenses, timber sale expenses and property taxes.

Data Analysis

The data was summarized in four ways for each survey year and for the 9 year period: mean cost per acre treated; percentage of landowners who engaged in the activities; and mean cost per acre owned for all respondents and only those respondents who conducted each activity.

Annual costs per acre treated were computed for the various silvicultural treatments by dividing each landowner's expenditures by the number of acres treated. Only landowners who reported both expenditures and acres treated were included in the initial mean cost per acre calculation. Where landowners reported only acres treated or expenditures, the missing values were estimated using the mean cost per acre treated. Arithmetic means, not weighted means (weighted by the number of acres treated), were computed. Expenditures were not weighted by acres treated because doing so assumed that treatments costs of NIPF landowners that treated more acres were more representative than treatment costs of landowners that treated fewer acres. Overhead expenses were computed on per acre-owned basis, which were also arithmetic averages and not weighted by acres owned.

The responses to the annual surveys were pooled to calculated average annual expenditures over the 9-year period and used analysis of variance (ANOVA) to test for differences in responses (expenditures per acre owned) between treatments (year) . Management activities were grouped into broader categories due to their relatively low frequency of occurrence in sub-categories. These categories included establishment, timber management, ad valorem taxes, overhead and total annual costs. Differences in management intensity between years were examined using ANOVA where expenditure per acre owned for all respondents was the dependent variable and the survey year was the treatment. Multiple comparison tests using Scheffe's method were employed because sample sizes varied from year to year (Kleinbaum and Kupper 1978). A general linear model that adjusted for unbalanced treatment effects was employed.

To examine differences in management intensity, for each of the five categorized management activities, we computed the average expenditures per acre owned for all respondents and tested for significant differences between years. To investigate trends in management intensity over time, a simple linear regression model (OLS) was employed. The dependent variable, expenditures per acre owned, was regressed over a proxy variable for time (corresponding to the 9 years in the study period), total acres owned, and percentage of ownership by forest type. Forest types were planted pine, natural pine, hardwood/pine and non-typed. In light of the small number of differences, we used the 0.1 significance level as the criterion for statistical significance.

Results

The average annual response rate was 25%. In light of the low response rate, response bias was a concern. Comparison of the distributions of ownership size for the respondents and that for the statewide population of forestland owners indicated that the response rate varied by ownership size. Ownership size was, therefore, regressed on total expenditure per acre owned. However, no significant relationship was found. Thus, response bias with respect to ownership size is unlikely to bias the sample means (Figure 2).

<u>Property Data</u>

The average ownership size over the 9 year study period was 278 acres (Table 1). The average area owned did not vary significantly over the study period. The median ownership size was 92 acres, which illustrated the under-representation of the smallest ownership class (20-50 acres) in

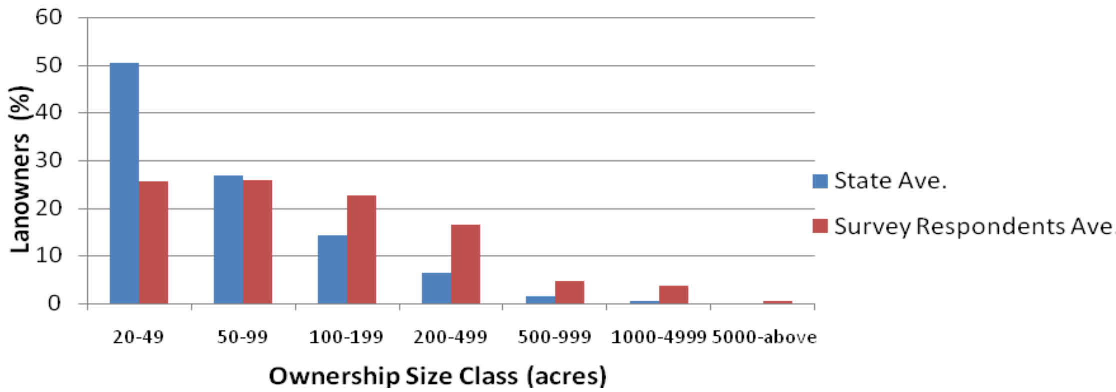

Figure 2. Mississippi NIPF landowners by ownership size class

our sample. Some ownerships in the sample were less than 20 acres, possibly because of the lag between the date when landowner lists were obtained and the date the surveys were conducted. Such landowners might have disposed of portions of their landholdings during the interim (Arano et al. 2002).

Table 1. Forest area owned by Mississippi NIPF landowners, 1998-2006

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**9 year**
Mean	230 [a]*	260[a]	287 [a]	352 [a]	243 [a]	229 [a]	340 [a]	273 [a]	274 [a]	278 [a]
Median	100	100	90	82	90	90	109	91	85	92
Minimum	1	0	20	20	20	20	20	20	20	20
Maximum	3837	15000	12000	97851	10000	6800	20000	16000	15000	97851

*Annual means in a row with the same letter are not significantly different at α =0.05.

Planted pine accounted for 36% of the acres owned by NIPF respondents in Mississippi (Figure 3) followed by hardwood (23%), natural pine (20%), and hardwood/pine (16%). Non-typed areas represented only 5% of total acres owned.

Frequency of Occurrence

Most silvicultural activities occurred infrequently. Fewer than 18% of respondents conducted any specific activity in any year during the survey period (Table 2). Property taxes were reported by an average of 72% of landowners. Approximately 5.7% of landowners conducted mechanical site preparation, 5.4% conducted chemical site preparation and 4.0% conducted site preparation burns. Approximately 5.4% of landowners reported some type of timber management in any year; 17.8% of landowners incurred routine costs; and 11.50% of landowners incurred fees for professional services.

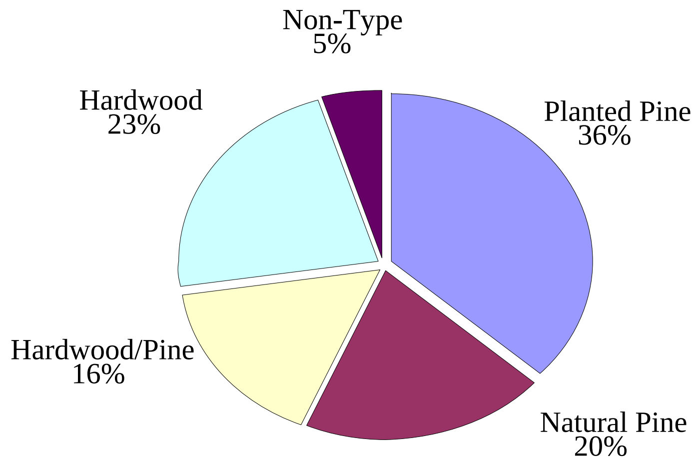

Figure 3. Timberland composition by forest type for Mississippi NIPF landowners (1998-2006 average)

Table 2. Percentage of Mississippi landowners who incurred forest management expenditures, 1998-2006

Expense category	1998	1999	2000	2001	2002	2003	2004	2005	2006	Ave.
					%					
Stand Establishment	16.99	16.17	17.44	16.02	13.79	10.41	11.37	15.92	16.98	15.09
Mechanical Site Prep.	5.01	5.61	5.87	5.81	4.78	6.11	4.31	6.73	7.76	5.74
Chemical Site Prep.	4.79	5.45	7.08	5.11	6.99	4.07	4.51	6.28	3.98	5.42
Site Prep. Burning	4.36	4.46	5.53	3.87	3.13	2.71	2.35	4.71	5.03	4.04
Fertilization	2.61	1.32	1.90	0.88	1.84	1.81	0.98	1.79	2.10	1.66
Regeneration Plants	11.33	11.55	10.71	10.56	8.08	6.10	6.67	8.07	12.16	9.57
Timber Management	4.58	4.99	5.18	4.58	5.73	3.85	4.72	7.22	8.17	5.40
Prescribed Burning	1.53	2.31	2.59	2.28	2.90	1.34	1.96	3.80	4.20	2.54
Fertilization	1.31	1.32	0.86	0.35	0.18	0.67	0.39	0.45	0.84	0.71
Pruning	0.44	0.17	0.69	1.05	1.09	0.67	0.78	1.79	1.26	0.86
Chemical Release	1.31	1.49	1.21	1.05	2.17	1.34	1.57	2.46	2.10	1.61
Pre-commercial Thin	0.00*	0.44	0.66	0.00*	0.18	0.36	0.45	0.20	0.67	0.32
TSI[†]	1.31	0.67	1.04	1.40	1.46	0.45	1.18	0.90	2.53	1.21
Routing Expenses	13.51	17.28	17.79	17.61	15.44	12.67	17.06	27.13	22.22	17.79
Fees For Pro. Service	8.93	12.46	11.23	9.68	12.34	7.92	12.75	13.90	14.05	11.50
Timber Sale Expenses	5.66	4.79	4.66	3.68	4.17	2.68	2.75	3.58	3.98	4.02
Hunting Management	7.19	8.75	6.91	7.90	7.25	8.48	9.02	6.49	8.60	7.85
Ad Valorem Tax	53.16	64.29	75.82	72.71	76.29	73.08	77.65	77.35	76.94	71.95

*None of the landowners in our sample reported pre-commercial thinning in year 1998 and 2001.
[†] Timber Stand Improvement.

Some of these percentages varied significantly over the survey period. Relative percentages are also informative, indicating how common various forest management practices are. For example, planting costs accounted for the majority of stand establishment expenditures reported and were incurred by 9.57% of the landowners over the study period. In contrast, site preparation costs were incurred by 5.2% of landowners. Agricultural conversions undoubtedly account for some of the area planted but not site prepared (Arano et al. 2002). However, these numbers suggest that substantial areas were planted without any type of site preparation.

Average Expenditures of Silvicultural Activities

Stand establishment costs averaged $71.61/acre treated (Table 3). Mechanical and chemical site preparation treatments averaged $90.55/acre treated and $67.70/acre treated, respectively. Site preparation burning averaged $18.68/acre treated.

Table 3. Mean cost per acre treated for Mississippi NIPF landowners who incurred the expenses, 1998-2006

Expense Category	1998	1999	2000	2001	2002	2003	2004	2005	2006
					$/acre				
Stand Establishment	49.93	52.15	64.45	85.34	89.15	77.83	52.21	83.47	100.11
Mechanical Site Prep	39.00	57.01	106.43	77.31	96.00	114.52	22.41	92.86	142.72
Chemical Site Prep	63.30	65.7	71.11	71.42	66.12	63.54	63.06	71.98	73.05
Site Prep Burning	13.01	11.44	22.69	19.97	25.53	14.31	11.52	11.45	38.23
Fertilization	29.38	22.25	34.18	33.26	18.19	28.92	25.56	38.67	25.78
Regeneration Plant	58.00	62.83	70.61	81.57	66.76	79.66	85.71	94.04	75.05
Timber Management	21.99	22.12	46.09	24.94	35.03	32.57	34.83	59.09	54.06
Prescribed Burning	8.60	7.32	6.99	8.97	8.06	17.38	7.51	9.55	26.73
Fertilization	21.41	32.52	15.43	31.25	10.00	19.26	32.50	119.2	10.56
Pruning	10.15	80.00	120.82	17.75	20.54	28.13	71.62	57.23	30.63
Chemical Release	32.94	45.95	49.37	60.65	74.63	70.19	76.97	68.66	76.52
Thinning	0.00	20.00	225.00	0.00	350.00	37.25	0.00	0.00	100.62
TSI*	15.41	12.23	27.73	28.56	32.69	52.50	3.92	69.79	81.81
Total Cost	47.30	47.47	62.27	64.50	79.48	72.33	49.98	78.19	96.96

* Timber Stand Improvement.

Regeneration costs averaged $73.64/acre treated. Timber management costs averaged $37.23/acre treated. Timber stand improvement and pruning averaged around $40.00/acre treated, while chemical release averaged $63.65/acre treated and pre-commercial thinning averaged $138.86/acre treated, which is relatively high compared with other researchers' results. Landowners may conduct multiple silvicultural activities on the same acres, so detailed data as mechanical site preparation, chemical site preparation and planting cannot be simply added into categorized silvicultural practices as stand establishment and timber management costs.

Average Expenditures for Landowners Who Incurred the Expenses

To provide better estimates of actual forest management expenditures landowners were likely to incur, we computed average annual expenditures per acre owned for respondents who engaged in activities. This method is suitable for property level activities such as fees for professional services, routine costs and property taxes (ad valorem taxes). Over the survey period, capital expenditures averaged $31.89/acre owned, while overhead expenses averaged $13.57/acre owned and property taxes averaged $4.97/acre owned (Table 4).

Table 4. Mean expenditures per acre owned for Mississippi NIPF landowners who incurred the expenses, 1998-2006

Expense Category	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
					$/acre				
Stand Establishment	21.54	21.68	26.02	29.67	39.82	23.70	18.70	29.15	39.00
Mechanic Site Prep	11.06	20.73	27.51	17.67	13.5*	19.36	3.48	19.97	24.89
Chemical Site Prep.	13.49	13.30	23.01	18.60	17.01	11.10	16.20	17.91	10.37
Site Prep. Burning	3.85	2.86	3.00	6.07	5.50	0.79	1.16	3.19	11.20
Fertilization	8.20	4.64	6.66	16.18	4.69	5.81	8.33	10.06	6.81
Regeneration Planting	18.45	13.41	14.60	22.71	18.76	13.60	17.00	22.81	24.30
Others	27.69	13.83	29.87	18.80	19.30	31.80	27.00	17.06	28.00
Capital Expenditures	29.34	22.58	34.80	30.81	36.82	32.20	26.50	32.32	41.60
Timber Management	7.46	4.36	15.80	4.78	13.24	6.36	6.31	31.21	13.00
Overhead Expenses	17.48	15.18	13.70	12.30	12.00	12.20	10.60	12.45	16.80
Routine Expenses	5.60	4.71	9.15	5.96	4.52	5.35	6.23	7.97	13.10
Fees for Prof. Service	6.84	8.30	9.93	10.83	7.68	8.15	7.49	9.11	9.30
Timber Sale Expenses	38.81	41.12	15.79	21.89	26.38	20.4	14.60	13.71	5.45
Hunting Expenses	4.29	4.74	3.10	4.04	3.30	16.00	5.29	4.96	7.56
Property Taxes	2.82	4.40	4.26	4.74	4.88	5.45	5.51	5.72	6.52
Expense Expenditures	9.36	9.98	9.83	8.80	9.32	8.75	9.34	13.40	13.40

<u>Average Expenditures for All Respondents</u>

To illustrate the magnitude of forest management expenditures for NIPF landowners as a group, we computed the sample means for all the reported expenditures for each forest management activity on a per-acre-owned basis for all respondents every year.

Over the survey period, total annual expenditures averaged $14.4/acre owned (Table 5). Annual capital expenditures averaged $6.6/acre owned, while overhead expenses averaged $3.63/acre owned for all respondents. Property taxes are NIPF landowners' most frequent and greatest expenditures, which accounted for 40% of expensed expenditures on average. Regeneration planting averaged $1.77/acre owned, which is 70% of total stand establishment expenditures.

<u>Differences and Trends between Years</u>

The ANOVA F-test confirmed that expenditures per acre owned differed among years (Table 6). For timber management, ad valorem tax and total annual cost, the null hypotheses that expenditures per acre owned did not differ over the study period was easily rejected with P-values of 0.0028, 0.0001 and 0.0762 respectively. However, expenditures per acre owned for

Table 5. Mean cost per acre owned for Mississippi NIPF landowners, 1998-2006

Expense Category	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
					$/acre				
Stand Establishment	3.74	3.54	4.62	4.81	5.51	2.48	2.12	4.61	6.63
Mechanical Site Prep.	0.55	1.17	1.62	1.03	2.65	1.19	0.15	1.34	1.94
Chemical Site Prep.	0.65	0.73	1.63	0.95	1.19	0.45	0.73	1.12	0.41
Site Prep. Burning	0.17	0.13	0.17	0.23	0.17	0.02	0.03	0.15	0.56
Fertilization	0.21	0.06	0.13	0.14	0.09	0.11	0.08	0.18	0.14
Regeneration Planting	2.09	1.56	1.56	2.40	1.52	0.83	1.13	1.84	2.96
Others	2.41	1.40	3.10	1.92	1.70	2.45	2.86	2.03	3.76
Capital Expenditures	6.09	4.93	7.65	6.67	7.20	4.91	4.99	6.67	10.23
Timber Management	0.34	0.22	0.82	0.22	0.76	0.24	0.3	2.25	1.04
Overhead Expenses	3.81	4.08	3.76	3.23	2.96	2.42	2.94	4.41	5.04
Routine Expenses	0.76	0.81	1.63	1.05	0.7	0.68	1.06	2.16	2.91
Fees for Prof. Service	0.61	1.03	1.11	1.05	0.95	0.65	0.95	1.27	1.31
Timber Sale Expenses	2.20	1.91	0.74	0.81	1.12	0.55	0.40	0.49	0.22
Hunting Expenses	0.24	0.32	0.28	0.32	0.20	0.54	0.52	0.49	0.60
Property Taxes	1.50	2.83	3.23	3.45	3.73	3.98	4.28	4.42	5.02
Expense Expenditures	5.65	7.14	7.81	6.89	7.41	6.65	7.52	11.01	11.07
Total Annual Cost	11.74	12.12	15.48	13.57	14.13	11.23	12.53	17.71	21.16

stand establishment and overhead did not differ over the study period. Therefore, a simple linear regression was used to test for trends over time, but was only applied to timber management, ad valorem tax and total annual costs.

We then made a comparison between each pair of annual means using Scheffe's multiple comparison tests. There were 36 comparisons for the nine years (Table 7). For property tax, the mean for year 2006 is the highest and the mean for year 1998 is the lowest. The means for year 2001 was not statistically different from that of year 2002, 2003, 2004 and 2005. For total annual cost, the mean of year 2006 was also the largest, while the means of years 1998, 1999, 2001, 2002, 2003, and 2004 were not significantly different.

Timber management expenditures, property taxes and total annual cost varied by years based on the pair-wise tests. Property taxes, timber management costs and total annual costs significantly increased over the study period (Table 8).

Not surprisingly, the main factor that affected stand establishment costs was the percentage of ownership of planted pine because planted pine can respond well to intensive management during planting. Planted pine also contributed to expenditures per acre owned of property tax and total annual expenditures.

Table 6. ANOVA table of average expenditures per acre owned for Mississippi NIPF landowners, 1998-2006

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-value	P-value
Stand Establishment					
Between Years	8	7953.8	994.2	1.2	0.3238
Within Years	4608	3972128.0	862.0		
Total	4616	3980081.7			
Timber Management					
Between Years	8	1631.7	204.0	2.9	0.0028
Within Years	4606	320070.0	69.5		
Total	4614	321701.8			
Overhead					
Between Years	8	2588.8	323.6	0.6	0.7927
Within Years	4617	2562432.2	555.0		
Total	4625	2565020.9			
Ad Valorem Tax					
Between Years	8	4048.5	506.1	9.5	<0.0001
Within Years	4618	246955.9	53.5		
Total	4626	251004.4			
Total Annual Cost					
Between Years	8	40308.2	5038.5	1.8	0.0762
Within Years	4596	13017011.9	2832.3		
Total	4604	13057320.1			

Table 7. Multiple comparison tests of average expenditures per acre owned for Mississippi NIPF landowners, 1998-2006

	Stand establishment	Timber management	Overhead	Property tax	Total annual cost
Year	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**
1998	3.67^{a}	0.34^{ab}	3.81^{a}	1.50^{c}	11.74^{b}
1999	3.54^{a}	0.22^{b}	4.08^{a}	2.83^{bc}	12.05^{b}
2000	4.55^{a}	0.82^{ab}	3.76^{a}	3.23^{b}	15.48^{ab}
2001	4.75^{a}	0.22^{b}	3.32^{a}	3.40^{ab}	13.57^{b}
2002	5.51^{a}	0.76^{ab}	2.96^{a}	3.73^{ab}	14.12^{b}
2003	2.48^{a}	0.24^{b}	2.42^{a}	3.99^{ab}	11.23^{b}
2004	2.12^{a}	0.30^{b}	2.94^{a}	4.28^{ab}	12.52^{b}
2005	4.64^{a}	2.25^{a}	4.41^{a}	4.42^{ab}	17.71^{ab}
2006	6.63^{a}	1.04^{ab}	5.04^{a}	5.02^{a}	21.16^{a}

*Annual means in a column with the same letter are not significantly different at α =0.05.

Table 8. Results of regression analysis on mean expenditures per acre owned for Mississippi NIPF landowners, 1998-2006

	Stand Establishment	Timber Management	Overhead	Property Tax	Total Annual Cost
Variable	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Intercept	-95.84451	-245.90558*	-80.66954	-661.25576*	-1282.59295*
Year	0.04939	0.12307*	0.04207	0.33154*	0.64632*
Total Acres	-0.00001	0.00005	-0.00002	-0.00004	-0.00005
%Planted Pine	6.39426*	0.48987†	0.28472	1.99716*	9.56389*
%Natural Pine	-2.05664†	0.14525	-0.26455	1.56267*	-0.27233
%Hardwood/Pine	-1.69261	-0.20119	-0.70843	0.64140†	-1.23580
%Non-typed	1.04992	0.67723	2.91969†	1.26990*	8.23803*
r^2	0.0099	0.0026	0.0009	0.0285	0.0079
r^2 -adjusted	0.0087	0.0013	-0.0004	0.0272	0.0066
F-test	7.6900	2.0300	0.7100	22.5100	6.1100

*Significant at the 5 percent level.
†Significant at the 10 percent level.

Discussion

The study examined forest management intensity of NIPF landowners in Mississippi during the period 1998-2006. Expenditures and activities data provided a wealth of information with potential uses in a broad range of applications. A substantial portion of expenditures required by timberland ownership are "nonproductive", as illustrated by the relatively high overhead expenses per acre owned for all respondents. Expenditures also reflected an informal ranking of timber management activities. Focusing strictly on stand establishment activities, it was clear that landowners viewed planting as the most important timber management activity. Over half the money spent on timber management was spent on planting.

The study also illustrated an interesting aspect of investing in forestland. Expenditures can vary dramatically depending on the activities a landowner undertakes. Expenses such as regeneration costs and timber sale costs, which were directly related to timber production, either through enhancing timber growth or returns on timber sales, accounted for more than half of the total annual expenditure per acre owned. On average, property taxes represented 40% of the expensed expenditures per acre owned and 25% of the total annual expenditures per acre owned for all respondents during the survey period. From a policy perspective, it is interesting to note that property taxes are NIPF landowners' greatest annual expenditure.

Most forest management expenditures occurred infrequently. NIPF landowners with smaller and fragmented holdings have the fewest management options (Conner and Hartsell 2002), which could be one of the reasons why most landowners do not engage in forest management. Fewer than 18% of respondents reported annual expenditures for any specific activity in any year during the survey period. Even when activities were grouped into broad categories, such as stand establishment, timber management cost, fees for professional service and routing expenses, the percentage of respondents incurring expenditures in these aggregated categories was still relatively low. This is, however, consistent with the long term nature of forestry (*e.g.*, a stand of forest is only regenerated once a rotation or about every 35 years).

Expenditures information may prove useful in predicting timber supply. All else being equal, greater expenditures indicate more intensive forest management. Hence, periodically monitoring forest management related expenditures might provide indicators of future timber supply trends. For example, constant expenditures over years (adjusted for inflation) suggest relatively consistent timber supply in the future. While NIPF landowners are not as actively involved in intensive management as industrial owners, these findings suggest some potential problems for future timber availability in the South. Intensive management of NIPF timberlands is needed to substantially reduce future timber scarcity (Provencher 1990).

Finally, the information provided by this study can be particularly useful in the policy arena. Repeated studies over time provided insight into changes and trends of forest management intensity in a cost efficient manner. Policy makers need accurate information concerning NIPF landowners' forest management intensity (*e.g.* what practices are being implemented, on how many acres, by whom, and at what cost) in order to develop appropriate policies as incentive means or legislation. For state owned many NIPF landowners as Mississippi, such policies and legislation may have impacts on rural economies. Property tax policies, as a specific example, may be influenced by accurate expenditure information. This study has shown that surveying landowners is an effective method for obtaining low-cost, reliable and current forest practices information that can be used for landowners, policy makers, timber supply modelers, and other public uses.

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EFFECTS OF LENGTH OF OWNERSHIP ON FORESTLAND MANAGEMENT AND USES ON THE CUMBERLAND PLATEAU OF TENNESSEE

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Abstract

The Cumberland Plateau of Tennessee has been the focus of a number of debates recently regarding the management of the region's natural resources. The main reasons include a significant divesture of land holdings by forest industry, a renewed interest in retirement- and second-home developments, and increased attention on the unique natural characteristics of the region. Using a 2005 survey data, this paper employed a logit model to identify how new landowners differ in motivations and demographics from those who have owned the land for a longer time period of time. Results suggest that new landowners have stronger motivations such as for privacy purpose, future timber use, as well as long-term financial investment. The significant demographic factors include where landowners spent most of their lives (rural, suburban, or urban), age, marital status, and residence acreage. To examine the effects of length of ownership on forestland management and uses, t-tests were used to show the differences in their past management practices, land uses, and future likelihood of activities. Results indicated that, in general, new landowners were more likely to have conducted management practices in the past five years. New landowners and their family members also used their lands more frequently for activities such as picking non-timber forest products (NTFPS), collecting firewood, and engaging in recreation. The comparison of likelihood of future activities is generally consistent with the past management and land uses. However, there is slightly more uncertainty on future land use change associated with new landowners. This study is useful not only for future natural resource management in Northern Cumberland Plateau but also for predicting future timber supply and other services from the forests of this region.

Keywords: Demographics, logistic regression, motivations, nonindustrial private landowners

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Introduction

Non-industrial private forests (NIPF) provide important environmental and economic benefits in the U.S., and landowner characteristics have important implications for forest sustainability, including timber production and other natural resource services (Butler and Leatherberry 2004). Anchored by federal and state-owned lands, the Cumberland Plateau harbors the largest expanse of un-fragmented, privately owned forestland in the South, with approximately 80% privately owned (Wear and Greis 2002). Recently, the Cumberland Plateau region of Tennessee has been the focus of a number of debates regarding the natural resource management, which is mainly caused by the trends in land markets and great changes in landownership in this region.

During the past decade the Plateau has experienced a divesture of land holdings by the largest forest industry landholders in the region, as well as some sales by coal companies that controlled a significant portion of the Plateau forests. A significant portion of this has been purchased by Timber Investment Management Organizations (TIMOs). The sale of forest industry lands has drawn attention to the trends of land ownership due to the amount of acres involved and the ongoing debates over forest management in the region.

The most significant change in the region has been the growth in retirement- and second-home development. Focus group interviews with real estate developers and local government officials have revealed that a substantial portion of large tracts in the region have changed hands in the past decade, peaking in 2005, and many of these tracts have been subdivided for development (Hartsfield et al. 2007). According to Hodges and Hawk (2007), the number of parcels sold in subdivision in a five-county portion of the Plateau more than doubled between 1996 and 2005, whereas non-subdivision parcels increased by less than 15 percent.

The other trend observed is a significant change in the individuals purchasing the parcels. Most notably, the number of Florida residents purchasing Plateau parcels increased from slightly less than 800 in the 1996-2000 period to almost 2000 residents for the 2001-2005 period. This can be attributed partially to the halfback phenomenon in which northern state retirees who moved to Florida for warmer weather have moved halfway back ‘home’. Additionally, a number of these individuals are moving north to escape high property values and the associated property tax, as well as the increased costs of insurance after the hurricane damage of the past few years (Hartsfield et al. 2007). There is also an increase in the number of people residing in southern and midwestern states such as Ohio, Michigan, and Wisconsin, who are moving to the Plateau to retire.

One recent study investigated the reasons for owning forestland in the Northern Cumberland Plateau (Longmire et al. 2007). The results revealed that non-consumptive uses received a greater percentage of important rating than unimportant, i.e., scenery enjoyment, privacy purpose, watershed protection, long-term financial investment. These reasons are consistent with motivations of southern NIPF landowners cited in earlier studies (Butler and Leatherberry 2004; Pan et al. 2007). However, few studies have examined the trends of NIPF landowners on the Northern Cumberland Plateau and the effects of these trends on forestland uses and the natural resources of the region. Therefore, the goal of this research was to identify how new landowners differ from those who have owned the land for a longer period of time, and how these differences will affect forest sustainability. The specific objectives are to: (1) identify new landowners' motivations and demographic factors associated with acquiring woodland on the Northern Cumberland Plateau; and (2) compare the management behaviors and woodland uses between the old and new forestland owners.

Methods and Data

Logistic Regression

To fully understand the changes in landowners' characteristics on the Northern Cumberland Plateau, a logit model was used to identify the differences in motivations and demographics between the new and old landowners. The dependent variable is a dichotomous variable created using the year of acquiring the majority of the woodland. Based on the woodland market in the Northern Cumberland Plateau, dummy took the value of 1 if the land was obtained in the year of 2000 or later, and zero otherwise. The logit model can be expressed as (Wooldridge 2006):

$$\Pr(y = 1|z) = \frac{e^z}{1+e^z};$$

$$z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k$$

The motivation factors analyzed included the landowners' opinion of the importance of various reasons for owning forestland as well as the likelihood of future timber use. A dummy variable was used for the importance of woodland; with a value of 1 if the landowner indicated that the factor was important or very important, and zero otherwise (Table 1). Three factors were examined, including the importance of woodland as a long-term financial investment, for privacy purpose, and for non-timber forest products (NTFPS), such as nuts, berries, and mushrooms. The likelihood of future timber use is the average likelihood of collecting firewood, cutting sawlogs, and cutting pulpwood over the next five years on the woodlands.

Demographic factors included age, gender, marital status, race, level of education, occupation, acreage of residence, income, and living area. Dummy variables were used for gender, marital status, race, and occupation factors (Table 1). The education factor was ranked into 8 levels, with 1 for less than 12th grade and 8 for a professional degree. Income is the estimate total household income over the past 12 months. It was classified into 6 levels, with 1 for less than 10,000 dollars and 6 for 100,000 dollars or more. The factor of living area indicates the area where landowners lived for most of their lives, with 1 for urban, 2 for suburban and 3 for rural areas. The model was then specified as:

$$\begin{aligned} &LOGIT\ P(new = 1|X_i) = \beta_0 + \beta_1 imp\_inv + \beta_2 imp\_ntim + \beta_3 imp\_priv + \beta_4 fut\_timus \\ &+ \beta_5 age + \beta_6 gender + \beta_7 marsta + \beta_8 race + \beta_9 educ + \beta_{10} farm + \beta_{11} resiarce \\ &+ \beta_{12} income + \beta_{13} arealife \end{aligned}$$

Table 1. Definition of independent variables in the logit model for the identification of new and old NIPF owners on the Northern Cumberland Plateau of Tennessee

Variable	**Definition**
imp_inv	Dummy = 1 if long-term financial investment is important
imp_ntim	Dummy = 1 if picking nuts, berries, etc. is important
imp_priv	Dummy = 1 if privacy purpose is important
fut_timus	Likelihood of future timber use (very unlikely *1* – very likely *4*)
age	Age of the landowner
gender	Dummy = 1 if male
marsta	Dummy = 1 if married
race	Dummy = 1 if white (non-Hispanic)
educ	Level of education (*1* for <12th grade – *8* for professional degree)
farmer	Dummy = 1 if the landowner is a farmer
Resiacre	Acreage of landowner's residence
income	Total household income (1 for <$10,000 – 6 for >$100,000)
arealife	Living area for most of life (Urban *1*, Suburban *2*, and Rural *3*)

The data for the analysis were obtained from a 2005 mail survey of private forest landowners in the Emory-Obed watershed, which covers Morgan and Cumberland counties and the Plateau portions of other six counties in Tennessee. After eliminating inaccurate addresses and landowners who no longer owned land in the watershed, the sample population was reduced to 1010 from the original 1462 surveys mailed out. 555 of the 1010 individuals returned usable surveys for a response rate of 55%.

Comparison of Management Behaviors and Land Uses

Based on the survey data of the Emory-Obed watershed, differences in landowner management behaviors and woodland uses, as well as likelihood of future activities, were compared to assess the effects of length of ownership. Assuming the data are normally distributed, the t-test was performed to examine the significance of difference between the mean of new and old landowners. The percentage of landowners who conducted each management activity in the past five years was used to evaluate the difference of the two landowner groups in this management practice. The management activities examined in this study included: timber stand improvement, building ponds or drainage ditches, building roads or trails, management for wildlife populations, applying pesticides or herbicides, and preparing land for tree planting.

The frequencies of different woodland uses in the past 12 months were used to compare the difference of two groups of landowners in land uses. The frequency in the survey was classified as never, once, seasonally, monthly, weekly, and daily. For the purpose of simplification, they are weighted as zero through 5 for the statistical mean comparison. The woodland uses included

NTFPs, firewood, and recreation activities. The recreation frequency is the average frequency of hunting, fishing, wildlife viewing and various sports such as hiking, biking, and off-road vehicles.

The likelihoods of activities over the next 5 years were used to compare landowners' future management and land use possibility. It was classified as very unlikely, somewhat unlikely, somewhat likely, and very likely. Future activities analyzed included management plan, timber stand improvement, tree planting, construction (i.e., building a home, ponds, drainage ditch, and shed), timber and non-timber uses, conservation, and land use change. The likelihood of timber use is the average likelihood of cutting sawlogs, pulpwood and collecting firewood.

Results and Discussions

Motivations

The results of the logistic regression revealed three significant motivation factors and four demographic factors. The marginal effects at the means of the categorical independent variables and discrete change for dummy independent variables are shown in Table 2. For new landowners, privacy, future timber use, and long-term financial investment were more important objectives relative to old landowners for owning forestland on the Northern Cumberland Plateau. The differences in the importance of these reasons are statistically significant at 1%, 5%, and 10% level, respectively. Holding all other factors constant, privacy exhibited more of an effect, relative to other reasons, on the probability of being a new landowner when the importance increases from zero to one. There was no significant difference in the importance of NTFPS.

Table 2. Effects on the probability of being new landowners in the Northern Cumberland Plateau of Tennessee for the logit model

	Factors	*dy/dx*	*P-Value*
Motivation:	*imp_inv* *	0.04482	0.083
	imp_ntim *	0.05478	0.298
	imp_priv *	0.06619	0.006
	fut_timus	0.04378	0.007
Demographics:	*age*	-0.00402	0.000
	gender *	0.02499	0.300
	marsta *	0.04446	0.069
	race *	-0.06901	0.583
	educ	-0.00545	0.475
	farmer *	-0.03386	0.243
	Resiacre	-0.00073	0.083
	income	-0.00287	0.794
	arealife	-0.05134	0.004

* indicates dy/dx is for discrete change of dummy variables from 0 to 1.

Demographics

The two most significant demographic factors were age and the setting in which landowners spent most of their lives, which were significant at 1% level (Table 2). Holding all other factors constant, the marginal effect on the probability of being new landowners at the mean value of the setting was larger than the factor of age. The negative sign of setting suggested that new landowners have lived in urban or suburban areas rather than rural areas for most of their lives compared with old landowners. The sign of age indicated that new landowners on average are younger than those who have owned the land for a long period of time. This may be partially explained by newer landowners inheriting the land from their parents or grandparents. The differences in marital status and acreage of residence were significant at 10% level. The sign of marital status indicates that more new landowners are married compared to old landowners. The results also suggested that, on average, new landowners have smaller tracts of forestland for residence.

Management behaviors

In general, there were more new landowners who conducted management practices in the past 5 years (Figure 1). Specifically, the percentage of new landowners who built or maintained roads or trails on their lands was significantly larger at 1% significance level. This can be interpreted by their stronger motivations of long-term financial investment. Also, a greater percentage of new landowners had prepared lands for tree planting (5% level). This difference is consistent with newer landowners' stronger likelihood of future timber use.

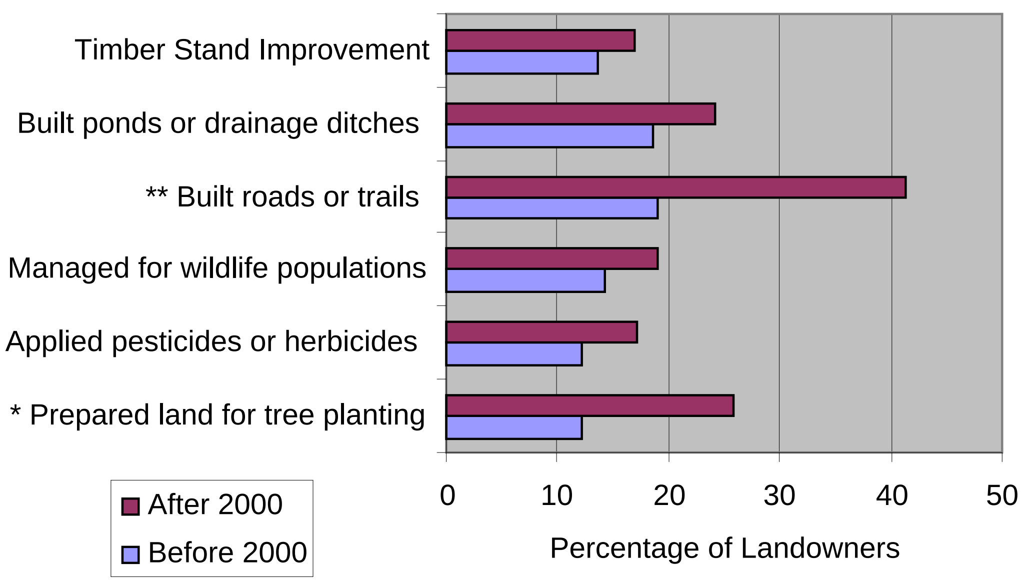

Figure 1. Woodland management behaviors
(* and ** indicate that the difference is significant at 5% and 1% level, respectively.)

Forestland Uses

In general, new landowners and their household members engaged in recreation (including sports and wildlife viewing) on their woodland more frequently (Figure 2), which was statistically significant at 1% level. New landowners and their family also engaged in picking NTFPs and collecting firewood more frequently, though the reason of NTFPs is not an important motivation for owning their lands. These results did not suggest the accurate average land use frequency of the two landowner groups, due to the simplified weights of frequency. But they are helpful for identifying the difference of the two groups in forestland uses. It must be noted that the frequency of land uses are influenced not only by landowners' motivations or characteristics but also by the distance of their houses to forestlands.

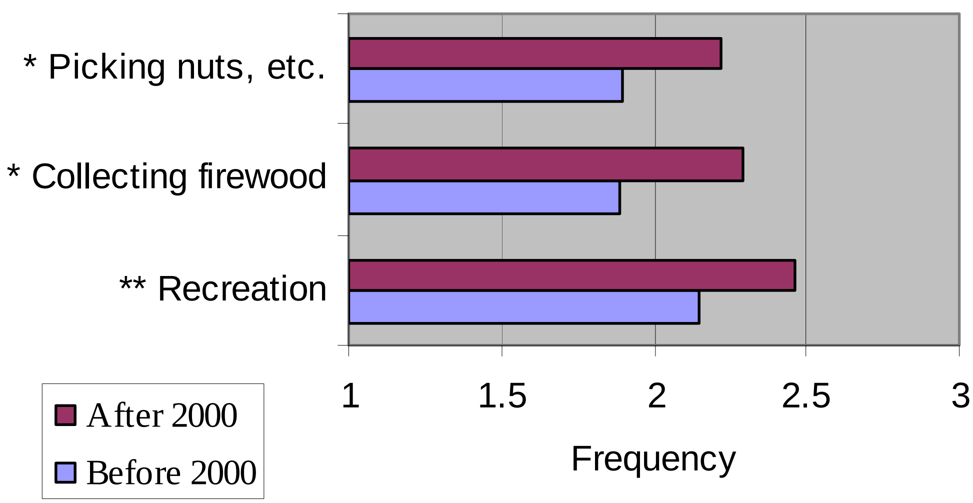

Figure 2. Woodland use frequency
(* and ** indicate that the difference is significant at 5% and 1% level, respectively.)

Future Management and Land Uses

The results suggest that new landowners were more likely to manage their lands according to their management plans; plant trees; and build ponds, homes or other structures (Figure 3), all statistically significant at 1% level. New landowners also were more likely to conduct timber stand improvement, use timber or non-timber products relative to old landowners (5% level). There was no significant difference in the probability of a conservation plan. Both new and old landowners were very unlikely to enroll all or part of the woodland in a conservation easement. However, new landowners were relatively more likely to convert all or part of the woodland to other uses, e.g. pasture, though the probability is small.

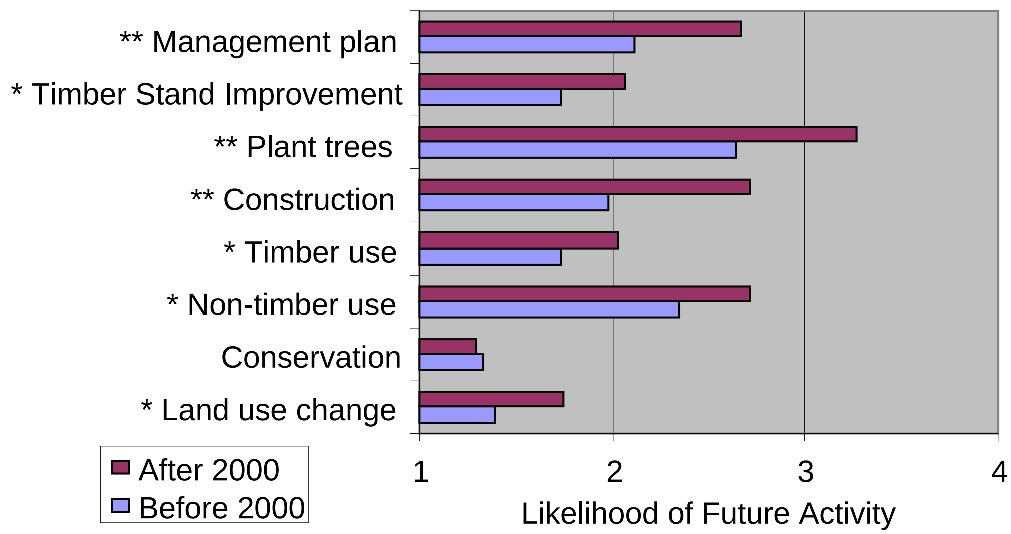

Figure 3. Likelihood of landowners' activity over the next five years
(* and ** indicate that the difference is significant at 5% and 1% level, respectively.)

Conclusions

Rather than the common reasons for owning forestland in the Northern Cumberland Plateau, this paper examined the trend of landowner demographics, motivations, management behavior, and land uses, due to the changes in land market in this region. The logistic regression was very helpful in identifying the motivation and demographic factors associated with recent acquisitions of forestland on the Northern Cumberland Plateau.

The results suggest that privacy is increasing in importance, which is consistent with the growth in retirement- and second-home development in this region. Compared with old landowners, new landowners also exhibited stronger motivations of future timber use as well as long-term financial investment. However, the motivations of future timber use is not necessarily more important than other reasons for owning forestland such as aesthetic enjoyment and environmental protection.

New landowners were, on average, younger than those who have owned the land for a longer time period, which is similar to the landowner trend in Alabama (Pan et al. 2007). Except for age, the setting in which they lived most of their lives was the other significant demographic factor contributing to new landowners' interest in the Northern Cumberland Plateau, which is consistent with the reason of privacy for owning the land and the growth of home development in this region.

New landowners' characteristics and stronger objectives obviously affect forest management and future land uses. In general, more new landowners conducted management practices in the past five years. They also used their land more frequently for NTFPs, firewood, and recreation. New landowners were more likely to manage and use their land in the next five years, which is consistent with the comparison results of past activities. However, it is noteworthy that there is slightly more uncertainty on future land use change associated with new landowners.

Analyzing the difference in management and land uses between new and old forestland owners is useful for future natural resource management in the Northern Cumberland Plateau. It can also help predict future timber supply and other services of forest resources. Future research should identify the factors influencing new landowner management decisions and participation in various government programs.

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EVALUATING CARBON PAYMENTS ON TIMBER MANAGEMENT REGIMES

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Abstract

Regardless of the fact that the scientific community has not provided incontrovertible evidence that anthropogenic CO_2 emissions are causing global scale temperature averages to increase (or decrease), there is interest in determining the amount of carbon removed from the atmosphere by tree and stand growth. It may be that such carbon sequestration by timber stands may allow timberland owners to benefit monetarily by selling this sequestered carbon to interested buyers. To determine the benefits that timberland owners will realize by selling carbon it is first necessary to determine how much carbon is sequestered in the timber stands of interest. This is easily accomplished by traditional mensurational techniques. Once the amount of carbon sequestered by timber stands is estimated, management regimes that include carbon payments have to be valued. I discuss this two step process and outline a method that will allow timberland managers to make objective decisions about the sale of carbon.

[Abstract Only]

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FINANCIAL FEASIBILITY OF SEQUESTERING CARBON FOR LOBLOLLY PINE STANDS IN INTERIOR FLATWOODS REGION IN MISSISSIPPI

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Abstract

There has been increasing interest in forest-related carbon sequestration because carbon trading can provide forest owners with supplemental income. Mississippi pine forests may play a significant role in increasing carbon sequestration through afforestation and reforestation. However, the magnitude of possible carbon storage in these forests is not fully understood. The objective of this study was to examine the potential for sequestrating carbon in loblolly pine (*Pinus taeda* L.) stands under three production regimes: “timber production only”, “carbon sequestration only”, and “joint production of timber and carbon” in the interior flatwoods region of Mississippi. The Forest Vegetation Simulator (FVS) model developed by the USDA Forest Service was used to simulate growth and yield of timber and carbon under selected management scenarios. A sensitivity analysis was conducted to determine the financial tradeoffs associated with carbon sequestration using Land Expectation Value (LEV). Results indicated that an “unthinned” scenario accumulated almost twice as much carbon as a “thinned” scenario. The financially optimal harvest age for the “carbon sequestration only” production regime increased from 40 to 50 years for the “unthinned” scenario and from 30 to 50 years for the “thinned” scenario when compared to “timber production only” regime. At a 5% minimum acceptable rate of return (MARR) and a carbon credit price of \$4.50/ton of CO_2, the LEV at the financially optimal rotation ages for the “timber production only” and “carbon sequestration only” regimes in the “unthinned” scenario was \$927.01/ac and \$483.44/ac, respectively. In the “thinned” scenario, the corresponding LEV values were \$1,475.58/ac and \$271.41/ac. A penalty for releasing carbon back to the atmosphere at the time of thinning and final harvest had little effect on the LEV for “unthinned” scenario (a reduction of less than \$218/ac). However, the penalty impact was greater for the “thinned” scenario (a reduction of up to \$758/ac).

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Keywords: Carbon sequestration, carbon trading, Forest Vegetation Simulator, Land Expectation Value, optimal harvest age

Introduction

Concern over negative effects of global warming has resulted in increased interest in forest-related carbon sequestration. Trees have been gaining increased attention because they can help reduce carbon dioxide (CO_2) in the atmosphere in a cost effective manner. Trading of carbon credits not only allows market mechanisms to address global warming in more efficient ways, but also provides forest owners with a unique opportunity to generate additional income. Financial incentives available through carbon programs have been considered in management decisions by an increasing number of forest owners. Consequently, carbon trading can encourage sustainable management of forests and help mitigate the negative effects of global warming (Ruddell and Walsh 2007).

Currently, several emission programs in the U.S. provide an opportunity to trade carbon credits. The Chicago Climate Exchange (CCX) is currently the only legally binding voluntary program for trading greenhouse gases in the U.S. (CCX 2007). In contrast, the Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort of 10 states in the Northeastern U.S. to achieve a 10% reduction in CO_2 emissions by 2019 (Malmsheimer et al. 2008). Currently, only afforestation projects qualify for this program. Likewise, California Climate Action Registry (CCAR) is a statewide program for inventorying greenhouse gases. Participants can earn credits for forest management and conservation and reforestation projects (CCAR 2007).

Mississippi can contribute significantly to CO_2 reduction by increasing sequestration in forests via afforestation and reforestation efforts (Cason et al. 2006). The Carbon Fund (2003) estimated that agricultural lands, if afforested, would sequester from 400 to 500 tons of CO_2 per acre (ac) during 70 to 99 years. Landowners can receive an upfront payment of $1 for each ton of sequestered CO_2 (The Carbon Fund 2003). However, it is still unclear how much CO_2 can be sequestered in different geographic regions in Mississippi (Cason et al., 2006).

Most studies on the economics of carbon sequestration have focused on the cost effectiveness of carbon sequestration through forestry activities, and several of them have found that growing trees could provide significant CO_2 reductions at relatively low cost (Richards, 2004; Sedjo, 2001; Newell and Stavins 2000). Cason (2006), evaluating the impacts of different management practices on carbon storage potential in loblolly pine (*Pinus taeda* L.) forests in Mississippi, found that the maximum carbon storage potential was 160 tons per ac in terms of biomass equivalents. Stainback and Alavalapati (2005) examined the effects of carbon markets on the optimal management of slash pine (*Pinus elliottii* Engelm.) plantations and established that carbon payments allowed for previously too costly fertilizer application. Huang et al. (2003) conducted an analysis to determine costs and profitability of sequestering carbon in green ash (*Fraxinus pennsylvanica* Marsh.) forests in the Lower Mississippi River Valley. They found that profitability ranged from $3,645/ac to -$248/ac at 2.5% and 15% real rates of return, respectively. In another study, Huang and Kronrad (2001) analyzed the cost of sequestering carbon in private forests in east Texas and calculated the compensation needed for forest landowners to manage forests for carbon and convert unstocked lands to productive forestlands.

Newell and Stavins (2000), on the other hand, used an analytical model of relevant land-use forest and farm options to examine sensitivity of carbon sequestration costs to changes in key factors such as management regimes, tree species, relative prices, and discount rates. They found that the cost of carbon sequestration could be greater if trees were periodically harvested rather than permanently established and that higher discount rates resulted in higher marginal costs of sequestered carbon.

Since some carbon trading programs permit payments for both carbon sequestration and timber (e.g. CCX and CCAR), both can be viewed as joint outputs that forest owners should consider when maximizing revenues through forest management. Based on carbon and timber prices, timber yields, and expected rates of return, it is possible to determine optimal financial forest rotations. Higher financial returns can be expected because of the two simultaneous outputs.

This study evaluated the financial feasibility of managing loblolly pine stands to sequester carbon in the interior flatwoods region of Mississippi. It evaluated two thinning scenarios (thinning and no thinning) and three production regimes: “timber production only”, “carbon sequestration only”, and “joint production of timber and carbon”. The study determined the physical quantities of carbon sequestered under these three production regimes and evaluated the financial tradeoffs associated with carbon sequestration.

Methods

Volume estimates for timber in a loblolly pine stand were determined using the Forest Vegetation Simulator (FVS) growth and yield model developed by the USDA Forest Service. Estimates were derived for selected harvest ages assuming regeneration of the stand from bare ground. A medium quality site (site index 105, base age 50) in the interior flatwoods of Mississippi was selected for the analysis.

Carbon estimates were determined for herbaceous, shrub, standing dead, litter, duff and woody debris carbon pools using the carbon sub-model of the Fire and Fuel Extension to the FVS (Reinhard and Crookston 2007). The pools for live and dead root biomass were estimated using a set of allometric equations included in the FVS and described by Jenkins et al. (2003). The carbon released back to the atmosphere due to thinnings and final harvest was estimated using four decay-fate categories presented by Smith et al. (2006). The analysis assumed that stems smaller than a threshold diameter of 9 inches diameter at breast height (dbh) were harvested for pulpwood. Stems equal to or greater than the threshold diameter were harvested for sawlogs. The fate of the carbon in each of the two categories (pulpwood and sawlogs) was recorded as being in use, deposited in a landfill, emitted with energy capture, or emitted without energy capture. Carbon accumulated in harvested merchantable products can be stored in these products and landfills for a long time. However, as decay occurs, carbon is emitted back to the atmosphere (Reinhardt and Crookston 2007). The transfer of carbon among fate categories was based on regional estimates from Smith et al. (2006).

The study evaluated two different thinning scenarios (no thinning and thinning from below) with minimum intervals of five years between successive thinnings. The first thinning occurred when the stand reached age 15. We assumed a residual target basal area after thinning of 70 square feet per ac and a minimum merchantable harvest volume of 400 cubic feet (cu ft) per ac. The analysis evaluated two management intensities: no site preparation and chemical site preparation. In addition, the analysis examined the effect of a penalty for releasing CO_2 due to thinnings and final harvests on the financial feasibility of carbon sequestration.

Land Expectation Value (LEV) was calculated at 5%, 10%, and 15% minimum alternative rates of return (MARR) to determine optimal harvest ages for three production regimes: "timber production only", "carbon sequestration only", and "joint production of timber and carbon". The payment for carbon sequestration was based on mean annual increment of carbon and was made to the landowner every year. The penalty for releasing carbon due to thinnings and final harvest was applied at a rate equal to the payment for sequestering carbon. Assumptions related to forest management and economic factors are summarized in Table 1.

Table 1. Summary of activities and costs associated with management of loblolly pine stand for timber production and carbon sequestration in Mississippi interior flatwoods region

Item	Value/Assumption
Site Index (base age 50)	105
Number of trees planted/ac	600
Site preparation	None and chemical
Thinning type	None and thinning from below
Thinning intensity	Residual basal area of 70 ft^2/ac
Minimum removal volume	400 cu ft of merchantable timber
Harvest age	20, 30, 40, and 50 years
Seedling cost[1]	$27.00/ac
Planting cost[1]	$52.00/ac
Chemical site preparation cost[1]	$90/ac
Sawtimber price[2]	$37.05/ton
Pulpwood price[2]	$7.86/ton
Carbon price	$ 4.50 and $10.00 /ton of CO_2 equivalent
A real minimum acceptable rate of return	5%, 10%, and 15%
Carbon payment	Annually based on mean annual increment of accumulated carbon
Penalty for carbon release	At thinning and final harvest based on amount of carbon released

[1] 2007 costs. Source: Dr. Andrew W. Ezell, Professor, Mississippi State University (Personal communication, 2008).
[2] Source: Timber Mart-South, 2008 (average price for four quarters in 2007).

Results

Carbon Sequestered and Released

The amount of carbon sequestered in a loblolly pine stand, and the amount of carbon released back to the atmosphere increased with final rotation harvest age for both thinned and unthinned management regimes (Figure 1). The largest amount of carbon was accumulated at age 50 years when an unthinned loblolly pine stand accumulated 269 tons of CO_2 per ac (1 ton of carbon = 3.33 tons of CO_2). At the same age, a loblolly pine stand thinned from below accumulated 141 tons per ac. An unthinned stand achieved maximum mean annual increment (MAI) of CO_2 at year 30 (7.85 CO_2 ton/ac/yr), whereas a thinned stand achieved maximum MAI of CO_2 at 15 years (6.20 CO_2 ton/ac/yr).

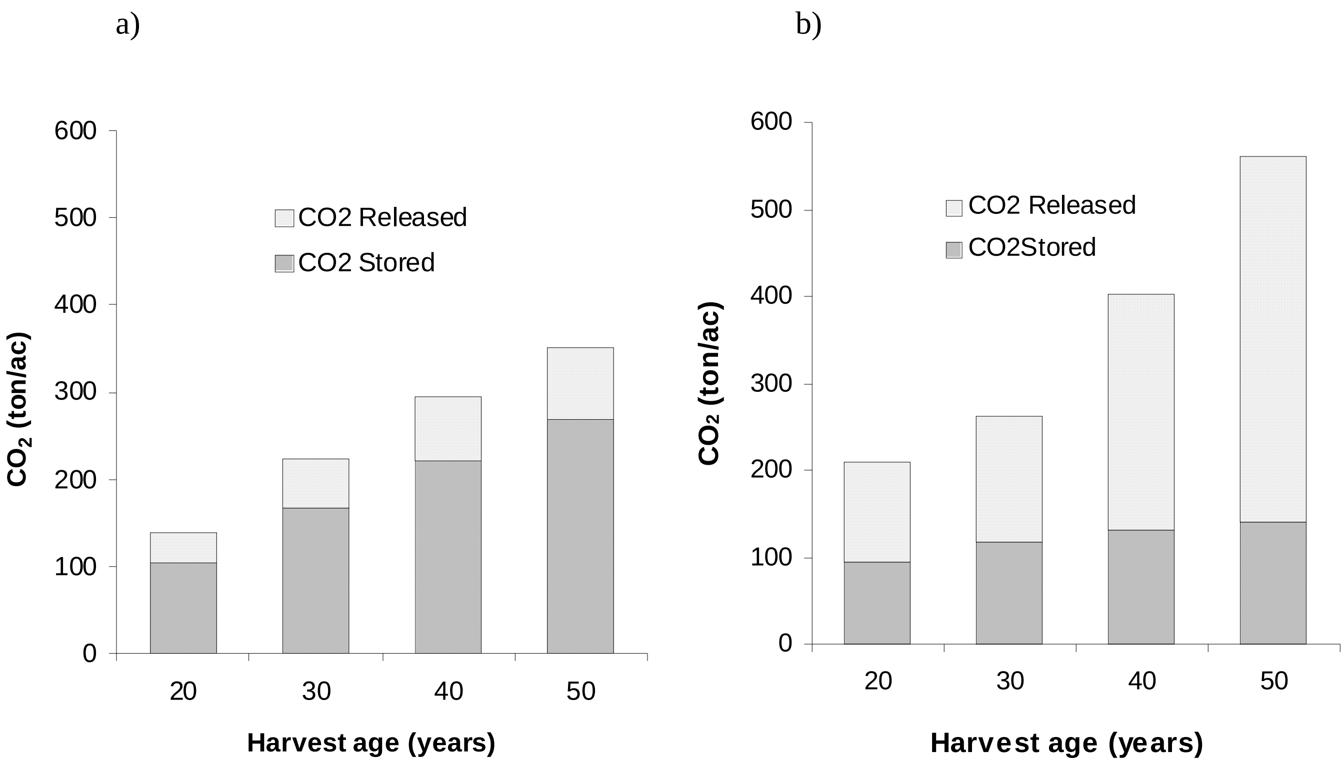

Figure 1. Carbon sequestered and released by loblolly pine stand in Mississippi interior flatwoods region managed in (a) "no thinning" and (b) "thinning" scenarios

<u>Optimal harvest ages</u>

No site preparation and no thinning scenarios

In the scenario assuming no site preparation and no thinning, results indicated that at a 5% real MARR and a carbon credit price of \$4.50/ton of CO_2, revenues from the "timber production only" regime were higher for harvest ages of 30 years and older when compared to the "carbon sequestration only" regime. At a 10% MARR, returns from "timber production only" regime were; however, lower than the returns from the "carbon sequestration only" regime for all harvest ages. At a 15% MARR the "timber production" regime generated financial losses at all harvest ages (LEV was negative). The return from the "carbon sequestration only" regime was still positive at a 15% MARR.

At a 5% MARR and a carbon credit price of \$4.50/ton of CO_2, the optimal harvest ages for the "carbon sequestration only" and "timber production only" regimes were 50 and 40 years, respectively, with corresponding LEVs of $483.44/ac and $927.01/ac (Table 2). At a 10% MARR and a carbon credit price of $4.50/ton of CO_2, the optimal harvest age for the "timber production only" regime was 30 years, whereas for the "carbon sequestration only" regime the optimal harvest age was 50 years with corresponding LEVs of $70.77/ac and $181.13/ac.

At a 5% MARR and a carbon credit price of $4.50/ton of CO_2, the "joint production of timber and carbon" regime resulted in an optimal harvest age of 40 years and an LEV of $1,394.20/ac. At 10% and 15% MARR, the optimal harvest age was 30 years with LEVs of $239.99/ac and $38.69/ac, respectively (Table 2).

At a carbon credit price of $10.00/ton of CO_2, return from the "carbon sequestration only" regime was higher than the return from the "timber production only" regime for all MARRs. The optimal harvest age was 50 years with corresponding LEVs of $1,180.04/ac, $499.84/ac, and $281.13/ac at 5%, 10% and 15% MARR, respectively.

Table 2. Land Expectation Value (LEV) for selected production regimes in loblolly pine stands with no site preparation and no thinning in Mississippi interior flatwoods region

Harvest age (years)	Production regime	Land Expectation Value ($/acre)		
		5%	10%	15%
20	Timber only	218.61	6.94	-46.94
	Carbon only, $4.50/ton of CO_2	358.08	143.29	69.06
	Carbon only, $10.00/ton of CO_2	950.61	431.77	256.25
	Joint production, $4.50/ton of CO_2	576.69	150.22	22.11
	Joint production, $10.00/ton of CO_2	1,169.23	438.71	209.30
30	Timber only	662.46	70.77	-41.19[1]
	Carbon only, $4.50/ton of CO_2	433.16	169.22	79.88
	Carbon only, $10.00/ton of CO_2	1,088.13	478.42	275.51
	Joint production, $4.50/ton of CO_2	1,095.62	239.99	38.69
	Joint production, $10.00/ CO_2	1,750.59	549.19	234.32
40	Timber only	927.01	58.32	-56.19
	Carbon only, $4.50/ton of CO_2	467.20	178.06	82.44
	Carbon only, $10.00/ton of CO_2	1,150.70	494.37	280.08
	Joint production, $4.50/ton of CO_2	1,394.20	236.38	26.25
	Joint production, $10.00/ton of CO_2	2,077.71	552.70	223.88
50	Timber only	793.12	-0.53	-70.53
	Carbon only, $4.50/ton of CO_2	483.44	181.13	83.04
	Carbon only, $10.00/ton of CO_2	1,180.04	499.84	281.13
	Joint production, $4.50/ton of CO_2	1,276.56	180.60	12.51
	Joint production, $10.00/ton of CO_2	1,973.16	499.31	210.60

[1] The calculated optimal rotation remained the same even with increased MARR because a 10-year increment was used to define potential harvest ages. A negative LEV indicates that regime was financially infeasible.

Site preparation and thinning scenario

For the scenarios assuming chemical site preparation and thinning, the optimal financial harvest age for the "carbon sequestration only" regime was generally longer compared to the "timber production only" regime. Results showed that at 5% and 10% MARRs, the optimal harvest age for the "timber production only" regime was 30 years with LEVs of $1,475.58/ac and $228.91/ac, respectively. However, at a 15% MARR, the "timber production only" regime generated a financial loss (LEV = -$29.82/ac). At a carbon credit price of $4.50/ton of CO_2, the optimal harvest age for the "carbon sequestration only" regime was 50 years at both the 5% and 10% MARRs with LEVs of $271.41/ac and $60.86/ac, respectively. The "carbon sequestration only" regime was not financially feasible at a 15% MARR and a carbon credit price of $4.50/ton of CO_2. However, this regime was financially feasible at the higher carbon credit price of $10.00/ton of CO_2 and the optimal harvest age was 50 years at 5%, 10%, and 15% MARRs with LEVs of $834.36/ac, $343.53/ac and $168.26/ac, respectively. The optimal harvest age for the "joint production of timber and carbon" regime was 30 years at 5%, 10%, and 15% MARRs at both carbon credit prices of $4.50 and $10.00/ton of CO_2 (Table 3).

Table 3. Land Expectation Value (LEV) for selected production regimes in a loblolly pine stand with chemical site preparation and thinning from below in Mississippi interior flatwoods region

Harvest age (years)	Production regime	Land Expectation Value		
		5%	10%	15%
20	Timber only	364.04	15.62	-77.78
	Carbon only, $4.50/ton of CO_2	197.24	31.56	-29.66
	Carbon only, $10.00/ton of CO_2	769.72	312.69	154.03
	Joint production, $4.50/ton of CO_2	561.28	47.18	-107.44
	Joint production, $10.00/ton of CO_2	1,133.77	328.31	76.25
30	Timber only	1,475.58	228.91	-29.82[1]
	Carbon only, $4.50/ton of CO_2	251.30	53.44	-19.67
	Carbon only, $10.00/ton of CO_2	827.12	337.81	165.96
	Joint production, $4.50/ton of CO_2	1,726.88	282.35	-49.49
	Joint production, $10.00/ton of CO_2	2,302.70	566.72	136.14
40	Timber only	1,430.27	169.87	-54.58
	Carbon only, $4.50/ton of CO_2	266.75	59.17	-17.71
	Carbon only, $10.00/ton of CO_2	833.48	342.66	167.91
	Joint production, $4.50/ton of CO_2	1,697.03	229.03	-72.29
	Joint production, $10.00/ton of$CO_2$	2,263.76	512.52	113.34
50	Timber only	1,270.49	126.07	-64.52
	Carbon only, $4.50/ton of CO_2	271.41	60.86	-17.30
	Carbon only, $10.00/ton of CO_2	834.36	343.53	168.26
	Joint production, $4.50/ton of CO_2	1,541.90	186.93	-81.81
	Joint production, $10.00/ton of CO_2	2,104.86	469.60	103.74

[1] The calculated optimal rotation stayed the same even with increased MARR because a 10-year increment was used to determine harvest ages. A negative LEV indicates that regime was financially infeasible.

Financial impact of penalty for releasing carbon

Our analysis revealed that in the "no thinning" scenario a penalty for releasing carbon back to the atmosphere had no effect on the optimal harvest ages, and had only a marginal effect on the total revenue. The total reduction in LEV ranged from \$36/ac to \$218/ac. However, in the "thinning" scenario, the penalty had a more substantial impact. The total revenue reduction ranged from \$154/ac to \$339/ac (at a carbon credit price of \$4.50/ton of CO_2). By comparison, at a carbon credit price of \$10.00/ton of CO_2, the decrease in revenue was substantially larger, ranging from \$342/ac to \$758/ac (Table 4).

Table 4. Expected revenues generated from managing loblolly pine plantations located in Mississippi interior flatwoods region for carbon sequestration

Scenario	Land Expectation Value (MARR 5%)			
	Harvest age (years)			
	20	30	40	50
No thinning, no penalty, \$4.50/ CO_2 ton	358.08	433.16	467.20	483.44
No thinning, penalty, \$4.50/ CO_2 ton	259.80	355.32	411.54	447.68
Thinning, no penalty, \$4.50/ CO_2 ton	197.24	251.30	266.75	271.41
Thinning, penalty, \$4.50/ CO_2 ton	43.56	35.00	-23.95	-67.48
No thinning, no penalty, \$10.00/ CO_2 ton	950.61	1,088.13	1,150.70	1,180.04
No thinning, penalty, \$10.00/ CO_2 ton	732.22	915.16	1,027.03	1,100.58
Thinning, no penalty, \$10.00/ CO_2 ton	769.72	827.12	833.48	834.36
Thinning, penalty, \$10.00/ CO_2 ton	428.21	346.44	187.46	76.27

Discussion

The results of this study were similar to those presented by Huang and Kronrad (2006), Stainback and Alavalapati (2005), Huang et al. (2003), and Huang and Kronrad (2001). These studies indicated that the optimal rotation age will tend to be longer and a greater proportion of long-lived products will be produced in response to a carbon market. The optimal harvest age for the "carbon sequestration only" regime was 50 years regardless whether the stand was thinned or unthinned. The optimal rotation age for the "timber production only" regime was 40 years for "no site preparation" and "no thinning" scenarios, and 30 years for "site preparation" and "thinning from below" scenarios. The optimal harvest age for the "joint production of timber and carbon" regime was the same as for "timber production only" regime (40 years at 5% MARR and 30 years at 10% and 15% MARR for stand with no site preparation and no thinning; 30 years for the stand with site preparation and thinning stand at 5%, 10%, and 15% MARRs).

Analysis indicated that in the "no thinning" scenario, the "carbon sequestration only" regime generated higher revenue at 10% and 15% MARR relative to the "timber production only" regime. The "no thinning" scenario reduced diameter growth in the stand causing the "timber production only" regime to be less profitable than the "carbon sequestration only" regime. However, in the thinning scenario, our analysis indicated that the "carbon sequestration only" regime generated less revenue than the "timber production only" regime for a 5% MARR and carbon credit prices of \$4.50 and \$10/ton of CO_2 (except 20-year rotation). This suggests that the financial incentives for carbon sequestration in this scenario were too small to induce forest owners to manage their stands for carbon sequestration only. The “carbon sequestration only” regime tended to generate more revenue than the “timber production only” regime for higher MARRs (10% and 15%). However, if payments are allowed for both timber and carbon sequestration (e.g., CCX and CCAR allow such payments), the “joint production of timber and carbon” regime increased financial returns to forest owners managing loblolly pine stands. The results of this analysis indicated that returns from a “joint production of timber and carbon” regime were always greater than the “timber production only” and “carbon sequestration only” regimes.

Currently, there are various regulatory mechanisms to account for potential losses in forest carbon. They include requirements of long-term conservation easements (e.g. RGGI) and the establishment of carbon reserve pools to offset carbon losses (e.g. CCX).

Many studies indicated that the penalties for releasing carbon could serve as a policy tool for maintaining a proper balance between carbon sequestered in forests and carbon released back to the atmosphere. However, imposing carbon release penalties could discourage landowners from managing their forests for increased carbon sequestration. This study explored the effect of imposing a penalty for releasing carbon during thinnings and final harvest and established that it had a relatively small impact on the financial returns in the “unthinned” scenarios – reduction in LEV ranged from $36/ac to $218/ac. However, the penalty had a greater impact in the “thinned” scenarios, where the LEV reduction ranged from $154/ac to $758/ac.

Conclusion

Results of this analysis indicated that loblolly pine stands on medium quality sites in the interior flatwoods of Mississippi offered a good potential to sequester carbon with a maximum mean annual carbon increment of 7.85 CO_2 ton/ac/yr. Results also indicated that more carbon was stored in “unthinned” stands than in “thinned” stands. Further, it was determined that the optimal harvest age was longer if the stand was to be managed only for carbon sequestration. Managing the same stand jointly for timber and carbon or for timber only resulted in a shorter rotation. Returns from the “joint production of timber and carbon” regimes at optimal rotation age were always greater than returns from the “timber production only” and “carbon sequestration only” regimes. A penalty for releasing carbon back to the atmosphere had a marginal impact for the unthinned stands.

Increased rotation lengths associated with carbon production regimes suggest that landowners may need to be compensated for managing forests solely for carbon sequestration as it would require retaining trees for longer time period. Further research is needed to expand this analysis beyond the interior flatwoods region of Mississippi, and to evaluate the financial feasibility of carbon sequestration for other commercially important species.

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DEVELOPING AN URBAN FOREST CARBON MARKET

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Abstract

Countries, states, localities, businesses, and individuals are taking action to mitigate greenhouse gas levels and production as a response to concerns over climate change. Europe currently has mandatory greenhouse gas emission legislation and a large developed emission trading market, as opposed to the U.S. where voluntary markets to reduce green house gas emissions are still developing. An integral part of these markets is permanently reducing or sequestering carbon dioxide (CO_2) to create a carbon credit and then selling this carbon credit. Currently, there is little differentiation between methods and locations of projects that create carbon credits. This project looks to investigate the potential for an U.S. urban forest carbon market. A supply of urban forest carbon in the U.S. exists as evidenced by urban forests sequestering 88.5 million tons of CO_2 in 2005, representing approximately 1.5% of the total U.S. CO_2 emissions. Not only is the supply significant, but it is also growing, as the amount sequestered in 2005 is approximately 53% greater than the amount sequestered in 1990. The interest, motivation, and willingness of market participants are determined by use of surveys. Potential urban forest carbon sellers, such as cities and urban counties, were surveyed to obtain insight to the feasibility of an urban forest carbon market.

Keywords: Forest carbon, urban carbon, carbon markets, urban forests

Introduction

The world climate is changing. The Pew Center on Global Climate Change (2008) reports that global temperature has increased 1.4 degrees Fahrenheit since 1900, that twenty-two of the hottest years on record occurred since 1980, and that the past ten years were the hottest in the last

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150 years. Global climate change may affect precipitation patterns, biodiversity, flood and drought cycles, and public health. As global temperature increased, atmospheric greenhouse gas levels also rose. Greenhouse gases include carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride. Many scientists believe that human activity lead to the increased levels of atmospheric greenhouse gases, which in turn caused the increases in global temperature.

Currently, there are many programs and initiatives, some mandatory and others voluntary, to reduce the atmospheric levels of greenhouse gases. Most of these programs involve both reducing greenhouse gas emissions and sequestering atmospheric carbon. For example, the European Union's Greenhouse Gas Emission Trading Scheme (EU ETS 2008) is a mandatory cap and trade program that includes all 25 member countries of the European Union and requires member countries to reduce their emissions to levels outlined in the United Nations Framework Convention on Climate Change's Kyoto Protocol. In contrast, U.S. companies, governments, and organizations are voluntarily reducing their greenhouse gas emissions through the Chicago Climate Exchange (CCX 2008) and independent actions. The Chicago Climate Exchange (2008) is the largest voluntary trading system to reduce emissions of all six major greenhouse gases, with offset projects worldwide. A common trait in many of the mandatory and voluntary trading schemes is the idea of offset projects. The EU ETS and the CCX allow companies to purchase certified sequestered carbon that was sequestered or avoided from a variety of approved projects. For the CCX, these offset projects include agricultural methane, agricultural soil carbon, energy efficiency and fuel switching, forestry carbon, landfill methane, renewable energy, coal mine methane, range land soil carbon, and ozone depleting substance destruction. The CCX does not differentiate between the different projects as it sells a single financial instrument to represent the certified sequestered carbon from the projects. Ecosystem Marketplace (Hamilton et al. 2008) reports differing prices for different project types that were traded between private parties, not in the CCX. The report states that "forestry projects, in particular those involving afforestation/reforestation, have remained some of the highest priced project types across 2006 and 2007 with weighted average prices of \$6.80 to \$8.20 per metric ton of CO_2 equivalent." The report also states that there were differing prices for projects in different geographic areas.

For this project, the investigators look at the potential for an urban forest carbon market that would provide urban carbon offset projects. The urban forest carbon resource is attractive as a source of offset projects because of its location and size. Over 75% of the U.S. population resides in urban areas and represent the major source of greenhouse gas emissions. In addition, the urban area in the U.S. is growing. From 1969 to 1994, urban area in the U.S. doubled in size to cover 3.5% total land area of the U.S. (Nowak et al 2001, Nowak and Crane 2006). This manuscript will discuss the preliminary results from a survey of local governments that were identified as potential suppliers of urban forest carbon.

Methods

The investigators identified local governments as potential sources for urban forest carbon to be sold in an urban forest carbon market. The investigators used a survey to determine the ability, willingness, interest, and motivation of local governments to supply urban forest carbon. Urban foresters and arborists were selected as the respondents best able to provide the desired information. The International Society of Arborists (ISA) is the trade society for arborists and urban foresters. The ISA hosts the Society of Municipal Arborists (SMA) that is a subgroup of arborists who work with municipalities and local governments. SMA members were selected to receive the survey. The raw response rate for the survey was 54%.

The survey was composed of 27 questions and covered three topic areas. The first area asked about urban forest management and requested information, such as who manages the urban forest resource and what inventories are available. The second area asked about interest and activities in climate change mitigation, such as participation in voluntary carbon markets. The third area asked about city characteristics, such as city land area. Respondents were asked to respond for the city, as opposed to providing their own opinions.

Results

The first part of the survey focused on available inventory information and management. These are important for producing a quality carbon credit with verifiability, additionality, and enforceability. The type and frequency of inventory information collected is important in order to verify the amount of annually sequestered carbon. Identifying who is responsible for the urban forest resource is important in establishing enforceability. Showing management of an urban forest resource addresses the issue of additionality, defined as a surplus of sequestered carbon above and beyond unmanaged forests or usual management.

The survey found that there is a supply of publicly owned urban trees. The respondents indicated that publicly owned trees included trees in the right-of-way, parks, government buildings' grounds, reservoirs, stream and river buffers, airports, landfills, undeveloped industrial parks, and other lands. Table 1 shows the percentage of the different types of trees that make up the public urban forest.

Table 1. Trees included in the public urban forest

Percent Response	Publicly Owned Trees
94%	Along the street in the public right-of-way
94%	In parks
50%	Reservoirs, stream and/or river buffers
37%	Other (airports, landfills, undeveloped industrial parks)
88%	Other developed public land (e.g., City Hall or schools)
2%	Not sure

The amount of carbon sequestered by an offset project compared to the amount of carbon sequestered by a pre-project management is referred to as additionality. The criterion for determining additionality is currently subjective. The California Climate Action Reserve (2008) defines additionality as "a concept from international GHG project accounting principles that requires that a project activity would not have occurred in the absence of a market for GHG emission reductions." The CCX (2008) on the other hand, does not provide a clear set of criteria for determining additionality. The CCX Rule Book Chapter 'CCX Exchange Offsets and Exchange Early Action Credits' does not mention any requirements such as those defined in the

California Climate Action Registry. However, the CCX does require that forestry offset projects be approved by the CCX Committee on Offsets. One could argue that carbon sequestered due to active management should count as additional to an alternative of no management. With regards to urban forest carbon sequestration, 37% of the survey respondents indicated that all of the urban forest resource was under an urban forest management plan. Of the urban forest resource partially covered under management plans, 85% covered street trees and 75% covered park trees.

Another important factor in producing a quality carbon offset is enforceability. Establishing who is responsible for the management of the resource provides recourse for non-fulfillment of a contract. Revisiting the carbon sequestration on the east face of the Rocky Mountains, there would be many different stakeholders. If the amount of carbon sequestered ended up less than the contract, then determining which stakeholder is liable would be difficult. With respect to urban forest carbon resource, 89% of the survey respondents identified an urban forester or arborists as the entity responsible for urban forest management.

In conjunction with establishing who is responsible for the urban forest, it is important to accurately determine the amount of carbon sequestered. This is a function of type and frequency of inventory. More than three quarters of the survey respondents indicated that they had either complete or partial inventories of the urban forest resource (Table 2). With regard to the frequency of inventories, more than three quarters of the survey respondent with inventories had completed those inventories within the past five years (Table 3). Not only are the majority of inventories recent, but more than half of the public urban forest resource will be inventoried again within the next 5 years (Table 4). The US Forest Service provides a software program, i-Tree 92008), that estimates the annual carbon sequestration for an urban forest. The researchers feel that i-Tree would provide a cost-effective means to estimate a city's sequestered carbon. Of all respondents, 76% indicated they were familiar with the i-Tree program. In summary, most of the cities in the survey had complete or partial inventories that were recent and intended to re-inventory their respective urban forest resources in the next five years. The ready availability of inventory information and familiarity with the i-Tree program leads the researchers to the conclusion that many local governments could accurately and easily estimate their urban forest sequestered carbon.

In the second part of the survey, investigators wanted to gauge local governments' interest in participating in an urban forest carbon market. The investigators asked about current local greenhouse gas initiatives and priorities. As questions became more specific, the number of "not sure" responses or omitted answers increased significantly.

Table 2. Type of inventory

Percent Response	Type of Inventory
56%	Partial or component inventory of public trees
22%	Covered part of the publicly owned trees
23%	None

Table 3. Date of last of inventory

Percent Response	Date of the Most Recent Inventory
52%	Within the last 2 years
26%	Between 2 to 5 years ago
12%	Between 6 to 10 years ago
10%	More than 10 years ago

Table 4. Date of next inventory

Percent Response	Date of Next Inventory
38%	Within the next 2 years
25%	In the next 2 to 5 years
4%	In the next 6 to 10 years
6%	Never
27%	Not sure

There are many initiatives to reduce greenhouse gas emissions. A little more than one third of the survey respondents indicated that reducing carbon emissions was a goal (Table 5). In contrast, only 17% indicated that, having considered the problem, reducing carbon emissions was not a goal.

With more than half of the respondents having discussed reducing carbon emissions (Table 5), the researchers wanted to look at the cities' exposure to carbon sequestration and/or trading. About three quarters of the survey respondents indicated that they were familiar at some level with carbon sequestration (Table 6).

Table 5. Reducing carbon emissions as a goal

Percent Response	Is Reducing Carbon Emissions a Goal?
26%	Yes, it is a priority
11%	Yes, but it is not a priority
17%	No, but it has been discussed
20%	No, but it has not been discussed
26%	Not sure

Table 6. Familiarity with carbon sequestration

Percent Response	Familiarity with Carbon Sequestration and/or Trading
12%	Very familiar
20%	Familiar
22%	Moderately familiar
18%	Somewhat familiar
16%	Not at all familiar
11%	Not sure

From the responses summarized in Tables 5 and 6, many cities are considering or are aware of carbon sequestration and/or trading. With regards to the established voluntary market in the U.S., only 21% of the respondents had heard of the Chicago Climate Exchange and only one local government of the 145 respondents are participants. The next step was to ask the level of interest in selling a city's sequestered carbon in urban forests. This question elicited a very high "not sure" response because very few cities are participating in carbon trading and fewer still sell the sequestered carbon in urban forests. Of those with an opinion on selling their sequestered urban forest carbon, the majority answered they had interest in selling sequestered carbon (Table 7). Only 7% of the respondents indicated that they had no interest in selling the sequestered carbon in urban forests. Another question revealed that 25% of respondents indicated interest in using certified sequestered carbon as an offset to their own governments' greenhouse emissions. Other questions concerning specifics of carbon trading, such as contract lengths, produced very high 'not sure" responses.

Table 7. Interest in selling sequestered carbon

Percent Response	Interest in Selling Certified Sequestered Carbon
10%	Very interested
10%	Interested
5%	Moderately interested
3%	Somewhat interested
7%	Not at all interested
64%	Not sure

Conclusions

The frequencies from the survey reveal that many local governments are interested in addressing climate change. Most cities have the inventory data available to accurately estimate the amount of sequestered carbon from their respective urban forests. Many of the local governments responded to the questions with "not sure", reflecting uncertainty or lack of experience with aspects of carbon sequestration projects. As the questions in the survey became more abstract, such as expressing interest in selling certified sequestered carbon, the percentage of 'not sure' responses increased significantly. This soundly shows that many of the cities may not have formed firm opinions concerning climate change mitigation. Of the respondents who expressed opinions on the abstract questions, the majority of the responses were positive on the idea of selling a local government's sequestered urban forest carbon resource. The researchers conclude that if the local governments were given more information on the specifics of selling sequestered urban forest carbon, more local governments would express interest in selling sequestered urban forest carbon in a market.

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SOUTHERN TIMBER MARKETS: HOW DID TIMBER MARKETS CHANGE IN 2007?

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Abstract

This paper reviews ten years of southeast U.S. timber prices from the 4th Quarter 1997 through 4th Quarter 2007 with implications in a changing timber market. This study focuses on a historical comparison with key market drivers such as housing markets and manufacturing of pulp and paper. Among market trends are changes in timberland ownership and timberland prices.

[Abstract Only]

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MARKET COMPETITIVENESS FOR RAW MATERIALS IN THE U.S. SOUTH: MEASURING THE RELATIONSHIP BETWEEN MARKET DEMAND AND STUMPAGE PRICES

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Abstract

This study investigates market competitiveness as a relationship between the demand for pine pulpwood, chip-n-saw and sawtimber and the corresponding stumpage prices across 17 Southern markets. In addition, we test the relationship between stumpage prices and the number of product consuming facilities. A strong and positive relationship is found for pine sawtimber, but insignificant for pine pulpwood and chip-n-saw. We further explore opportunities to estimate the price elasticity of demand at the market level in several markets of U.S. South.

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ELECTRONIC COMMERCE ADOPTION IN WEST VIRGINIA'S PRIMARY AND SECONDARY HARDWOOD INDUSTRIES: PRELIMINARY RESULTS

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Abstract

It has become widely accepted that businesses need to embrace e-commerce to compete in the global economy. Since primary and secondary hardwood industries of West Virginia are important components of the State's economic base, these hardwood industries must follow the lead of corporate America in adopting e-commerce to remain competitive in the national and global markets. A mail survey was conducted in the fall of 2007 to investigate e-commerce adoption and trends in West Virginia's primary and secondary hardwood industries. Preliminary results of the survey indicate that 47% of the respondents have adopted e-commerce in their business. The majority of those who adopted e-commerce have done so prior to 2000 and have spent less than $10,000 on e-commerce-related activities. All of the companies who adopted e-commerce use email for communications. In addition, a majority of these companies have websites, take customer orders over the internet, use online banking, and make online purchases for supplies. Less than 50% advertise or sell products on other company's websites. The top three reasons for adopting e-commerce include greater exposure to potential customers, improvement of service to customers, and improvement of company's competitiveness. On the other hand, the three major concerns for not adopting e-commerce include profitability, information security, and cost. The majority (70%) of those who have not adopted e-commerce indicate that they do not plan to do so in the future.

Keywords: E-commerce, Appalachian hardwoods, internet, export

Introduction

Physical markets are no longer necessary for producers and consumers to interact in the buying and selling of goods and services. Digital technology has paved the way to the development and growth of a digital economy. The electronic market place, which is referred to as the emerging market economy where buyers and sellers interact electronically or digitally in some way, has grown tremendously in the last two decades. Market transactions in the electronic market place can be referred to as electronic commerce or e-commerce and include both business-to-consumer and business-to-business transactions. These transactions are not limited to the purchase of a product but also include all information and services that a company may offer to its customers over the internet ranging from pre-purchase information to after-sale service (Dufour 1999). E-commerce is a modern technology that addresses the needs of organizations, merchants, and

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consumers to cut costs and increase service delivery speed without compromising the quality of goods and services (Kalakatoa and Winston 1996). E-commerce has created a means for companies to develop a competitive advantage in the marketing of their products.

E-commerce has opened a new paradigm for carrying out business transactions and can have a very important impact on how businesses carry out their operations. It reduces transaction costs, allows for faster and more effective communication, removes geographic and temporal limit, and gives consumers a wider range of product choices (Perry and Schneider 2002). According to Brown (1999), e-commerce is creating a new and distinct boom in the global economy. It has become widely accepted that businesses need to embrace e-commerce to compete. Many U.S. companies – ranging from electric utilities to credit card firms to computer equipment manufacturers – have adopted e-commerce (Georgiou and Stefaneas 2002) to maintain a competitive advantage in their businesses. Small businesses are also catching up with this trend, which they need for their on-going survival (Akkeren and Cavaye 1999). The forest products industry also needs to examine and consider adopting this growing trend in the digital economy if it wants to remain competitive, not only regionally but also globally.

While the forest products industry has shown growing interest in the adoption of e-commerce, its application has been limited. Vlosky (1999) examined the application of internet-based technologies for conducting business in the top 100 companies (by product volume) in the solid wood products as well as the pulp and paper sectors of the forest products industry in the United States and Canada. Their findings showed that less than 50% of the companies surveyed made use of internet-based technology, ranging from customer contacts (47%) to sales to customers (31%). Pitis and Vlosky (2000) evaluated the use of internet among the U.S. primary wood products exporters. While a majority (80%) of their respondents employed the internet in conducting business, the most prevalent use was in the form of email and web navigation. Application of e-commerce is yet to be realized on a large scale (e.g., online trading of wood products). These studies have focused on the electronic activities of relatively large companies in the forest products sector, mainly primary industries. While these large companies in forest products sector have begun to adopt e-commerce in their business operations, other industries (i.e. secondary industries and smaller companies) must follow suit if they want to remain competitive.

Of particular interest is how the primary and secondary hardwood industries in West Virginia are responding to the expanding electronic market. Hardwood resources are a major component of the State's economic base. Approximately 78% (12.0 million acres) of West Virginia is forested and hardwoods make up over 90% of this forest cover (Griffith and Widmann 2003). The contribution of the wood industry to West Virginia's economy has been increasing since the 1980s. Greenstreet and Cardwell (1997) reported that the industry created 29,283 jobs and generated a total industry output of $3.2 billion in 1995. Approximately 91% of the State's production in the logging sector and 99% of the lumber production in the sawmill sector are in hardwoods, reiterating the role of West Virginia as a major producer of hardwood. The State's hardwood industries will need to respond to this growing trend in the digital economy or will need to expand their use of e-commerce to increase their productivity and efficiency, and thus, remain competitive in the national and international markets. No information is currently available on the status of e-commerce adoption among West Virginia hardwood industries or on the factors affecting e-commerce adoption. Such information is important to assess the State's timber industry readiness for the digital economy of the future. This paper investigates e-commerce adoption and trends in West Virginia's primary and secondary hardwood industries. It presents preliminary findings of a statewide industry survey carried out in the fall of 2007.

Methods

A mail survey of the primary and secondary hardwood industries in West Virginia was conducted in Fall 2007 to collect information related to e-commerce adoption. A survey instrument was developed for the mail survey and questions that were included drew from constructs and measures used by previous studies (e.g., Vlosky 1999, Shook et al. 2002). A summary of the information collected from the survey includes:

- Industry characteristics (e.g., plant size, number of workers, output)
- E-commerce activities (e.g., customer contacts, webpage, marketing, sales)
- Perceived benefits from adopting e-commerce (e.g., increased access to industry information, increased exposure to potential customers, reduced costs of business operations)
- Impediments/constraints in the adoption of e-commerce (e.g., availability of technical resources, security, availability of information technology personnel, costs)

The questionnaires were submitted to the Human Subjects Review board of the university for approval. The participants in the survey included both the primary and secondary hardwood industries in West Virginia. The names and addresses of industries were obtained from the Forest Industry Database maintained by the Appalachian Hardwood Center (AHC). Dillman's (2000) Tailor Design Method was used in developing and administering the mail survey. Three mailings were sent to the potential survey respondents to ensure a high response rate: initial mailing of the survey instrument, follow-up mailing (three to four weeks after the initial mailing), and final mailing to non-respondents (three to four weeks after the follow-up). Summary statistics were calculated for the variables collected from survey. In addition, relative frequencies and chi-square tests were conducted to examine the relationship between e-commerce adoption and industry characteristics.

Results

Survey Results

Of the 287 questionnaires that were initially mailed out, about 19 were returned due to undeliverable addresses and industries that were out of business. Thus, the effective sample size was reduced to 268. The survey resulted in 56 usable responses or a 21% response rate.

Industry Characteristics

Table 1 presents the industry characteristics of the survey respondents. Most of the companies have their main office in West Virginia. In terms of industry size, most of the companies employ less than 10 employees. Primary and secondary hardwood companies in West Virginia were older; many were established more than 50 years ago. A majority of the companies had gross sales revenue of greater than $500,000 in 2006. In addition, most of these companies have wholesalers as their primary customer base and have not participated in the export market.

Table 1. Characteristics of the hardwood industry survey respondents, West Virginia, 2007 (percent of respondents)

Main Office Location/Headquarters			
West Virginia: 84%	Out-of-State: 16%		
Number of Employees			
<10: 38%	41-50: 4%		
11-20: 14%	51-100: 9%		
21-30: 16%	>100: 16%		
31-40: 4%			
Company Age			
<5 years: 4%	21-30 years: 16%		
5-10 years: 9%	31-40 years: 16%		
11-15 years: 13%	41-50 years: 7%		
16-20 years: 7%	>50 years: 29%		
Gross Sales Revenue in Previous Year			
<$500,000: 25%	>$500,000: 66%	No answer: 9%	
Primary Customer Base			
Wholesalers			
	Yes: 50%	No: 48%	No answer: 2%
Distributors			
	Yes: 27%	No: 71%	No answer: 2%
Retailers			
	Yes: 25%	No: 73%	No answer: 2%
Export Products to Other Countries			
Yes: 20%			
No: 80%			

E-Commerce Application

Out of the 56 industries who responded to the survey, 46% reported that they have adopted some form of e-commerce technology in their business operations. A majority of those who adopted e-commerce had done so in 2000 or before, with a few more of the companies following the trend after 2000 (Table 2). The most common e-commerce tool employed by those who adopted e-commerce is email (Table 3). All the companies reported that they use email communications. Most of the companies also have their own website in which to advertise their products. In addition, a majority of those who adopted e-commerce use the internet to take customer orders as well as to purchase their own supplies. The least common e-commerce tool used by companies is using another company's website for product advertisement. Most respondents spent less than $10,000 to date on their e-commerce-related activities (Table 4).

Table 2. Year that hardwood industry survey respondents first adopted e-commerce in their business operations, West Virginia, 2007

Year	% of Respondents*
Prior to 2000	35
2000	15
2001	12
2002	8
2003	8
2004	12
2005	4

*Do not add up to 100% because some respondents chose not to answer the question.

Table 3. E-commerce activities employed by the hardwood industry survey respondents who adopted e-commerce in their business operations, West Virginia, 2007

E-Commerce Activities	Adoption (% of respondents)*	
	Yes	No
1. Website	81	12
2. Use email for communications	100	0
3. Use of internet for customer orders	77	19
4. Advertise or sell products on other company's website	42	50
5. Use internet banking for financial transactions	46	42
6. Purchase company supplies online	85	12

*Some activities do not add up to 100% because some respondents chose not to answer the question/s.

Table 4. Expenditure to date of hardwood industry survey respondents on e-commerce applications, West Virginia, 2007

Expenditures ($)	% of Respondents*
<10,000	46
10,000-50,000	15
50,001-100,000	8
100,001-250,000	4
250,001-1,000,000	15

*Do not add up to 100% because some respondents chose not to answer the question.

Chi-square tests were conducted to examine the relationship between industry characteristics and e-commerce adoption. The results indicate that there is a significant relationship between industry size and adoption of e-commerce (Figure 1). Specifically, companies who have more employees are more likely to adopt e-commerce than companies who have fewer employees. There is also a significant relationship between gross sales revenue and adoption of e-commerce (Figure 2). Companies with greater than $500,000 in earnings were more likely to adopt e-commerce in their business operations. The results also indicate that companies who export their products abroad were more likely to implement e-commerce tools (Figure 3).

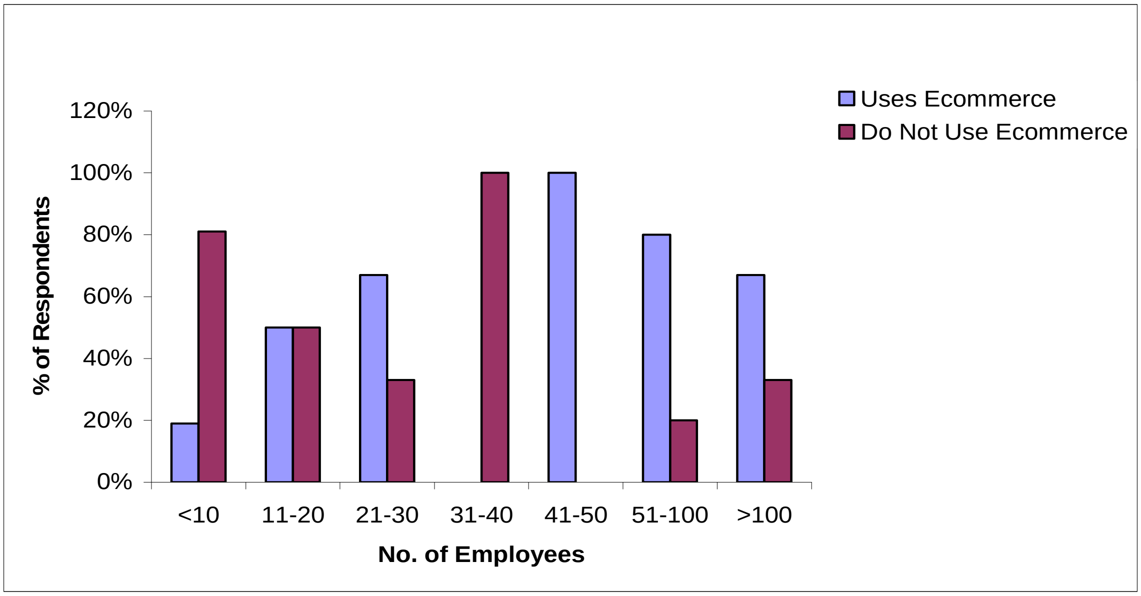

Figure 1. Distribution of respondents by number of employees and adoption of e-commerce, West Virginia, 2007

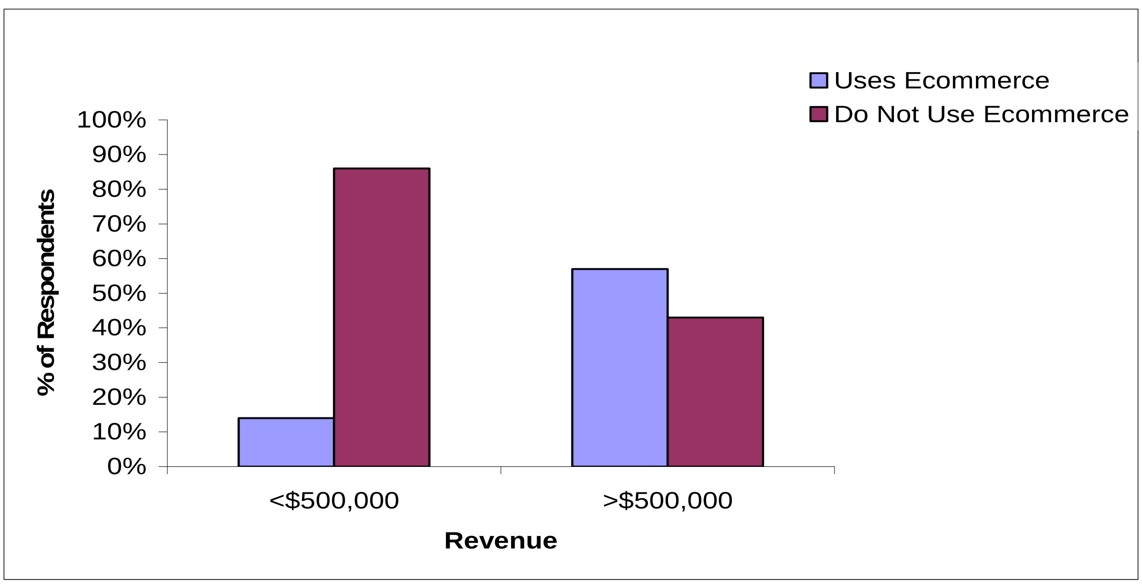

Figure 2. Distribution of respondents by previous year gross sales revenue and adoption of e-commerce, West Virginia, 2007

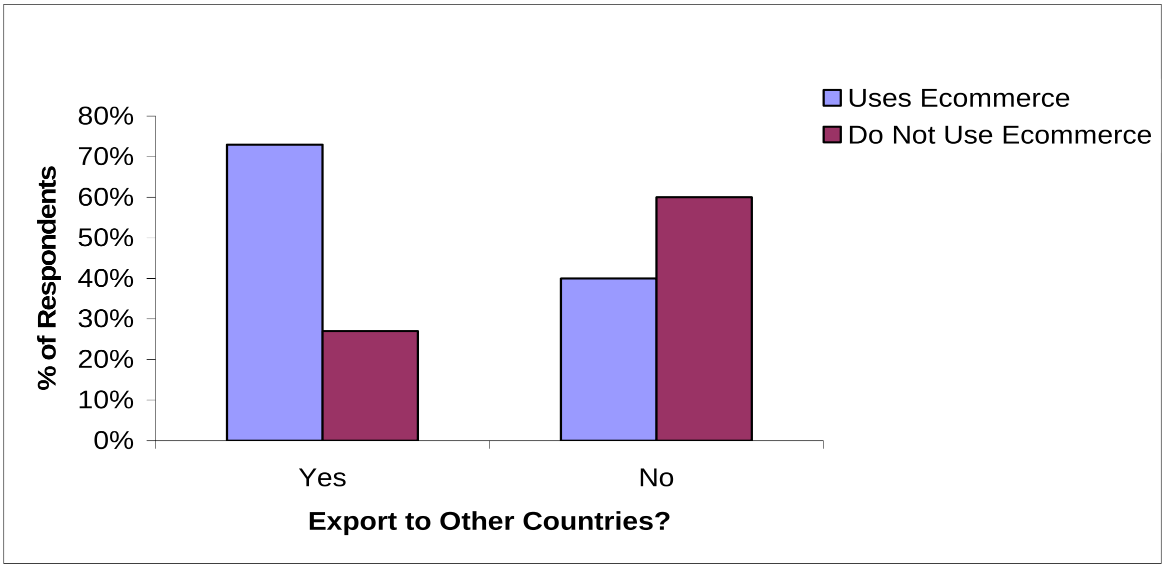

Figure 3. Distribution of respondents by whether they export their products to other countries and adoption of e-commerce, West Virginia, 2007

Respondents who reported not adopting any type of e-commerce tool were asked whether they have any plan to use-ecommerce in the future. The majority (60%) of them reported that they have no plan to adopt e-commerce in the near future.

<u>Perceived Benefits and Constraints in E-Commerce Adoption</u>

Respondents who adopted e-commerce in their business operations were presented with a list of possible benefits of e-commerce and were asked to rank these benefits according to level of importance. Customer service improvement, greater exposure to potential customers, greater access to vendors, and improvement in company competitiveness were the perceived benefits that rank the highest in terms of importance (Table 5). Providing customers with lower prices was reported to be the least important benefit of e-commerce.

Respondents were also presented with a list of possible constraints for adopting e-commerce in their business operations and were asked to rank these reasons in terms of degree of concern. The four major concerns reported by respondents include the security of sensitive information, cost, availability of technical resources, and profitability (Table 6). The need to restructure the company and the notion that e-commerce is just a passing fad were not considered major concerns by a majority of the respondents.

Summary and Discussion

This study presents the preliminary findings of a forest industry survey carried out in the fall of 2007 regarding the status and trends of e-commerce adoption among the primary and secondary hardwood industries in West Virginia. The baseline information that was collected from this study can be used in the development of a strategy that will bring the hardwood industries into the digital economy, thereby making them more competitive, not only nationally but globally.

Table 5. Perceived benefits from e-commerce adoption by hardwood industry survey respondents, West Virginia, 2007

Perceived Benefits	Very Important (%)	Important (%)	Not very important (%)	Not at all Important (%)
1. Increased access to industry information	57.69	23.10	7.70	11.54
2. Greater exposure to potential customers	76.92	11.54	3.85	7.70
3. Enhance image of company	46.15	30.77	19.23	3.85
4. Increase sales	57.69	19.23	19.23	3.85
5. Greater access to vendors	65.38	30.77	3.85	0.00
6. Improve service to customers	82.61	27.27	0.00	3.85
7. Improve competitiveness	65.38	19.23	15.38	0.00
8. Increase customer retention	46.15	23.08	26.92	3.85
9. Lower cost of doing business	46.15	26.92	19.23	7.69
10. Faster product/service delivery	46.15	30.77	11.54	11.54
11. Lower prices to customers	26.92	23.08	34.61	15.38

E-commerce adoption in West Virginia's wood industry follows the same trend as the national and other states' wood industries. The results indicate that close to 50% of the hardwood industry in West Virginia has adopted some form of e-commerce tools in their business operations. Vlosky (1999) examined the application of internet-based technologies in the solid wood products and paper industry specifically focusing on the top 100 U.S. and Canadian companies. Their findings showed that less than 50% used the internet. Shook et al. (2002) also investigated e-business application in 3 states (Idaho, Montana, and Washington) in the Pacific Northwest and found that approximately 30% have used e-business tools. While West Virginia's e-commerce application is close to these figures, Vlosky's study was conducted almost 10 years ago while Shook et al. was done 6 years ago. Based on the findings of this paper, e-commerce applications in West Virginia's wood industry have not grown that much over the last few years. The majority of those who adopted e-commerce have done so prior to 2000 with a few more of the companies following the trend after 2000. This also indicates that e-commerce adoption peaked prior to 2000. This is not surprising since there was a dramatic increase in internet use in the forest products industry around the late 1990s (Vlosky 1998).

The most common e-commerce tool adopted by West Virginia's wood industry is email. In fact, all the companies who used e-commerce reported using email in their communications. This is consistent with the findings of previous studies (e.g., Pitis and Vlosky 2000, Shook et al. 2002). The least common tool is using another company's website either to sell or advertise products.

One possible explanation for this is that a majority of the companies who used e-commerce have their own website. This could diminish the need to rely on other companies' websites.

Table 6. Constraints in e-commerce adoption by hardwood industry survey respondents, West Virginia, 2007

Constraints	Major Concern (%)	Concern (%)	Not a concern (%)	Not a major concern (%)
1. Security of sensitive information	50.00	27.08	6.25	16.67
2. Training of personnel	20.83	33.33	20.83	25.00
3. Need to change established procedures	20.83	39.58	25.00	14.58
4. Availability of technical resources	33.33	22.92	25.00	18.75
5. Cost	40.42	29.78	17.02	12.77
6. Loss of contact with customers	28.57	34.69	14.29	22.45
7. Not profitable	32.61	10.87	32.61	23.91
8. Need to restructure the company	8.51	19.15	31.91	40.42
9. It is a passing fad	4.35	8.70	33.33	58.70

The results of this study indicate that larger companies (i.e., those who have more employees) were more likely to adopt e-commerce compared to smaller companies. According to Shook et al. (2002), smaller companies usually lack the internal structure to handle adoption of new technologies. This could be one of the reasons why smaller wood products companies in West Virginia were less inclined to adopt e-commerce. The results also show a significant relationship between a company's gross sales revenue and e-commerce adoption. Specifically, higher gross sales revenues were associated with e-commerce adoption. This may imply that e-commerce adoption may boost a company's income. Adoption of e-commerce tools can improve a company's competitive advantage by lowering promotional and other business transaction costs while significantly increasing its promotional reach and thus increasing product gross margins (Shook et al, 2002). A significant relationship was also found between exports and e-commerce adoption. Specifically, companies who export their products abroad were more likely to adopt e-commerce. Previous studies have also found a strong relationship between the use of e-commerce and export markets (e.g., Pitis and Vlosky 2000; Stennes et al. 2006). Using e-commerce tools allows companies to communicate with their overseas customers at a lower cost and also provides the opportunity to market their products at a wider geographic range at lower costs. In fact, according to Pitis and Vlosky (2000), companies who are exporters tend to adopt e-commerce tools because of promotion benefits and increased operating effectiveness.

The most important benefit of e-commerce that was reported by the survey respondents was the improvement of service to customers. On the other hand, the major concern to e-commerce adoption was the security of sensitive information. Vlosky (1999) also reported this as major concern among the U.S. and Canadian forest products industry.

While some of the companies in West Virginia's forest products industry are following the lead of corporate America in e-commerce adoption, the majority were still not using any type of e-commerce tool. In order to increase efficiency, productivity and competitiveness, the forest products industry in general should continue to expand its use of e-commerce tools (Vlosky 1999). However, in West Virginia, about 60% of those who are currently not using e-commerce indicated that they have no plan of adopting e-commerce in the near future. There is therefore the need to encourage these companies to adopt e-commerce if they want to remain competitive in the business. This is even more critical now with the increasing global competition in the forest products market and the current housing slump in the U.S.

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ANALYZING THE RETURNS BEHAVIOR OF TIMBER-ORIENTED SECURITIES VERSUS PRIVATE TIMBERLAND FUNDS

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Abstract

With the dramatic shift of timberland ownership toward institutional investors, there has been an increased demand for timber-related financial products. Timberland investment analysts have discussed the potential utility of synthetic timberland indexes and derivatives in improving the management of timberland within diversified portfolios. At least two indexes have been constructed using samples of globally traded, timber-rich entities: the Standard and Poor's Global Timber and Forestry Index (S&P Timber Index) and the Clear Global Timber Index. The Clear Global Timber Index is the basis for a newly developed exchange-traded index fund, the Claymore Exchange-Traded Fund Trust 2, which trades on the American Stock Exchange. The S&P Timber Index reflects the performance of 25 large, publicly traded entities based in the United States, Canada, Finland, Sweden, Australia, Spain, South Africa, Japan, and China. To date, no publicly available index funds or derivatives products have been developed to track the S&P Timber Index.

Applications of these indexes include, among others: benchmarking the performance of private timberland funds, achieving asset allocation targets for timberland prior to managers' purchases of actual properties, and offering institutional and retail investors a passive investment alternative relative to actively managed timberland properties and funds. Given the significant time delays between the establishment of timberland asset allocation targets and the actual accumulation of timberland exposure in private markets, the availability of a synthetic timberland alternative may serve as an important tool for portfolio managers.

In: Siry J, Izlar B, Bettinger P, Harris T, Tye T, Baldwin S, Merry K, editors. 2009. Proceedings of the 2008 Southern Forest Economics Workers Annual Meeting; 2008 Mar 9-11; Savannah, GA. Athens (GA): Center for Forest Business, Warnell School of Forestry and Natural Resources, University of Georgia. Center for Forest Business Publication No. 30.

A critical, related research question is: Does the S&P Timber Index serve as a substitute for private timberland funds managed by timberland investment management organizations (TIMOs)? The purposes of this paper are to (1) explain the potential applications of the S&P Timber Index and other similar indexes, (2) critique the construction of the S&P Timber Index and similar indexes, and (3) assess the effectiveness of the S&P Timber Index in tracking the returns of private timberland funds as reflected by the NCREIF Timberland Property Index.

[Abstract Only]

INFLATION AND TIMBERLAND RETURNS

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Abstract

Timberland is often described as an inflation hedge and the correlation between the two is usually cited as proof. (In fact, the literature indicates that timberland is a hedge against unexpected levels of inflation.) The correlation coefficient for inflation and timberland returns is generally positive, and fairly strongly so. Analysis shows that U.S. timberland returns, as measured by the NCREIF Timberland Index, appear to lead the U.S. Consumer Price Index by a year and those returns are highly positively correlated with inflation. However, timber prices, which are a major driver of timberland returns, are not always highly correlated with inflation. It appears that a geographically diversified timberland portfolio is required if investors want timberland returns to be positively correlated with inflation over the long term. We also look to see if U..S timberland returns provide an inflation hedge for investors based outside the U.S.

Keywords: Timberland, investment, inflation

Introduction

Timberland is often described as an inflation hedge and the correlation between the two is usually cited as proof. (In fact, the literature indicates that timberland is a hedge against unexpected levels of inflation.) The correlation coefficient for inflation and timberland returns is generally positive, and fairly strongly so.

Inflation and Timberland Returns

Figure 1 shows a typical correlation analysis comparing timberland returns with other asset classes and inflation. The correlation coefficient for timberland and inflation is 0.4493.

Figure 2 compares time series of timberland returns and inflation. The timberland returns are calculated using the NCREIF Timberland Index for the period 1987 – 2006 and the Wilson Model (commonly known as the John Hancock Timber Index) for the period 1960 – 1986.

Note in Figure 2 that timberland returns peak in 1973 and 1989, and inflation peaks in 1974 and 1990. Timberland returns hit lows in 1975 and 1985, and inflation hits lows in 1976 and 1986. While the relationship is not perfect (e.g., both series peak in 1969), it appears that inflation highs and lows closely follow timberland returns highs and lows.

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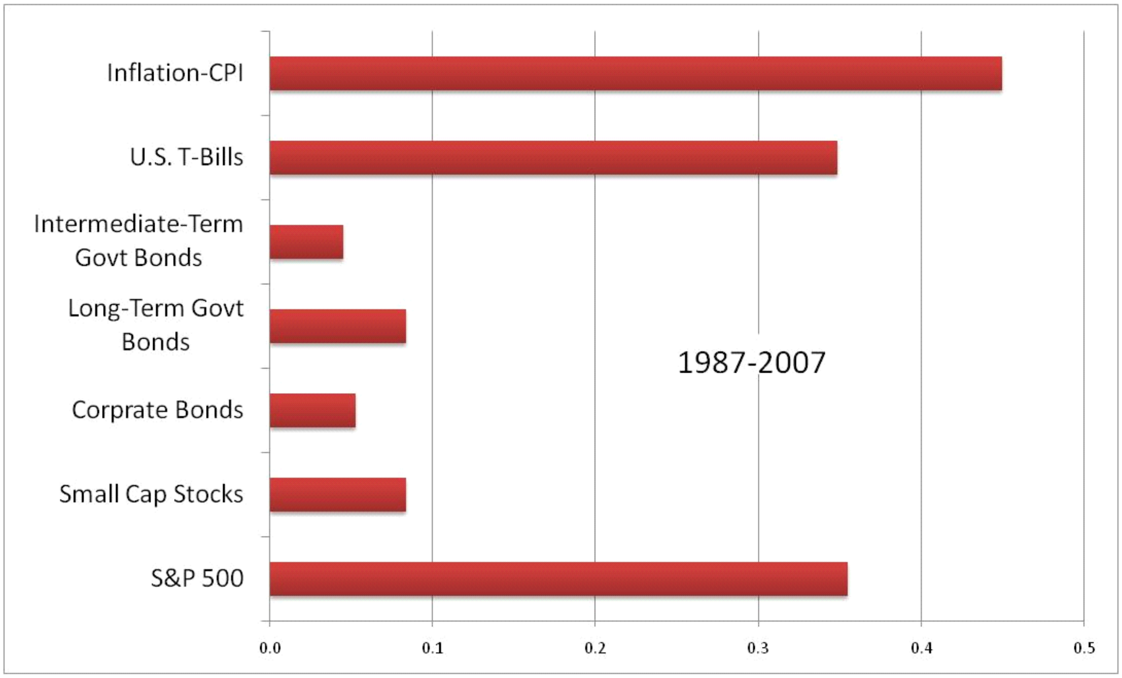

Figure 1. Correlation with Timberland
Sources: NCREIF, Ibbotson Associates

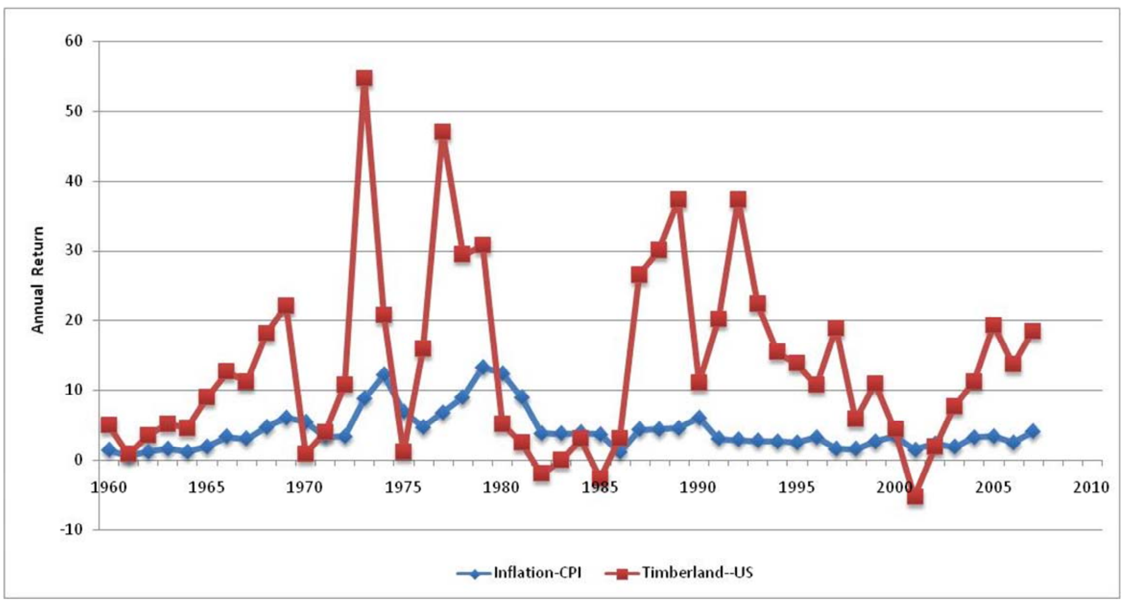

Figure 2. Inflation and Timberland Returns
Sources: NCREIF, Ibbotson Associates

In Figure 3 the timberland returns are lagged a year. This means one year's timberland returns are paired with the following year's inflation rate. For example, timberland returns for 1960 are paired with the inflation rate for 1961 and timberland returns for 1994 are paired with the inflation rate for 1995. Most of the peaks and troughs are now aligned with each other. The correlation coefficient jumps from 0.38 (1960-2007) to 0.60 (1961-2007).

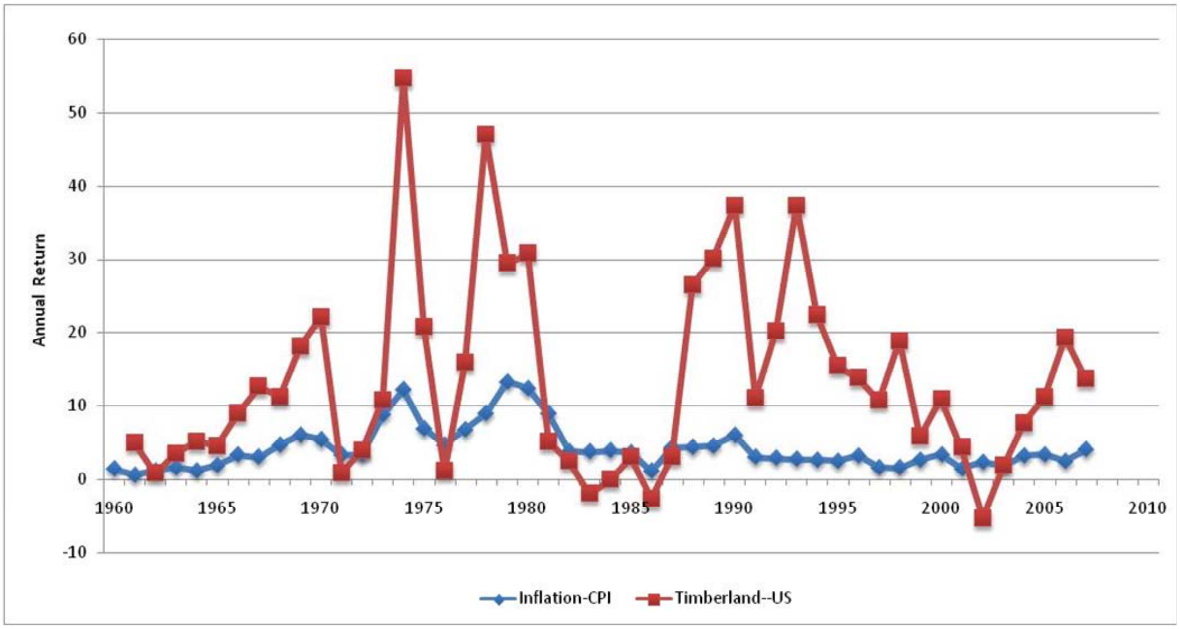

Figure 3. Inflation and Lagged Timberland Returns
Sources: NCREIF, Ibbotson Associates

<u>Inflation and Timber</u>

Since timberland returns lead inflation, it is reasonable to assume that timber prices might lead inflation too, since timber prices are important drivers of timberland returns. But Table 1 shows that timber prices are not necessarily strongly correlated with inflation.

Table 1. Inflation, Lagged Timberland Returns and Lagged Changes in Timber Prices

	Inflation – CPI	Timberland – US	DF #2 Saw	So. Pine Saw
1960 – 2006	1.0000	0.5979		
1987 – 2006	1.0000	0.6017	0.5306	0.1703

We find that, while U.S. timberland returns are strongly correlated with inflation, this appears to be a result of the geographical diversity of the NCREIF portfolio. The correlation between inflation and timberland returns by region varies over time (Table 2).

Table 2. Correlation Coefficients for Inflation and Lagged Timberland Returns

	Inflation – CPI	Timberland – US	Timberland – SO	Timberland – PNW	Timberland - NE
1960 – 2006	1.0000	0.5979	0.6016	0.5266	0.2449
1987 – 2006	1.0000	0.6017	0.1355	0.6990	-0.0001
1997 – 2006	1.0000	0.0944	-0.0617	0.1693	0.4421

Table 3 shows that changes in southern timber prices are highly correlated with timberland returns, even if they are not highly correlated with inflation.

Table 3. Southern Timber, Timberland and Inflation

	Inflation – CPI	Timberland – SO	So Pine Saw	So Pine CNS	So Pine Pulp
1960 – 2006	1.0000	0.6016			
1977 – 2006	1.0000	0.5001	0.2431		0.2638
1987 – 2006	1.0000	0.1355	-0.1337	-0.0259	0.2790
1997 – 2006	1.0000	-0.0617	-0.4123	-0.2453	0.0272
1977 – 2006		1.0000	0.7139	0.6609	0.4962
1987 – 2006		1.0000	0.5817	0.8173	0.6493
1997 – 2006		1.0000	0.6161	0.7960	0.6566

Whether or not timberland returns are correlated with inflation, timberland returns in all U.S. regions have outpaced inflation over the past 20 years (Table 4).

Table 4. Returns for Inflation and Lagged Timberland Returns

	Inflation – CPI	Timberland – US	Timberland – SO	Timberland – PNW	Timberland - NE
1987 – 2007	2.79%	13.71%	9.91%	18.02%	
1987 – 1996	3.68%	22.13%	13.82%	32.10%	
1997 – 2007	2.21%	7.81%	7.85%	7.84%	11.37%

<u>Inflation Calculations</u>

It is interesting to note that two of the major sources of inflation data calculate annual inflation rates differently. The U..S Department of Commerce, which reports monthly inflation rates, calculates the annual rate by averaging the inflation index values for the year and then expressing the annual rate as the percent change in the index from year to year. Ibbotson Associates, on the other hand, calculates the annual rate by compounding the monthly rates. The differences can be appreciable over a very short period, but do not appear to cause significant differences over long periods (Figure 4).

The question of methodology is of some importance because some of the readily available inflation data for some countries is calculated using the USDC methodology, not the Ibbotson methodology.

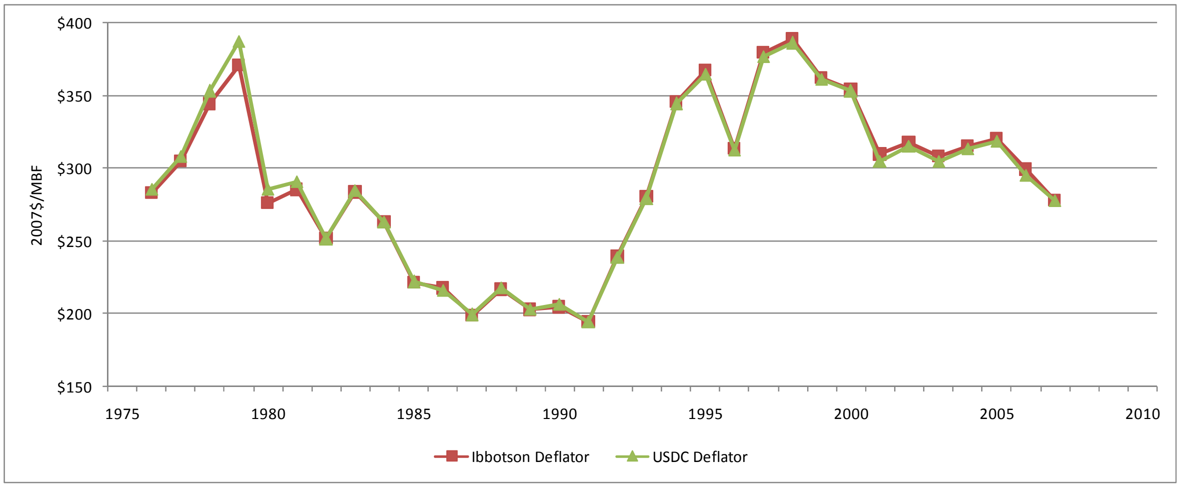

Figure 4. Pine Sawtimber Stumpage Prices Deflated Using USDC and Ibbotson Annual Inflation Rates
Source: Timber Mart-South

<u>Timberland and International Inflation</u>

But are U.S. timberland returns positively correlated with inflation from other countries? Can Non-U.S. investors use U.S. timberland investments as an inflation hedge? Figure 5 shows that inflation in other countries is not always positively correlated with U.S. timberland returns.

Figure 6 shows that, correlated or not, U.S. timberland returns have exceeded inflation rates in most of the countries shown.

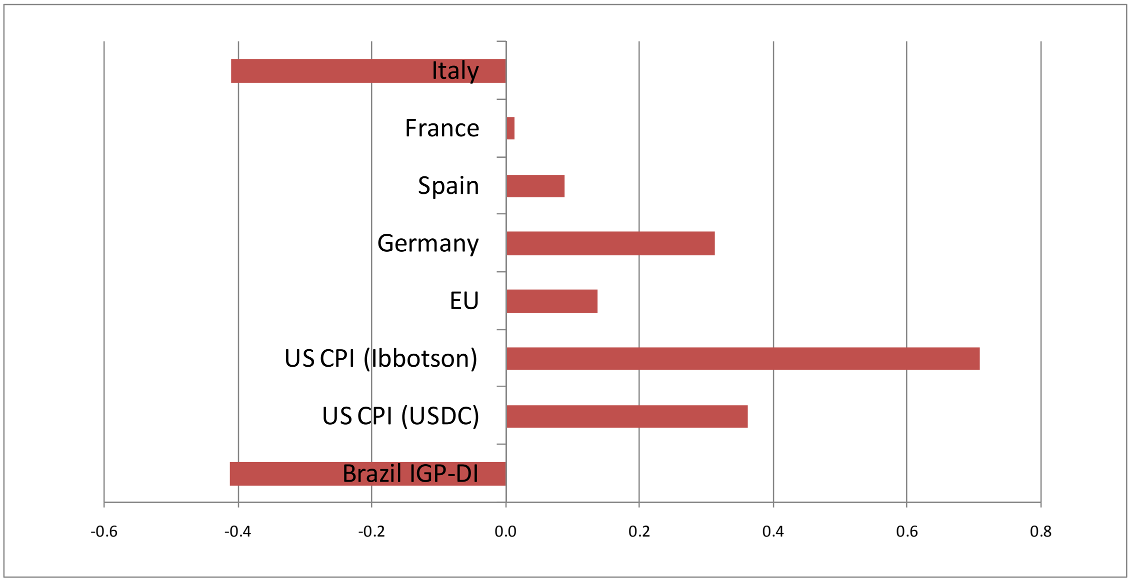

Figure 5. Correlation Coefficients for Timberland Returns and Inflation Rates, 1998-2007
Sources: NCREIF, U.S. Department of Commerce, Banco Central do Brazil, EuroSTAT

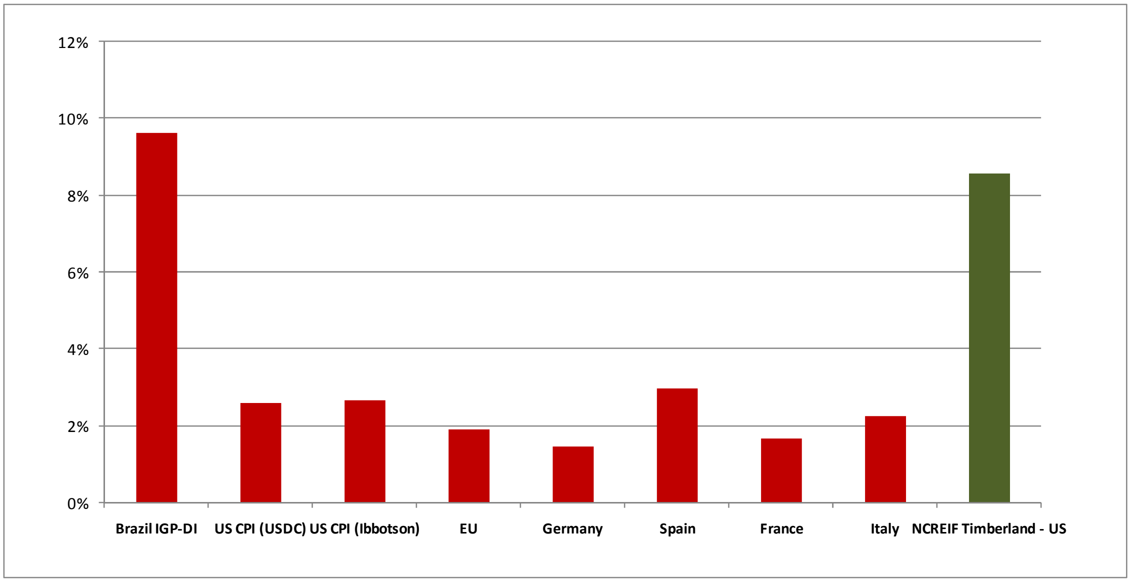

Figure 6. Inflation Rates and U.S. Timberland Returns, 1998-2007
Sources: NCREIF, U.S. Department of Commerce, Banco Central do Brazil, EuroSTAT

Summary

A geographically diversified U.S. timberland portfolio can serve as an inflation hedge. A less diversified portfolio may be less strongly correlated, but can still provide returns that are higher than inflation. Many international investors will find that U.S. timberland returns outpace inflation in their countries as well.

A METHOD FOR CALCULATING THE INTERNAL RATE OF RETURN ON MARGINAL SILVICULTURAL INVESTMENTS

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Abstract

As with most investment managers, foresters regularly are faced with quantifying the impact of expenditures on the financial performance of the asset they manage – timber and timberland. The most common measures of financial performance are net present value and internal rate of return. Internal rate of return is the more common measure used while net present value is generally preferred by academics when making such financial decisions. In many, if not most, cases, foresters will calculate both measures for use in the investment analysis. However, there do exist small, but at times meaningful, differences in the decisions selected based upon the investment criteria used. Additionally, there are cases where the investors are interested in quantifying the marginal impact of each silvicultural treatment being evaluated in the investment process. This research develops methodology for calculating the internal rate of return on these marginal investment decisions in a plantation forestry context.

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WILLINGNESS TO PAY FOR HUNTING LEASES IN MISSISSIPPI: INSIGHTS FROM ALTERNATIVE MODELING PERSPECTIVES

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Abstract

Willingness to pay for hunting leases is more complex than willingness to pay for access to the land. Based on this premise, we analyzed factors influencing willingness to pay for hunting leases in Mississippi while taking into account the potential sample selection bias. The modeling approach involved dichotomous choice modeling, choice experiments and contingent ranking. Preliminary results based on bivariate probit estimation of dichotomous choice data suggested that the Mississippi hunting lease market is characterized by sample selection bias issues. The selection component of the model indicated that hunters with the following characteristics were more likely to buy hunting leases: annual household incomes in excess of 40 thousands dollars, avidity, no alternative access options to hunt, and the perception that freely available hunting lands were crowded. The regression component of the model, designed to predict willingness to pay for hunting leases, identified three sets of factors to influence hunters' willingness to pay more for site access. These included a) lease rate per acre, b) the site's potential for game diversity and ATV accessibility, and c) hunters' annual household income, alternative access options, and state residency.

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GROWING LOBLOLLY PINE WITH WILDLIFE FOOD PLOTS, HUNTING LEASE ASSUMPTIONS AND LIABILITY ISSUES

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Abstract

In the southeastern United States, non-industrial private forest landowners (NIPFL) have experienced reduced product market availability and increase price uncertainty. NIPFL's need additional management options for the most commonly grown southern pine species – loblolly pine (*Pinus taeda* L.). Profitability and cash flow of production forestry enterprises need to be improved. At the same time, NIPFL's desire increased flexibility to achieve marketable forest products. This paper examines feasibility, profitability, and cash flow of a mixed product, 33-year rotation with management options for loblolly pine plantations that incorporate management activities such as thinning, wildlife food plots, and hunting leases under alternative levels of productivity and product prices. Calculated financial measures of profitability include soil expectation value (SEV), annual equivalent value (AEV), and internal rate of return (IRR). With 7% of the acreage in food plots and hunting lease values of $8, $10, $12, and $14 per acre per year, IRR values were 11.14%, 11.62%, 12.31%, and 12.67% respectively. Hunting leases add income for NIPFL's but landowners worry about liability risk. Studies analyzing lawsuits showed that perceived risk was greater than actual exposure. Landowners can take simple precautions to reduce liability risk when leasing land for recreation.

Keywords: Internal Rate of Return, liability risk, hunting lease, wildlife management, timber management

Introduction

Non-industrial private forest (NIPF) landowners across the South question whether to plant loblolly pine on cutover and old-field sites. They also question spending moderate to large sums of money on intensive forest management under current and anticipated stumpage prices and economic uncertainty. Landowners seek options to maximize returns from their forestland. Hunting leases can provide an additional income stream for some landowners. Simple hunting leases may require little financial investment by the landowner. However, lease prices can often be improved by incorporating forestry practices such as thinning and land management practices such as creating food plots. Landowners need information on the financial benefits of these practices (Glover and Conner 1988).

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Other authors have discussed related issues such as non-timber forest product enterprises (Chamberlain and Predny 2003), timber management for northern bobwhite quail and gray squirrel (Barlow et al. 2003), and compatibility of agriculture and natural resource based enterprises (Waide 2003).

In 2006, hunting leases for white-tailed deer (*Odocoileus virginianus*) had an estimated farm gate value of 108.2 million dollars in Georgia (Boatright and McKissick 2006). The economic impacts of hunting in Georgia exceeded $651 million in 2006 (USFWS 2006). The farm gate value of timber in Georgia declined from approximately 720 million dollars per year in 1999 to approximately 585 million dollars per year in 2006 (Boatright and McKissick 2006). During the same period, the total farm gate revenue from deer hunting leases increased from approximately 50 million dollars in 1999 to 108 million dollars per year in 2006.

Hunting leases have many benefits for landowners including income generation, public relations (for both industrial lands and private lands), and property protection. Problems related to leasing may include road damage, trash, illegal hunting including over harvest, fire, damage to timber and liability exposure (Morrison et al. 2001).

The objectives of this paper are to review the financial results of various timber management scenarios with and without hunting lease assumptions. In addition, I will briefly discuss hunting lease liability issues.

Methods

Common assumptions

Cost figures for food plots are difficult to obtain - numbers are available in the wildlife literature but are very variable due to assumptions made by previous authors. The total cost to produce one ton of forage can vary from $45.76 per acre to $107.20 per acre (Wear et al. 1997). Costs include lime, fertilizer, and seed. Equipment cost is often ignored, as is labor cost because it is frequently assumed that the landowner and/or hunter perform the work. Additional specifies related to assumptions and management scenarios are given in Mengak et al. (2004).
General recommendations are for 5 to 10 percent of the tract to be in food plots to have any measurable impact on ecological carrying capacity and thus, herd size. However, individual animal size and hunter probability of successfully harvesting any deer increase with even one small food plot. White-tailed deer readily use food plots (Kammermeyer et al. 1993, Hehman and Fulbright 1997, McDonald and Miller 1995). No one knows how much larger the individual animal becomes, nor does any literature indicate the difference in harvest probability.

I assumed a landowner has 160 acres (1/4 section) and puts seven percent of the acreage into food plots (1/2 in cool season forage; 1/2 in warm season forage). That would amount to 11.2 acres of food plots in this example. These acres could be 11 one-acre food plots evenly distributed over the tract. Alternatively, one could plant several two- or three-acre plots strategically located for deer, with one larger acreage plot planted to attract doves (*Zenaida macroura*) and/or turkeys (*Meleagris gallapavo*).

Food plot area is now foregone timber income, i.e., timber income is reduced seven percent. I assumed a mid-range cost of the food plots ($60/ac or $672 on the 160-acre tract). The average price of a deer lease in Georgia was $12.00 per acre per year, or $1,920 per year for 160 acres (Boatright and McKissick 2006).

The rotation age was set at 33 years for loblolly pine plantations with two thinnings to produce an even mix of pulpwood, chip-n-saw, and sawtimber. I used a discount rate of 8 percent for the next-best alternative investment to calculate soil expectation value (SEV) and annual equivalent value (AEV). The calculation of internal rate of return (IRR) assumes that intermediate, positive cash flows are reinvested in the enterprise at the IRR, not the discount rate. We assumed fire protection cost at $2/ac/yr, stand management at $2/ac/yr, and property taxes at $5/ac/yr. Thus, the total annual cost for each year of the rotation was $9/acre. This value cost goes in the transaction table as an annual cost during the rotation. The present value of this net, annual cost flow is $103.63 during the 33-year rotation (The multiplying factor for present value of an annual terminating series at eight percent for 33 years is 11.51389). I report results in constant dollars, before taxes. Throughout the scenarios, I assumed the land is already owned.

Site Preparation and Planting Costs

Site preparation and planting (SP&PL) costs total $125/acre (Dubois et al. 1999). These costs represent the following site preparation and planting scenario: The relatively low site preparation and planting cost of $125/acre could include machine planting and the use of a post-planting herbicide to control herbaceous weeds on an old-field site or glyphosate at 1 gallon/ac or prescribed burning (low level) site preparation and rough land machine or hand planting on a cutover site.

Site preparation options and associated costs vary extensively by location, prior stand history, harvesting utilization, landowner objectives, monies available, and anticipated future stumpage value and demand. The assumption was that the level of site preparation intensity matched the level of competition control needed so that wood-flows were comparable within site productivity levels, after site preparation and planting. If the establishment cost is greater than the relatively low SP&PL cost used in this paper, then SEV, AEV, and IRR will be reduced (Dickens et al. 2005).

Product class specifications

Product class specifications are: pulpwood (PW) at a dbh of 4.6 to 9 inches to a 3 inch top; chip-and-saw (CNS) at a dbh of 9 through 12 inches to 6 inch top; and, sawtimber (ST) with a dbh greater than 12 inches to a 10-inch top (inside bark) were assumed.

Georgia stumpage prices, reported through Timber Mart-South (TMS 2004) for 1st quarter year 2004 average, used in this analysis for loblolly pine, were net of property taxes at harvest (2.5 percent) and net of marketing costs (8 percent). The low TMS prices for PW and CNS were used for thinning prices and average TMS prices for pulpwood, CNS, and ST were used for the clearcut.

Thinning

All scenarios include two thinnings at 15 and 24 years old for the 33-year rotation. Residual basal area (RBA), after thinning (5th row with selection from below), was set at 65 sq. ft./ac. To address questions related to profitability of timber management and hunting leases, we used the

Georgia Pine Plantation Simulator (GaPPS 4.20) growth and yield model developed by Bailey and Zhao (1998).

<u>Species-specific assumptions</u>

Loblolly pine survival is assumed to be 500 TPA at age 5-years. The mean annual increment (MAI) for loblolly is assumed to be 2.15 cds/ac/yr (5.77 tons/ac/yr) through age 33-years with the two thinnings.

<u>Scenarios</u>

The ten loblolly pine scenarios examined were: (1) No food plots, no hunting lease, i.e., 100% forested tract, (2) 7% unplanted openings, no hunting lease, (3) 7% food plots, no hunting lease, (4) 7% food plots, $2/ac/yr hunting lease, (5) 7% food plots, $4/ac/yr hunting lease, (6) 7% food plots, $6/ac/yr hunting lease, (7) 7% food plots, $8/ac/yr hunting lease, (8) 7% food plots, $10/ac/yr hunting lease, (9) 7% food plots, $12/ac/yr hunting lease, and (10) 7% food plots, $14/ac/yr hunting lease.

Results

Internal rate of return (IRR) for all ten scenarios ranged from 9.47-12.67 (pine scenarios with site preparation and planting cost of $125/ac, food plot establishment costs of $60/ac, seven percent of area in food plots and variable hunt lease price using the aforementioned assumptions; Figure 1). Generally, the levels of forest management are economically justifiable in these cases, even using low to medium 1st quarter 2004 stumpage prices (TMS 2004) for Georgia.

Establishing the entire tract in pine with no food plots or hunting lease resulted in an IRR value of 10.41 percent. Keeping seven percent of the tract out of pine production and with forest openings, but no food plots, lowered the IRR value to 10.1% (Figure 1). However, establishing seven percent of the tract in food plots, but with no hunting lease, further lowered IRR to 9.47 percent.

Adding income in the form of a hunting lease changes the IRR values. Greater income from a hunting lease leads to higher IRR values in a nearly linear fashion (Figure 1). Compared to the 100 percent forested tract, the tract with seven percent of the acreage in food plots and a hunting lease of approximately $5 per acre per year earns a comparable IRR. Generally, increasing management, including the addition of food plots and securing a hunting lease, increased internal rates of returns for our 160-acre tract of land.

Rotation has thinning in years 15 and 24 to a residual basal area (RBA) of 65 square feet per acre, with site prep and plant (SP&PL) cost of $125/acre. Comparison is made between a 100 percent forested tract, a tract with no hunting lease with seven percent of tract in unplanted openings, and a tract assumed to have seven percent of area in food plots with increasing levels of hunting lease price per acre. Food plot establishment costs were set at a mid-range of $60/acre. MAI is 2.01 cds/ac/yr (5.40 tons/ac/yr); wood-flow is 34% PW, 37% C-N-S, and 29% ST.

Figure 1. Relationship of hunt lease price to internal rate of return (IRR in %) and annual equivalent value (AEV in $s/ac/yr) value for a 160-acre tract of a 33-year loblolly pine plantation.

Discussion

Adding pine straw income from the plantation would greatly improve IRRs. The 2.15 cds/ac/yr MAI (5.77 tons/ac/yr) productivity levels at age 33-years for loblolly can be achieved on cut-over sites with good fertility and soil moisture holding capacity soils using a low cost chemical site preparation achieve adequate competition control (Pienaar and Rheney 1996) and is conservative on most old-field sites.

The profitably of food plots is influenced by several factors including timber price, forage yield and lease price. The tendency of food plots to attract and hold deer depends on surrounding habitat. I know of no studies that document the certainty of food plots to produce high quality deer or more deer in the absence of sound wildlife management. While producing a mature buck takes 3 or more years (McBryde 1995) and trophy buck management can be inefficient (DeYoung 1989, 1990) the installation of food plots can have an immediate impact on deer harvest. However, unlike cattle producers or row-crop production, timber growers who convert acreage from pine production to food plots may not easily revert to pine. In this case, a commitment to forego timber must be recognized as a long-term (as least through the current pine rotation) investment.

The value of food plot management for non-economic returns such as non-game wildlife, plants, and insects is largely unknown. I recognize that non-game values are increasing. Net economic value of wildlife watching is estimated at $51/day (USFWS 2003). Nature-based tourism, turkey hunting leases and duck hunting leases have an estimate annual value in Georgia of $51 million, $6.0 million, and $2.2 million, respectively (Boatright and McKissick 2006). Values for wildlife watching activities nationwide are also increasing (USFWS 2006). Potential returns from all wildlife values, when coupled with our analysis of financial returns for deer hunting leases, shows that wildlife management and timber management can increase the financial returns to landowners.

The financial analysis does not include management fees for items such as legal advice or liability insurance. I acknowledge the importance of liability coverage. However, insurance rates are difficult to determine. Individual factors (including history, size of the hunt club, number of acres, location of the property, and coverage amount) determine premium rates. For example, one company in South Carolina advertises a minimum premium rate of $364 per million dollars of coverage. Landowners should have liability insurance and should require lessees to acquire adequate liability coverage amounts. Wright et al. (2003) concluded that the myth and perception of liability is greater than the actual risks but landowners must educate themselves and act to protect their interests.

Non-industrial private forest landowners do have some attractive forest management options with loblolly pine even when using low to medium stumpage prices (TMS 2004). Generally, increasing forest management activities (thinning, fertilization, adding pine straw) increased internal rates of return at the wood growth increments used (Dickens et al. 2005). If an internal rate of return of eight percent or better is a landowner goal with the stumpage prices used (TMS 2004) and the wood production rates of 2.15 cds/ac/yr (5.77 tons/ac/yr), then all loblolly pine scenarios at the lower site preparation and planting establishment costs achieved that as shown by models in other papers (see Dickens et al. 2005). Food plot establishment costs do not push IRR value below 9.5 percent.

If an internal rate of return of 10 percent or better is a landowner objective under these assumptions, then a hunting lease for as little as $4/ac achieves that. This price is well below the $12/ac average deer hunting lease price reported for Georgia counties.

An internal rate of return of 12 percent or better is realized at the highest deer hunting lease prices of $12/ac and $14/ac. These prices are reasonable and we have anecdotal evidence of deer hunting lease prices approaching $25/ac in some areas of Georgia.

Landowners often express concerns over liability issues related to leasing lands for hunting. The issue of leasing and liability was the subject of several recent papers (Mozumber et al. 2007, Wright et al. 2002). As noted by Wright et al. (2002), “Generally, landowners perceptions of liability are not balanced with the reality of legal risks.” Numerous authors have noted the distinction in U.S. common law for three groups of recreational users (Wright et al. 2002). Trespassers receive the lowest level of protection. A trespasser is defined as a person on the property of another without any authority or permission. A licensee is a person who enters the property by permission only and without any economic or other inducement to the landowner. This would include social guests as long as their use of the property is gratuitous and not economically beneficial to the landowner. The third recreational user is the invitee. The invitee is a person who is invited onto the property for a public or business purpose. This group would include the hunter who pays a lease fee.

Generally, the highest standard of care is expected for the invitee. Landowners have a duty to inspect the property and facilities, to warn users about hazards, and to keep the property in reasonably safe repair. Landowners should anticipate foreseeable activities and take precautions to protect users. Georgia state law (OCGA 51-3-20 through 51-3-26) explicitly shields landowners from civil liability for injuries to persons using land for recreational purposes without charge. Recently, an amendment to Georgia law (OCGA 21-3-1) extends this protection to landowners and lessees who give permission to hunt or fish with or without charge.

Wright et al. (2002) reviewed 637 recreation cases involving injury or death nationwide since 1965. In Georgia, five cases were brought against public agencies but none resulted in a judgment of liability. Also, eighteen cases in Georgia were brought against private landowners and only two resulted in an adverse judgment. As noted in Wright et al. (2002), of 23 total cases in Georgia since 1965, eight were related to swimming accidents and no cases related to hunting, camping, picnicking, hiking or nature study resulted in adverse judgments against landowners.

Of course, the filing of a lawsuit by a recreational user can result in both emotional and financial hardship to the landowner. Properly drafted leases and liability release clauses, drawn by qualified lawyers and signed by all parties and members of hunting clubs will greatly reduce the liability exposure for landowners (Mozumber et al. 2007). Adequate insurance coverage by both the landowner and leasing party is strongly recommended. As shown in this paper, hunting leases can provide positive improvement to IRR calculations when used in conjunction with sound timber management and wildlife management practices. The perception of landowner liability is often less than the actual risk. Landowners should consider adding hunting leases and wildlife management activities to their intensive forest management regime to increase cash flow and improve overall returns on investment.

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FORESTLAND OWNERSHIP AND WILDLIFE HUNTING IN THE SOUTHEASTERN UNITED STATES: A SPATIAL DEMAND MODEL

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Abstract

A recent study revealed that hunting demand has been declining in the southeastern United States. One of the reasons is limited access to forest land. Because hunting demand is a function of access, it is important to understand how forest landownership change impacts hunting demand. In this study, we model hunting demand among resident hunters in the southeastern United States by incorporating the availability of forest land under different ownerships using county level, cross-sectional data.

The hunting demand model is estimated by simultaneously controlling for heteroskedasticity and spatial autocorrelation typically found in data for cross-sectional spatial units. The hunting demand model is generally heteroskedastic because spatial units are often heterogeneous. Spatial heterogeneity typically implies structural breaks across space, or heteroskedasticity due to spatial regimes. Measurement error or misspecified spatial units may cause heteroskedasticity, which in turn may be a source of spatial autocorrelation.

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Spatial heterogeneity may also be associated with spatially varying parameters or spatially dependent functional forms. The usual consequences of overlooking these issues are inferior forecasts, biased coefficients, and compromised inference. The hunting demand model was estimated using recently developed generalized spatial two-stage least squares/generalized moment (2SLS/GM) estimators.

[Abstract Only]

VALUING TIMBER INVENTORY INFORMATION

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Abstract

Timber inventory data is the basis for many monetary transactions related to timber and timberland sale/purchase as well as for development of timber management plans. The value of such data is well known and, much appreciated, for the sale/purchase of standing merchantable timber. Unfortunately, the value of timber inventory information for planning purposes is less well understood. I discuss the results of a large simulation study that was undertaken to evaluate the utility/value of timber inventory data for timber management plan development for a typical timberland ownership found in the southern United States. Our results indicate that timberland managers are likely producing management plans that do not maximize the profitability of their timberland holdings. Specifically, our results indicate that for those timber management organizations which develop timber management plans with stand level data that has sampling error of 25%, it is likely that they are experiencing expected losses in net present value (NPV) in excess of $170 per ha on a large proportion of the acreage found on typical timberland parcels in the southern United States.

[Abstract Only]

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DECISION TREE APPLICATIONS FOR FORESTRY AND FOREST PRODUCTS MANUFACTURERS

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Abstract

Research results are presented for two studies which use the common statistical method of decision trees. First, regression trees of the internal bond (IB) of 0.750" medium density fiberboard (MDF) identified significant regressors ($\alpha < 0.05$) as "refiner steam pressure" which interacts with "press start control" and "dry fuel bin speed." The highest IB (mean = 151 psi) occurred with "refiner steam pressure" >_54.6 and "press start control" ≤ _933.0. The lowest IB (mean = 132 psi) occurred with "refiner steam pressure" ≤_54.6 and "dry fuel bin speed" ≤_27.7.

Second, classification trees of 495 forest landowners in the Cumberland Plateau region of Tennessee revealed that the most significant factor ($\alpha < 0.05$) influencing tree harvests was whether or not the respondent was a farmer. Seventy-three percent of farmers had harvested timber previously. For those who were not farmers, the most significant factor ($\alpha < 0.05$) was "years residing at current address." If a non-farmer resided at the current resident longer than 36.5 years the chance of harvesting timber was 69.6 percent. For landowners that conducted commercial timber harvests, the only significant factor ($\alpha < 0.05$) from the classification tree was unsurprisingly the importance of income from the harvest. Seventy-five percent of these respondents conducted a commercial timber harvest.

Keywords: Regression trees, classification trees, medium density fiberboard, forest landowners, timber harvesting

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Introduction

Quantifying predictability is the key to scientific inquiry. As Friedman (2001) noted, given a set of measured values of attributes, characteristics or properties of an object (observation) $\boldsymbol{X} = (X_1, X_2, \ldots., X_n)$, which are often called "variables," the goal is to predict (estimate) the unknown value of another attribute Y. In quantifying predictability, de Mast and Trip (2007) note the important distinction between exploratory and confirmatory data analysis. Confirmatory data analysis is concerned with testing a pre-specified hypothesis. The purpose of exploratory data analysis is hypothesis generation. This research was undertaken in the spirit of exploratory data analysis and hypothesis generation.

Results are reported for two studies using the common method of decision trees. Decision trees were developed for modeling the internal bond (IB) of medium density fiberboard (MDF) using real-time industrial data. Decision trees were also developed from survey results of forest landowner attitudes towards harvesting timber in the Cumberland Plateau region of Tennessee.

Decision trees are one of the more popular predictive learning methods used in data mining. Decision trees were created largely in response to the limitations of kernel methods (Friedman 2001). No matter how high the dimensionality of the predictor variable space, or how many variables are actually used for prediction (splits), the entire model can be represented by a two-dimensional graphic, which can be plotted and easily interpreted (Friedman 2001). Decision trees have an advantage of being very resistant to irrelevant regressor variables, i.e., since the recursive tree building algorithm estimates the optimal variable on which to split at each step, regressors unrelated to the response tend not to be chosen for splitting (Breiman et al. 1984). Decision trees represent a contemporary scientific method for foresters interested in improving the understanding of forest landowner attitudes, and for forest products practitioners interested in identifying and reducing variability of industrial processes.

Methods

Decision Trees

The machine learning technique for inducing a decision tree from data is called decision tree learning, or (colloquially) "decision trees" (Young 2007). Decision tree (DT) methods can be applied to either numerical or categorical data. A "regression tree" is a decision tree for numerical data. A "classification" tree is a decision tree for categorical data. DT models have grown into a powerful class of methods for examining complex relationships with many types of data. Since the main advantage of a decision tree is the ease with which it can be interpreted, it is important that the construction method be free of selection bias among the regressors (Loh 2002). In this research, "GUIDE" and "CRUISE" software for decision trees were used given their absence of selection bias.

The AID (*"Automatic Interaction Detection"*) algorithm by Morgan and Sunquist (1963) was the first implementation of the DT idea. A weakness of AID is that it has a "greedy search" and a bias in variable selection, e.g., if X_1 and X_2 are regressors with $n_1 > n_2$, X_1 will have a higher chance of being selected which results in erroneous inferences from the final tree structure (Doyle 1973). CART© (*"Classification and Regression Trees"*, http://www.salford-systems.com/ referenced 9/20/07) followed AID and is a popular DT method (Breiman et al.

1984). However, CART© also suffers from the selection bias in the predictors similar to AID when the n_i associated with the predictors (X_i) are unequal. Other popular DT algorithms are: MARS© (*"Multivariate Adaptive Regression Splines"*) by Friedman (1991); Quinlan's (1992) M5 method; and FIRM (*"Formal Inference-based Recursive Modeling"*) by Hawkins (1997).

Regression Trees

A regression tree (RT) is a piecewise constant or piecewise linear estimate of a regression function constructed by recursively partitioning the data and sample space. Its name comes from the practice of displaying the partitions as a decision tree, from which the roles of the regressors are inferred. Construction of a regression tree consists of four iterative steps:

- Partition the data,
- Fit a model to the data in each partition,
- Stop when the residuals of the model are near zero or a small fraction of observations are left,
- Prune the tree if it over fits.

GUIDE Regression Trees

The GUIDE, ver. 5.2 (*"Generalized, Unbiased, Interaction Detection and Estimation"*) algorithm was used in this research. GUIDE (Loh 2002) extends the idea of Chaudhuri et al. (1994) by means of "curvature tests" (www.stat.wisc.edu/~loh/ referenced 10/5/07). A curvature test is a chi-square (χ^2) test of association for a two-way contingency table where the rows are determined by the signs of the residuals (positive versus non-positive) from a fitted regression model. The idea is that if a model fits well, its residuals should have little or no association with the values of the regressor variable. As Loh (2007b) noted, GUIDE does not have the selection bias of CART© (Breiman et al. 1984) and other tree algorithms that rely solely on greedy search optimization.

As Kim et al. (2008) noted, GUIDE has five properties that make it desirable for the analysis and interpretation of large datasets: (1) negligible bias in split regressor selection; (2) sensitivity to curvature and local pairwise interactions between regressors; (3) applicability to numerical (continuous) and categorical variables; (4) choice of simple linear, multiple, best, Poisson, or quantile regression models (and proportional hazard analysis); and (5) choice of three roles for each numerical predictor variable (split selection only, regression modeling only, or both). GUIDE also uses boot-strap adjustment of p-values, which is an important consideration when dealing with small sample sizes often encountered with industrial data. Preliminary versions of the GUIDE algorithm are described in Chaudhuri et al. (1994) and Chaudhuri (2000). Additional documentation can be found in Chaudhuri and Loh (2002), Loh (2006, 2007a, 2007b), Kim et al. (2008), and at www.stat.wisc.edu/~ loh/ (referenced 4/15/08).

Classification Trees

Classification trees (CTs) build a tree by recursive binary or multi-way partitioning of the subspace that becomes homogeneous with respect to the class variable. At each step (node) in fitting a classification tree, a chi-square (χ2) test of a contingency table is carried out to select a regressor variable (Brieman et al. 1984). Split points for each regressor are obtained from a chi-square test of the quartiles of the regressor.

The key in constructing a classification tree is determining the best split conditions to construct an informative tree (Brieman et al. 1984). Selection bias is a problem with classification trees and is an important consideration when using survey data which have missing values. Also, greedy search algorithms such as CART©, have selection bias due to joint selection of the predictor variable and the split point (Loh and Shih 1997). CRUISE (Kim and Loh 2001) was used in this research given that it is not a greedy search algorithm and is almost free of selection bias.

CRUISE Classification Trees

CRUISE is an acronym for "*Classification Rule with Unbiased Interaction Selection and Estimation.*" As Wang et al. (2008) note CRUISE has three split methods, i.e., univariate splits, linear combination splits and univariate splits with bivariate node models. CRUISE also has three types of variable selection, three pruning methods, and four possible ways to handle missing values. It also has the following properties:

- Prediction accuracy is at least as high as those of CART© and QUEST,
- Fast computation speed using multi-way splits without greedy search,
- Almost free of selection bias,
- Sensitive to local interaction between variables,
- Maintains the above properties with missing values in the learning sample.

Additional documentation can be found in Loh and Vanichsetakul (1988), Kim and Loh (2001), and at the web-site http://www.stat.wisc.edu/~loh/ (referenced 4/14/08).

Data Sets

Regression Trees

The primary mechanical property defining strength quality for MDF is internal bond (IB). The real-time data fusion database of Young and Guess (2002) as refined by Dawson et al. (2006) was used. Three nominal products of the producer were used: 0.750 inches ("); 0.625"; and 0.500". The 0.500" MDF product had 209 records; 0.625" MDF product had 517 records; and the 0.750" MDF product had 245 records. The MDF data set had 183 possible regressors that corresponded to real-time sensors on the production line. Sensor data were time-lagged in the data to reflect the location of the sensor relative to the press where the MDF panel is created (Dawson et al. 2006).

In model building, an accepted rule of thumb is to use 80 percent of the entire data set for the training (or learning) and the remaining 20 percent for validation or calibration (Kutner et al. 2004). Many authors note that the ideal record length should be six to ten times the number of regressors (Kutner et al. 2004). Unfortunately, the long sampling intervals between MDF destructive tests did not allow for this ideal to be met.

Classification Trees

In 2005, a private woodland owner survey was conducted in seven counties in the Cumberland Plateau region of Tennessee. The objective of the survey was to characterize differences between forest landowners who harvest trees and those who do not. The survey response rate was 55 percent of 1,012 verifiable landowners in the region (Longmire et al. 2007). In the CT analysis, the 495 survey responses were used to develop two types of CTs: 1) trees for all 495 forest landowners and 2) trees for forest landowners who distinguished between commercial and non-commercial tree harvests.

Results and Discussion

Regression Trees of MDF Manufacture

Fifty-six parametric RT models and 32 non-parametric quantile RT models were developed for the IB of MDF. In the spirit of model-building and to advance the understanding of data set dimensionality and its influence on model development (Kutner et al. 2004), RT models were developed for short and long record lengths, e.g., 62 records, 100 records, 200 records, 300 records and 400 records.

The RT analysis indicated that "resin percentage", "refiner plate position" and "press set-points" were all important in influencing IB variation across most RT models. "Waste fiber addition to refined core fiber" was a key variable for the thickest MDF (0.750"). A key process variable for the thinner 0.500" MDF was "mat weight at the Thayer scales." This may reflect difficulties with proper weight formation for thinner MDF products. "Operator" was a surprising source of IB variation for 0.625" MDF. Operator induced variation can be a "nuisance" source of variation and usually indicates the need for additional training (Deming 1993).

Given the vast scope of presenting results for all RT models, the RT model for a nominal MDF product (0.750"), which was also a difficult product to model, is presented. For MDF 0.750" with a record length of 100, a non-parametric quantile RT model without node pruning had a root mean square error (RMSE) of 8.54 pounds per square inch (psi), root mean square error of prediction (RMSEP) of 22.17 psi and homogeneous residual pattern (Figure 1). Note that if the last five observations are removed from the time series validation data set, the RMSEP is reduced to 11.94 psi The RT model had 13 total nodes and seven terminal nodes. This RT exhibited high explanatory value and predictive capability in the near term (Figure 2).

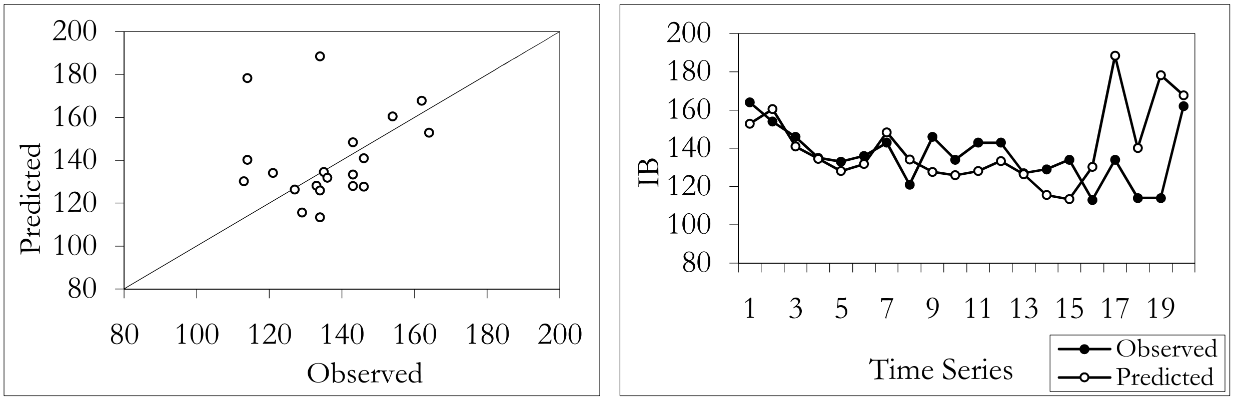


Figure 1. XY scatter plot (left) and time series plot (right) of validation data set for the RT model for 0.750" MDF

The highest IB (mean = 151 psi) occurred with "refiner steam pressure" >_54.6 and "press start control" ≤ _933.0 (Figure 2). The lowest IB (mean = 132 psi) occurred with "refiner steam pressure" ≤_54.6 and "dry fuel bin speed" ≤_27.7. This model was a good example of the explanatory value of RT models (Kim et al. 2008). "Core scavenger resin rate" has a significant influence on IB within each sub-tree as indicated by the quantile regression coefficients. However, the level and direction of influence of "core scavenger resin rate" is dependent on other process variables and the levels of the process variable within a sub-tree.

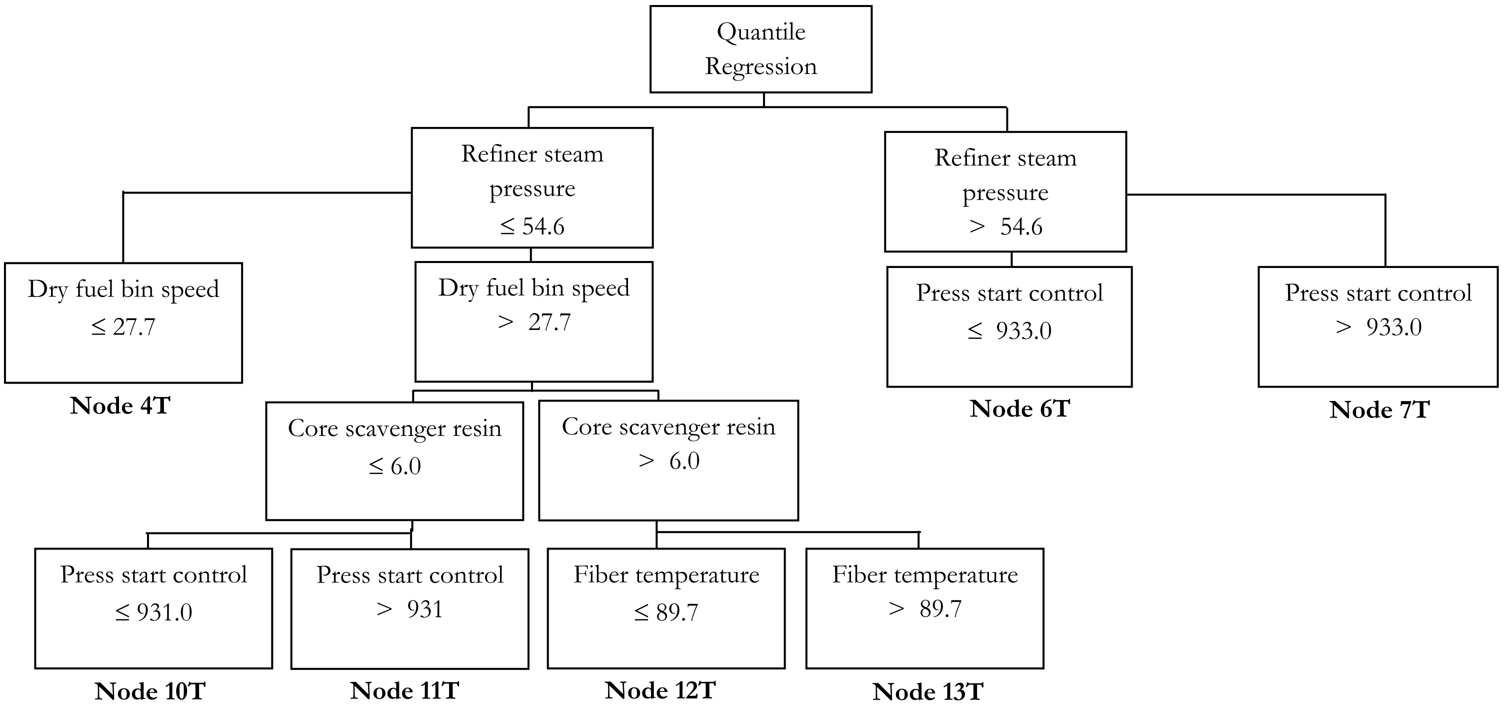
<u>Classification Trees of Forest Landowners</u>

Comparing "Timber Harvest" with "No Timber Harvest" Survey Responses

Thirteen classification trees were built using different combinations of split methods, variable selection methods and split point selection methods. The split method of univariate splits with node models gave the smallest misclassification rate for both resubstitution and cross-validation and was selected for the final CT model (i.e., the optimal classification tree correctly classified 330 of the 495 responses for a misclassification rate of 33 percent).

Of the 495 responses, 243 landowners harvested timber and 252 did not harvest timber (Figure 3). The four significant factors ($\alpha < 0.05$) were:

- Are you a farmer *(categorical "yes" or "no")*?
- How many years have you resided at current address *(numerical "number of years")*?
- When you make land-use decisions about this woodland, do you make a multi-year plan or do you focus only on the current year *(categorical "multi-year plan yes or no")*?
- Do you own any land outside the study area *(categorical "yes" or "no")*?



Node 4T:

Quantile Regressor	Coefficient
Constant	22938.0
Refiner steam pressure	-2.61
Press start control	1.48
Core scavenger resin	-4010.2
Dry fuel bin rate 236	-21.24
Dry fuel bin rate 237	21.54
Fiber temperature	-0.13

Node 6T:

Quantile Regressor	Coefficient
Constant	13750.0
Refiner steam pressure	-1.08
Press start control	-0.22
Core scavenger resin	-2211.4
Dry fuel bin rate 236	-1.63
Fiber temperature	-0.21

Node 7T:

Quantile Regressor	Coefficient
Constant	-16418.0
Refiner steam pressure	1.39
Press start control	1.34
Core scavenger resin	2561.8
Dry fuel bin rate 236	-1.02
Dry fuel bin rate 237	-5.78
Fiber temperature	-1.24

Figure 2. Multiple linear quantile RT model without node pruning for 0.750" MDF (Nodes 10, 11, 12 and 13 on next page)

Node 10T:

Quantile Regressor	Coefficient
Constant	-2734.4
Refiner steam pressure	0.85
Press start control	0.84
Core scavenger resin	34.27
Dry fuel bin rate 236	-2.63
Fiber temperature	0.86

Node 11T:

Quantile Regressor	Coefficient
Constant	4020.8
Refiner steam pressure	-0.27
Press start control	0.15
Core scavenger resin	-667.37
Dry fuel bin rate 236	-154.25
eM2237Spd	154.49
Fiber temperature	-0.01

Node 12T:

Quantile Regressor	Coefficient
Constant	-41307.0
Refiner steam pressure	1.21
Press start control	-1.83
Core fiber scavenger resin rate	7094.60
Dry fuel bin rate 236	7.85
Fiber temperature	3.18

Node 13T:

Quantile Regressor	Coefficient
Constant	21874.0
Refiner steam pressure	-0.97
Press start control	-0.59
Core fiber scavenger resin rate	-3519.70
Dry fuel bin rate 236	0.89
Fiber temperature	-4.59

Figure 2 (continued)

The most significant factor ($\alpha < 0.05$) in the first split of the CT was whether or not the respondent was a farmer. Seventy-three percent of farmers had harvested timber previously. For those who were not farmers, the next most significant split ($\alpha < 0.05$) within this group was "years residing at current address." If the non-farmer resided at the current resident longer than 36.5 years the chance of harvesting timber was 69.6 percent. Respondents residing at their current address less than 36.5 years who had a multi-year management plan, and did not own any land outside the study areas had a 56.7% chance of harvesting timber.

Comparing "Commercial Harvest" with "Non-commercial Harvest" Survey Responses

Of the 243 respondents who harvested timber, 111 conducted a "commercial harvest" (e.g., pulpwood or sawtimber), and 126 conducted a "non-commercial harvest" (e.g., firewood or sawtimber for personal use). Six respondents did not respond to type of harvest. The CT with smallest misclassification rate after cross-validation (29.1 percent) came from the method of univariate split with node models. Only one factor was significant ($\alpha < 0.05$) in this CT (Figure 4).

The significant factor ($\alpha < 0.05$) was unsurprisingly:

- How important is it to make money from your woodland (*categorical "Not Important", "Of little Importance", "Somewhat Important", "Important" and "Very Important")*?

For those who answered that "income from their woodland was somewhat to very important", 75 percent had conducted a commercial timber harvest.

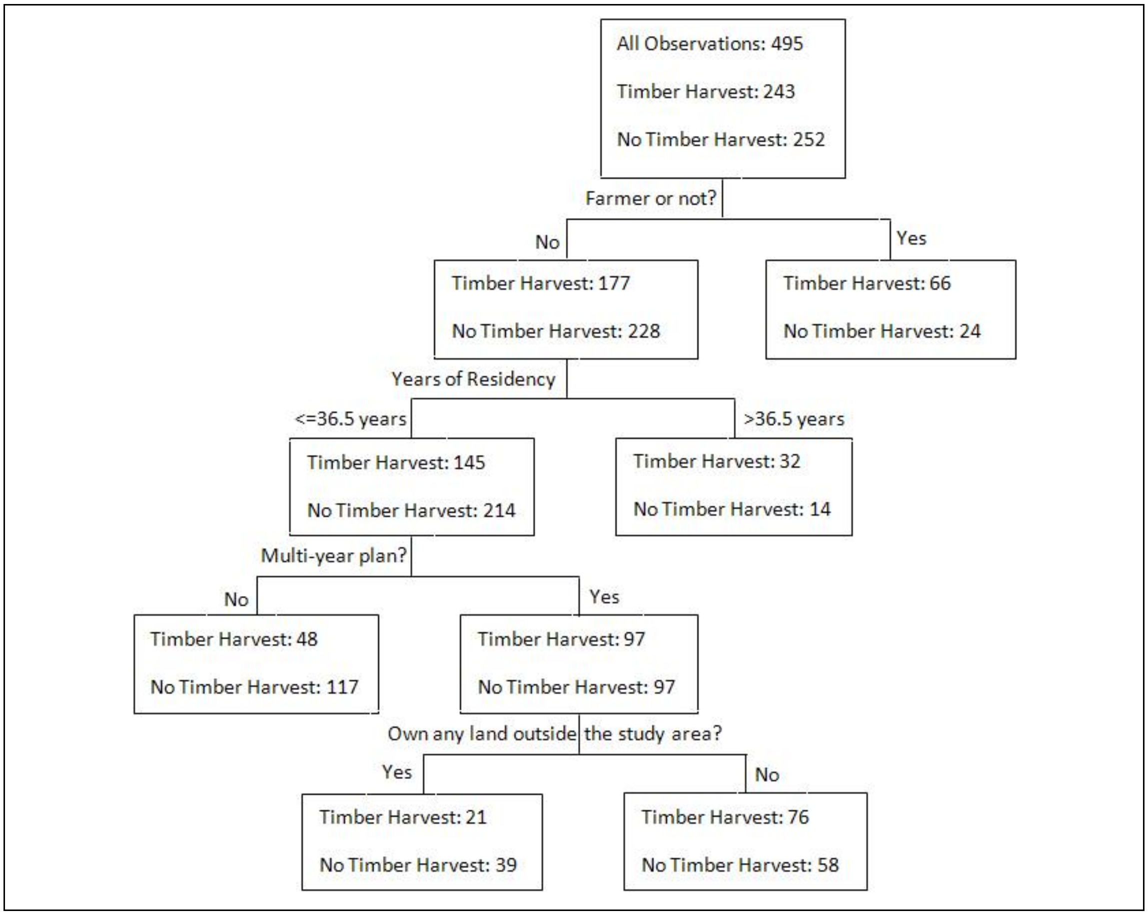


Figure 3. CT of "Timber Harvest" with "No Timber Harvest" responses

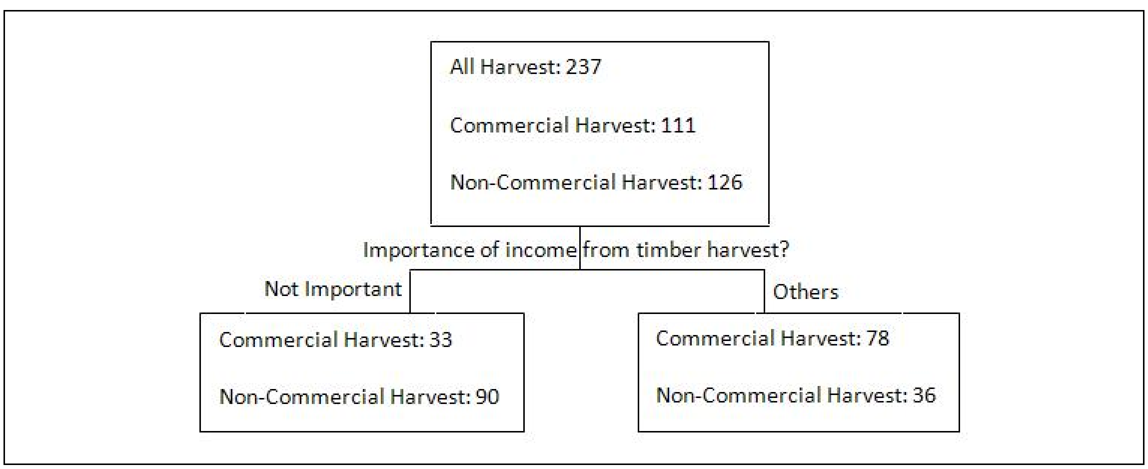


Figure 4. CT of "Commercial Harvest" with "Non-commercial Harvest" responses

Summary and Conclusions

Accurately quantifying causality between independent variables (*X's*) and response variables (*Y's*) with a high level of inference is the foundation of science. A challenge in most research is to accurately quantify and model causality when data are non-homogenous. Decision tree theory directly addresses modeling heterogeneous data and identifies hidden interactions.

In this research, the causality between independent variables that influence the IB of MDF was quantified using regression trees for one important product type of MDF (i.e., 0.750"). Significant regressors ($\alpha < 0.05$) as identified by the regression tree were "refiner steam pressure" as interacting with "press start control" and "dry fuel bin speed." The highest IB (mean = 151 psi) occurred with "refiner steam pressure" >_54.6 and "press start control" ≤ 933.0. The lowest IB (mean = 132 psi) occurred with "refiner steam pressure" ≤_54.6 and "dry fuel bin speed" ≤_27.7.

The second part of this research quantified causality for forest landowners who harvest timber in the Cumberland Plateau Region of Tennessee. Of the 495 useable survey responses from 1,012 verifiable landowners in the region, 243 landowners harvested timber. The most significant independent variable ($\alpha < 0.05$) for the first split of the tree was whether or not the respondent was a farmer. Seventy-three percent of farmers had harvested timber previously. For those who were not farmers, the next most significant split ($\alpha < 0.05$) within this group was "years residing at current address." If the non-farmer resided at the current resident longer than 36.5 years the chance of harvesting timber was 69.6 percent. Non-farmers residing at their current address less than 36.5 years, had a multi-year management plan, and did not own any land outside the study areas had only a 56.7 percent chance of harvesting timber. For landowners who conducted commercial timber harvests, the only significant factor ($\alpha < 0.05$) identified from the classification tree was the importance of timber income.

For MDF manufacturers, regression trees provide a scientific method for identifying causality and hidden interactions that are presented in an easy to interpret two-dimensional tree structure. For a forester interested in identifying landowners likely to conduct a timber harvest, the classification trees provide a scientific method for quantifying these characteristics.

Acknowledgements

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TIMBER VALUE ISSUES RESULTING FROM HARVEST ACTIVITY IN APPALACHIAN FORESTS

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Abstract

An examination of the hardwood inventory in the Appalachian Region reveals timber growth and shifts in species composition. In the past, changes in composition were feared because species that regenerated tended to be of lower value in the current market, and because of acceptance of the select-species hypothesis, which concludes that low-value species today will continue to be low-value. However, past market behavior has demonstrated that the industry will adopt alternative species if sawtimber inventories become plentiful. Furthermore, the hypothesis eclipses two other issues influencing timber value: the decline in timber quality and multi-aged forests that can occur after repeated selective cutting. In this paper, we examine changes in the Appalachian forests resulting from harvest activity and examine the impact of selective harvesting on residual stand attributes. We conclude that selective harvesting based on species, diameter, and quality may foster the regeneration of species that have the potential of being marketable in the future but may also result in large diameter cull trees being left in the stand. Furthermore, partial harvests may foster damage-induced heartwood, inconsistent ring count, and pin knots.

Keywords: Hardwood, timber management, harvesting

Introduction

An examination of the hardwood inventory in the Appalachian Region reveals continued growth and changes in species composition resulting from partial canopy removal during past harvests (Figure 1). The Appalachian region contains 410 counties in the mountainous regions of Ohio, Pennsylvania, New York, West Virginia, Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, South Carolina, Tennessee, and Virginia. While increased timber volumes generally are welcomed by the forest products industry, forest composition changes are met with caution primarily because of the acceptance of the select-species hypothesis. This hypothesis concludes that species that have a low or high market value today will continue to have the same value relative to other species in the future.

In: Siry J, Izlar B, Bettinger P, Harris T, Tye T, Baldwin S, Merry K, editors. 2009. Proceedings of the 2008 Southern Forest Economics Workers Annual Meeting; 2008 Mar 9-11; Savannah, GA. Athens (GA): Center for Forest Business, Warnell School of Forestry and Natural Resources, University of Georgia. Center for Forest Business Publication No. 30.

While this hypothesis may be true for a few species, such as black walnut or black cherry, past market behavior has demonstrated that the industry will adopt alternative hardwood species for appearance or industrial applications when sawtimber inventories of these species become

plentiful. For instance, the northern red oak *(Quercus rubra)* was not considered a desirable species in the early 1950s and the regeneration of the yellow-poplar *(Liriodendron tulipifera L.)* during this period was considered quite desirable because of its relative value (Wray 1952). In 1989, red oak stumpage was selling for more than twice as much as yellow-poplar stumpage in many areas of Appalachia (Ohio Agricultural Statistics Service 1990). Furthermore, the belief in the select-species hypothesis tends to eclipse two important issues influencing timber value and marketability: the decline in timber quality as a result of market-driven selective cutting protocol and the multi-aged forests that have emerged as a result of continual selective cutting in the absence of large-scale disturbances such as fire.

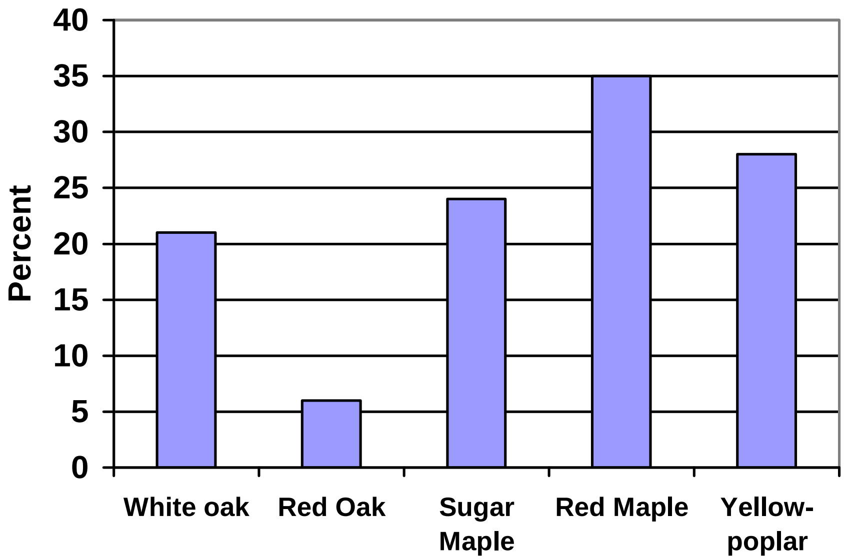

Figure 1. Percent change in the cubic-foot volume of live trees for major species groups found in the Appalachian forest from the late 1980s to 2004
Source: USDA Forest Service 2007

In this paper we examine how selective cutting practices appear to have a detrimental long-term effect on timber value in the Appalachian region. We first examine major changes in species composition in the Appalachian region by analyzing these changes in West Virginia (the only state that lies entirely in the Appalachian region). We then discuss timber quality issues associated with the species that regenerate after partial canopy removals. Next, we provide a real world demonstration of removal practices by analyzing residual stand attributes of FIA inventory plots in the eastern portion of Kentucky measured in 1990 and re-measured in 2000. The three survey units in eastern Kentucky (Eastern, North Cumberland, and South Cumberland) were selected because these units are in the central portion of the Appalachian region and had harvesting activity on a large number (127) of plots surveyed in 1990 and then re-measured in 2000.

Changes in Species Composition

There are many issues resulting from partial canopy removal, but five major composition and structure-related issues include: the decline of northern red oak, the expansion of red maple *(Acer rubrum L.)*, the continued growth of yellow-poplar, the ability of white oak *(Quercus alba)* to survive across multiple conditions, and the emergence of stands containing a significant basal area in trees of two or more diameter classes. Each is discussed below.

The Decline of Red Oak and the Expansion of Red Maple

The decline of northern red oak and the increase in red maple volume is probably the most significant change occurring in the Appalachian forest (Figure 2). It is well known that northern red oak, which has been heavily harvested during the past 40 years, regenerated after a combination of clearcutting, fire, drought, and loss of American chestnut *(Castanea dentate Marsh.)*, which along with low deer populations, provided a competitive advantage for this species early in the 20^{th} century (Luppold and Miller 2005). It also is well-documented that the surge in maple stems is the result of these shade-tolerant species' ability to regenerate in partially cut-over stands during the past 60 years. While there has been a small increase in the volume of northern red oak, this growth has been confined to larger diameter trees. For trees less than 13 inches in diameter at breast height (dbh), double-digit declines have occurred in most counties in the Appalachian Region (USDA Forest Service 2007).

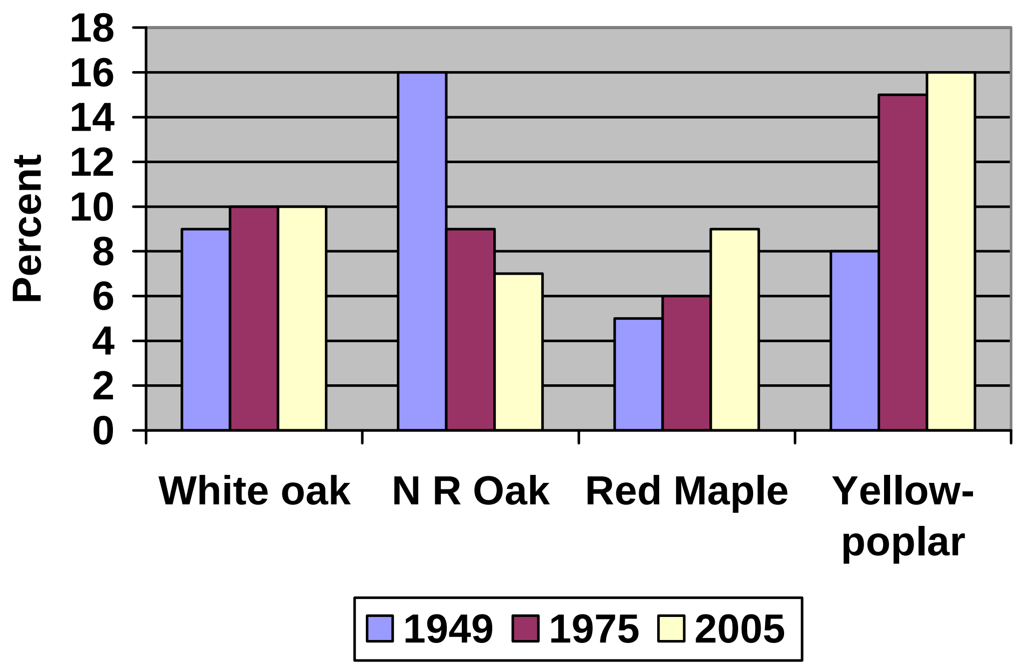

Figure 2. Percent of cubic volume of growing stock for major hardwood species groups, West Virginia for 1949, 1975, and 2000

Sources: Wray (1952) – 1949; USDA Forest Service (1990) - 1975 revised; USDA Forest Service (2007) – 2005.

By contrast, red maple has regenerated in most Appalachian states since the 1950s. The major market concern for red maple is not abundance, but quality. Tree grades for maple species tend to be lower for any given diameter class when compared to red oak. This is the case in all Appalachian states (USDA Forest Service 2007).

Continued Growth of Yellow-Poplar

Given adequate seed sources, both red oak and yellow-poplar can become established when forest cover is removed or when farmland is abandoned. Yellow-poplar usually will dominate northern red oak on better sites in the absence of drought. This ability to regenerate and grow rapidly has allowed yellow-poplar to become the most abundant individual species in second- and third-growth Appalachian forests. Still, much of the volume of yellow-poplar is in the larger diameter classes.

Survival of White Oak

White oak was once the dominant species existing in the southern and central Appalachian forest but was less abundant in northern portions of this region. The tylosis in true white oak made this species ideal for ship construction and tight cooperage, resulting in significant harvesting of white oak before the use of steel and plastic for these products. Unlike northern red oak, white oak can survive under a full or partial canopy for a considerable period while retaining the ability to respond to overstory removal. Once released, it can grow rapidly and live hundreds of years ensuring that white oak will continue to be a large part of forests in the Appalachian region (Figure 2).

Emergence of Multi-Aged Forests

Stands that have been harvested repeatedly during the past 50 years conceivably could have significant basal area in two or more diameter classes with each class containing a different species mix. Such stands have several marketability issues. If markets are not currently available for all size classes then these sites probably will not be harvested until the smaller diameter trees increase to merchantable size. However, residual stand damage after harvest may reduce the future value of the remaining intermediate trees by the time such harvests occur. In some cases, markets must exist for multiple species for harvesting to be economically feasible. It also is more expensive to harvest an uneven-aged stand (in terms of dollars per thousand of board feet harvested) than an even-aged stand of merchantable-size timber.

<u>Quality Issues Arising After Harvest</u>

While there are multiple factors affecting timber quality, tree quality issues associated with prior harvesting include damage-induced heartwood, inconsistent ring count, and pin knots associated with epicormic budding. Of the three, damage-induced heartwood is probably the most value reducing phenomenon and can be associated with prior harvests or weather disturbance.

Damage-induced heartwood is the result of pathogens attacking the tree after root or limb damage and the tree's effort to encapsulate these pathogens. The resulting heartwood in some species is non-conical in nature (*e.g.*, it is not confined to a particular group of growth rings), and its presence substantially reduces the value of a log or tree. In the case of red maple and sugar maple *(Acer saccharum Marsh.)*, damage-induced heartwood is dark brown or black while damage-induced heartwood in yellow-poplar can be purple or black (Shigo 1984).

After a selective harvest removes most of the large trees, the remaining codominate trees will grow at a faster rate resulting in an inconsistent ring count across the basal area of a log. This change in ring count may reduce the value of a well formed tree from veneer quality to saw log quality because it can change the appearance and texture of the resulting veneer or lumber.

Some species will develop epicormic buds after partial canopy removal. While these buds may be covered by new growth within a few years, this process can produce pin knots. Pin knots are insidious because they may not appear until all the dimensioning processes are completed.

A Case Study in Eastern Kentucky

Residual stand attributes embody the structure, composition, and quality of the timber remaining after a partial cut. In any particular stand, timber removed is determined by local markets for sawtimber, pulpwood, peeler logs, and roundwood for oriented strand board (OSB), as well as distance from these markets. Consequently, timber removal varies considerably across the Appalachian region. We examined 127 plots from FIA's 2000 inventory of Kentucky. We analyzed trees that were removed between 1990 and 2000 from the North Cumberland, South Cumberland, and Eastern units. The major roundwood market in these units is for saw logs, but yellow-poplar peeler logs and OSB material are also sourced from this region.

Table 1 presents a summation of the proportion of basal area removed by species and diameter class. As would be expected for an area where the primary market is for saw logs, trees 16 inch dbh or larger were removed at a much greater rate than smaller diameter trees of any particular species. The one exception to this finding is beech *(Fagus grandifolia Ehrh.)*. Nearly two-thirds of the beech left in the woods was low grade with rotten or missing (cull) portions (USDA Forest Service 2008).

In the 16 inch and larger diameter class the species with the highest rates of removal were northern red oak, black oak *(Quercus velutina)*, scarlet oak *(Quercus coccinea)* and yellow-poplar. Between 1990 and 2000, the prices of all grades of red oak were relatively high, resulting in a high rate of removal. While the price of yellow-poplar lumber was not high during this period, this species was highly merchantable because of the market for peeler logs and OSB roundwood. White oak and hickories *(Carya spp. Nutt.)* also were removed at relatively high rates, as the lumber prices for these species were relatively high but not as high as for red oak. Still the white oak left in the woods could develop inconsistent growth rings and pin knots as a result of epicormic budding. However, more than 50 percent of the chestnut oak *(Quercus prinus)* 16 inch or larger in diameter was left in the woods, which is indicative of the quality issues associated with this species.

Table 1. Percent of basal area removed through harvesting by species and diameter class based on 127 re-measured one-sixth acre plots in eastern Kentucky with harvest activity between 1990 and 2000

Species	*5 to 11.9 inches removed (percent)*	*12 to 15.9 inches removed (percent)*	*16 inches or larger removed (percent)*
Red maple	*16*	*24*	*35*
Sugar maple	*11*	*21*	*45*
Hickory	*12*	*25*	*61*
Beech	*24*	*36*	*3*
Y-poplar	*27*	*22*	*78*
White oak	*23*	*35*	*60*
Chestnut oak	*16*	*27*	*49*
N. red oak	*44*	*30*	*78*
Black oak	*27*	*36*	*68*
Scarlet oak	*29*	*19*	*71*

Source: USDA Forest Service 2008.

Even though the price of sugar maple lumber was high between 1990 and 2000, removal of this species in eastern Kentucky was relatively low. Eastern Kentucky is the southern portion of the sugar maple's range and, in this region, its quality is low. This is evident by the fact that two-thirds of the sugar maple left in the woods contained cull portions. The relatively small quantity of larger diameter red maple removed from this area was a result of a poor market for this species during the 1990s and the fact that 50 percent of the trees left in the woods had cull portions (USDA Forest Service 2008). In addition, the smaller diameter maple left in the woods has a fairly high probability of developing damage-induced heartwood if logging caused limb or root damage.

Conclusions

While the volume of hardwood timber in the Appalachian Region is increasing, the species mix and quality characteristics are changing. Because it is impossible to predict the future price of specific hardwood species, and the fact that new markets develop once a species becomes abundant, current harvesting practices may foster the regeneration of species that have the potential of being marketable in the future. However, individual timber sites within the Appalachian forests are developing an increasingly heterogeneous species mix and tree diameter on sites that have been entered multiple times with only a few select trees being removed. The complex structure of these stands may inhibit future harvests because of the heterogeneity of species and diameter. Furthermore, continued entries into these stands are likely to cause damage to the remaining trees by initiating damage-induced heartwood in some species or reducing the value through inconsistent ring counts or epicormic budding.

Our analysis of eastern Kentucky indicates that industry favors the removal of large-diameter trees of species that have a high market value and that the large trees remaining after harvest have a high percentage of cull. In Kentucky, we see residual stands with a high proportion of red maple, sugar maple, and yellow-poplar. These stands also have potential for damage-induced heartwood, white oak that could develop epicormic buds, and the retention of cull beech and chestnut oak. While more research should be conducted to determine the extent of the potential loss in value caused by current harvesting practices, the probability of such a loss seems substantial.

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ANALYSIS OF LOGGING PRODUCTIVITY IN ALABAMA, 1995 TO 2000

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Abstract

Logging costs are a large proportion of wood material cost for forest industries. The efficiency and productivity in the logging industry is an important factor that affects the competitiveness of forest industry in the regional and international marketplace. This paper analyzes logging productivity in Alabama using data from a mail survey in year 2000. The survey was sent to loggers selected from firm owners, co-owners, or corporate officers who had completed a logger education training program in Alabama. Labor productivity and capital value (the machine) productivity as well as the substitute between labor and capital are examined. The results indicate that firms using newer machines could achieve higher labor efficiency. Unitary substitution elasticity between labor and machine cost is derived from estimated coefficients of production functions using the ordinary least square econometric method. The Alabama logging industry is also estimated to have ha decreasing returns to scale in 2000 but obtained increasing returns to scale if dynamic behaviors from 1997 to 2000 are considered.

Keywords: Efficiency, labor productivity, substitutes, Cobb-Douglass function, non-parametric test

Introduction

Timber harvesting systems in the Southeastern United States changed from a labor-intensive to almost totally mechanized operations over the past 50 years (Hines et al. 1981). Still timber harvesting costs are of continuing interest to loggers (Carter et al. 1994). The impact of technical change on the forest products sector has been examined by various econometric studies. While the first generation studies are based on a simple measure of output and consider only capital and

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labor as productive factors, the second generation studies use flexible function forms with more complex representations of production technology like raw materials (Stier and Bengston 1992). Moroney (1968), Greber and White (1982), Stier (1982) and Stier (1983) have used the constant elasticity of substitution (CES) production function with two factors of labor and capital. Those studies found the technical change bias to be capital-using and labor saving. Using Maximum Likelihood Estimation techniques for non-homothetic translog cost functions with two variable inputs, labor and capital, Smith and Munn (1998) found that substitution possibilities of two basic inputs, labor and capital, were limited. Other studies using the translog functional form are Stier (1980), Cain and Paterson (1981), Jorgerson and Fraumeni (1981), Sherif (1983), Rao and Preston (1984), De Borger and Buongiorno (1985), Martinello (1985). Studies by Merrifield and Singleton (1986), Meil et al. (1988), and Bernstein (1989) combine short-run cost minimizing and profit maximization behaviors with the dynamics of firm adjustment over time.

For technical efficiency valuation, Carter et al. (1994) and Carter and Cubbage (1995) state that average industry harvesting costs of the U.S. pulpwood harvesting industry declined significantly during the period of 1979 to 1987 with production shifts from shortwood to mechanized longwood harvesting systems and efficiency increase in the latter systems. Despite the existence of a series of efficiencies, studies in forestry based on two basic factors of production, capital and labor, LeBel and Stuart (1998) affirm that a better understanding of capacity utilization, contractor's zeal, procurement organization's philosophy, and government regulation may improve the efficiency and performance of individual contractors and the wood supply system. After reviewing the literature on productivity and efficiency studies of the Canadian wood industry, Salehirad and Sowlati (2006) also suggested that further research in this area may develop by incorporating factors and aspects specific to the wood industry and including desirable and undesirable outputs of the production process into the models. LeBel and Stuart (1998) with a nonparametric model found that the scale of an operation also affects its technical efficiency.

With 22 million acres of forest land in Alabama (2/3 of the state), forestry generates approximately $13 billion for Alabama each year and forest industry employs about 10% of Alabama's total work force (Alabama Forestry Association). However, there is little literature on technical efficiency and factors affecting logging capacity of Alabama loggers.

This study examines effects of firm scale, machine age and products on productivity of logging firms in Alabama using non-parametric statistical tests and calculates substitution elasticity between labor and machine cost from linear production functions estimated with the OLS method.

Data

A survey was conducted in December 2000 with 200 questionnaires mailed to Professional Logging Manager (PLM) trained Alabama loggers. The initial mailing was followed with a postcard on December 22, 2000. The loggers selected were firm owners, co-owners, or corporate officers who had completed the PLM training. Names were selected from that list of just over 900 loggers. Twenty loggers were randomly chosen from each of the 10 Alabama Loggers Council Districts. If more than one person from the same address was selected, only the first person's name (alphabetically) was included. It is possible that we sent surveys to co-owners or corporate officers of the same firm. Excluding multiple names from the same firm would have been a problem since at times a firm name is not included in the database and similar appearing firm names may or may not be the same firm.

Eighty-two responses were received from the 193 surveys sent to valid addresses. Of those respondents, 67 were currently in the logging or log hauling business. Six more had left the logging business in the last 3.5 years, and five out of those six left in the past 2 years. Half the respondents' firms were started before 1983, with an average start year of 1981.

Most firms work primarily as cut and haul contractors on company or dealer owned stumpage (34%), followed by cut and haul contractors on company lands (31%), and owners of their own stumpage (25%). Several reported working in more than one category. Those firms moved wood primarily in tree-length form (94%) followed by log length (15%). Several reported multiple forms of delivery.

Methods

Non-parametric tests of Kruskal-Wallis, Median One-Way Analysis, Van der Waerden One-Way Analysis, and Savage One-Way Analysis are used to explore a significant difference between firm groups. A significant advantage of non-parameters is that they do not require normality in data distribution which needs more complex statistic tests. Firms are categorized by size, machine ages and products. According to size, firms which had employed less than six workers are included in the small group, the ones had more than eight workers are large firms, the others are medium firms. Based on machine age, a firm is named 'new' if it had more than 30% machines less than 1 year old, 'normal' if less than 30% new machines but more than 50% machines in firm lifetime, and 'old' group if it used mostly old machines with less than 50% machines still in firm lifetime. For product group, the first group included the firms which had harvested hardwood sawtimber, the second are the ones which harvested pulpwood without pine sawtimber and the third harvested pine sawtimber.

In the second section, a simple linear regression was conducted for a production function of Alabama logging firms to identify substitution coefficients between labor and machine costs. In the regressed model with firm group sizes, machine ages and products included, we examined the effects of variables on production of Alabama logging firms in 2000.

From the basic Cobb-Douglas function and a simplification in interpretation of substitution coefficients of labor and machine costs through a substitution elasticity measure, empirical models of Alabama logging production was regressed in the following form

(1) $\ln(\text{Loads}) = a_0 + a_1\ln(L_i) + a_2\ln(K_i) + \varepsilon_i$

Where, i = logging firm,

Loads =Production (the number of truck loads harvested per week)

L=Labor (the number of employees multiplied by the working days per week)

K=Machine cost (depreciated cost of machines used by the firms).

The summation of a_1 and a_2 measures return to scale or the function coefficient (Beattle and Taylor, 1985). Restriction of $a_1+a_2=1$ are also restricted in models to test whether the Alabama logging production has a constant return to scale following the assumption of the Cobb-Douglas function. Two versions of the function are regressed with two kinds of machine cost, with and without trucks. In this study, machine expenses are depreciated using the Modified Asset Cost Recovery System (MACRS) method and a salvage value of 20% of purchase price.

From the coefficients of labor days and machine cost in regressed models, elasticity of substitution between labor and machine cost is also calculated. Elasticity of substitution measures the percentage change in factor proportions due to a change in marginal rate of technical substitution. In other words, for the production function, $Y = f(K,L)$, the elasticity of substitution between capital and labor is given by:

$$\sigma = d\ln (L/K)/d\ln (f_K/f_L) = [d(L/K)/d(f_K/f_L)]*[(f_K/f_L)/(L/K)]$$

In production functions with firm groups of size, machine ages and products included, we can examine the effects of the variables on production of Alabama logging firms in 2000. The model specification test with SPEC option in SAS programming confirms homoskedasticity of all models regressed. From the logarithm form production functions regressed, the substitution elasticity between labor and machine cost is calculated by the ratio a_2/a_1. The long run elasticities of production with respect to labor and machine costs were also calculated from respective short-run elasticities estimated from the production function.

Results

Statistical analysis results

Since the number of truck loads per week represents a firm's production, labor efficiency is production divided by number of employees. Machine cost efficiency is the production for each thousand dollars of machine cost. Descriptive statistics are summarized in Table 1.

Table 1. Descriptive statistics

	Unit	N	Mean	S.D.	Min	Max
production in 2000	loads/week	60	37.77	24.89	5	110
production in 1997	loads/week	59	43.37	29.42	7	138
production in 1995	loads/week	56	40.34	28.21	5	150
labor efficiency	weekly loads/employment	60	6.02	2.69	0.95	15.83
machine cost efficiency	weekly loads/1000 USD	60	0.15	0.08	0.03	0.65

The non-parametric tests confirm the difference in production between firm sizes. The firms that employ more labor get more loads per week. However, there is no significant difference between firm sizes in either labor efficiency or machine cost efficiency (Table 2). Although the statistical results exhibit that the number of employees in each firm does not affect either labor efficiency or machine cost efficiency of the firm, the diminishing rule of marginal return is obeyed when the efficiencies are highest in medium firms and decreases in the larger firms.

Table 2. Difference between firm sizes

Firm size (employment number)	**N**	**Production** (loads/week)			**Labor efficiency**	**Machine efficiency** (with truck)	**Machine efficiency** (without truck)
		1995	1997	2000			
Small (1-5)	33	25.60 (17.37)	26.13 (15.02)	24.71 (14.70)	6.1691 (2.5636)	0.1462 (0.0548)	0.1647 (0.0682)
Medium (6-8)	12	55.17 (34.30)	60.08 (25.80)	44.33 (21.97)	6.6925 (3.6030)	0.1903 (0.1480)	0.2419 (0.1667)
Large (>8)	15	59.21 (24.71)	66.80 (32.50)	61.23 (26.63)	5.1350 (1.8726)	0.1362 (0.0577)	0.1689 (0.0682)
Kruskal Wallis Test	χ^2	21.16	24.89	23.53	4.50	2.00	4.50
	P-value	<0.0001	<0.0000	<0.0001	0.1055	0.3684	0.1055
Savage One-Way Analysis	χ^2	16.18	20.86	22.24	4.20	1.19	4.20
	P-value	0.00	<0.0001	<0.0001	0.1222	0.5517	0.1222

Note: In parentheses are standard deviations of the means.

Among machine groups, there are significant differences in production of harvesting firms (Table 3). The firms using new machines are likely to get higher weekly production. These firms also achieve higher labor efficiency relative to the firms using older machines. However, there is no significant difference in machine cost efficiency between the firm groups of machines, despite the Savage One-Way Analysis finds a difference in machine (without truck) cost efficiency at the 90% significance level (Table 3). The results confirm that the logging firms which use newer machines get higher labor efficiency; thus, newer machines play an important role in decreased labor needs for the Alabama logging industry.

Table 3. Difference between machine groups

Machine group	**N**	**Production** (loads/week)			**Labor efficiency**	**Machine efficiency** (with truck)	**Machine efficiency** (without truck)
		1995	1997	2000			
NEW (≥ 30% machines in 0-1 year old)	18	51.17 (24.46)	56.14 (26.66)	57.08 (25.37)	7.8170 (3.5393)	0.1363 (0.0301)	0.1608 (0.0390)
NORMAL(<30% are new, >50% in lifetime)	30	43.13 (30.29)	45.27 (30.53)	34.95 (20.53)	5.2154 (1.8820)	0.1704 (0.1073)	0.2073 (0.1257)
OLD (≤50% in life time)	12	15.77 (8.93)	17.32 (7.68)	15.83 (7.78)	5.3125 (1.3781)	0.1321 (0.0584)	0.1464 (0.0660)
Kruskal-Wallis Test	χ^2	17.06	18.39	24.65	8.88	2.31	3.79
	P-value	0.0002	0.0001	<0.0001	0.0118	0.3146	0.1502
Savage One-Way Analysis	χ^2	9.58	9.86	17.67	12.64	3.99	5.81
	P-value	0.0083	0.0072	0.0001	0.0018	0.1361	0.0549

Note: In parentheses are standard deviations of the means.

The non-parametric tests fail to find a significant difference in production of the firms in years of 1995, 1997 and 2000 between firm groups of logging products despite the fact that Kruskal-Wallis test and Van der Waerden One-Way Analysis identify a difference in 2000 production at 90% significance level (Table 4). Firms harvesting hardwood sawtimber get lower production relative to others. The tests fail to explore a significant difference in labor and machine efficiencies.

Table 4. Difference between firm groups of products

		production (loads/week)			L: labor efficiency	K1: machine efficiency (with truck)	K2: Machine efficiency (without truck)
Product Group	**N**	**1995**	**1997**	**2000**			
I (Hardwood sawtimber)	11	36.35 (32.07)	35.50 (33.01)	25.32 (16.50	4.8851 (1.9848)	0.1863 (0.1739)	0.2185 (0.2010)
II (Pulp without pine sawtimber)	19	46.11 (25.10)	46.68 (31.83)	44.95 (22.92)	6.5948 (2.1818)	0.1454 (0.0377)	0.1677 (0.0502)
III (Pine sawtimber)	30	38.05 (24.52)	43.90 (27.11)	37.78 (27.35)	6.0627 (3.0768)	0.1446 (0.0465)	0.1761 (0.0604)
Kruskal-Wallis Test	χ^2	3.37	2.48	***5.32***	3.77	0.00	0.33
	P-value	0.1853	0.2893	***0.07***	0.1515	0.9997	0.8484
Van der Waerden One-Way Analysis	χ^2	2.94	2.37	***5.27***	3.90	0.01	0.25
	P-value	0.2304	0.3055	***0.0719***	0.1425	0.9952	0.884

Note: In parentheses are standard deviations of the means.

Production Function

Not all the firms that achieved an increase in production gained an increase in net worth. Data on changes in production and net worth of Alabama logging firms were rescaled based on the Likert scale, ranging from one to five. Production and net worth increase with the higher score of the firms. With the scaling, twenty-eight of the fifty-six logging firms responded that their production increased during 1997-2000. Twenty-six firms had increased net worth (Table 5).

Table 5. Frequencies of firms in production and net worth

Score	**Description**	**Production**	**Net worth**
1	decrease by >20%	15	15
2	decrease by 0 - 20%	9	9
3	no change	4	5
4	increase by 0 -20 %	15	15
5	increase by >20 %	13	11

Based on the Equation 1, production functions were regressed to examine the effects of labor-day (L) and machine cost on weekly logging production in Alabama. Two kinds of machine costs are considered: the cost including truck expense (K1) and the cost excluding truck expense (K2). Categorical variables of firm size (from 1 - 3 respectively from smaller to larger firms) and machines (from 1 – 3 respectively from newer to older machines) were included in the function as controlling variables. Dummy variables for firm group of products were also added in the function regression to explore possible effects of different kinds of harvested products. The regression results for logging production in Alabama are described in Table 6 and Table 7. All estimated equations are relevant with sign-expected and significant coefficients of labor and machine cost, either with or without truck. In the production equations (Table 6), firm size is not confirmed to have a significant effect on production. In the model with machine cost excluding trucks, the significant coefficient of *machine group* (-0.14) suggests that the firms with older machines got lower production than the firms with newer machines. The insignificant coefficients of *product group2* and *product group3* show that the difference in product kinds does not have a significant effect on logging production, confirming the above statistical results.

The coefficients of machine costs and labor days both are regressed to be consistent with diminishing marginal returns to factor usage as they both are positive and less than 1. The summation of both, without the unitary restriction, is also less than 1. The Alabama logging industry had decreasing returns to scale in 2000. With restriction of unitary summation, labor appears to influence Alabama logging production in 2000 because its coefficients are higher than 0.5 while the coefficients of machine cost are less than 0.5 in both equations with or without truck (Table 6). However, the *t*-test fails to reject that the coefficients in all production functions in 2000 (see Table 6) are different than 0.5. The assumption of a constant return to scale in the Alabama logging industry thus cannot be rejected when the statistical test fails to reject the unitary function coefficients. With the test, the labor and machine costs are likely to give equal influence on the firms' production as their coefficients are estimated around 0.5. When either weekly labor days or machine expenses increases by 10%, given other variables, the weekly loads increased by 5%. The results also show that the substitution elasticity between labor days and machine cost is unitary. That means when machine cost increases by 1%, working labor days decrease by 1% in 2000 production.

Considering the dynamic behavior of the logging firms from 1997 to 2000, the significance of previous weekly loads in 1997, regressed in production equations (Table 7), permits the calculation of long run output elasticities with respect to labor days and machine costs from the respective short-run elasticities of logging production. The long run output elasticity of labor ranges from 0.56 to 0.79 while the one of machine costs ranges from 0.68 to 0.82, indicating that machine costs were contributing more to the Alabama logging production during 1997 - 2000. The function coefficient in regression results also show that when dynamic behaviors from 1997 to 2000 are considered, returns to scale of the Alabama logging industry increases (ranging from 1.23 to 1.61) instead of decreasing in the year 2000. The returns to scale were also estimated to increase from 1.20 in 1979 to 1.32 in 1987 in long pulpwood harvesting of the southern states by Carter et al. (1994). The increasing returns to scale of Alabama loggers might be thus explained by a 9% increase in volume of softwood growing stock in the state from 1990 to 2000 (Hertsell and Brown, 2002) and the fact that 49/60 firms involved in this study were harvesting softwood timber during 1995 - 2000.

Table 6. Production function (Dependent variable: production (loads/week) in 2000 in logarithms)

	Model 1a		Model 1b		Model 2a		Model 2b	
Variable	**Estimate**	**t Value**	**Estimate**	**t Value**	**Estimate**	**t Value**	**Estimate**	**t Value**
Intercept	**-3.42148**	-2.31	**-3.97471**	-4.18	**-3.2276**	-2.02	**-3.70157**	-3.83
Firm Size	-0.06528	-0.63	-0.10486	-1.61	-0.04817	-0.45	-0.07842	-1.15
Machine Group	-0.15943	-1.65	-0.13355	-1.66	-0.15973	-1.58	***-0.13819***	-1.68
Product Group2	0.19105	1.22	0.18066	1.17	0.18435	1.14	0.17424	1.1
Product Group3	0.10207	0.72	0.09771	0.69	0.12534	0.86	0.12256	0.85
Ln (L)	**0.45317**	3.06	**0.50748**	5.21	**0.49208**	3.26	**0.53424**	5.38
Ln (K1)	**0.45999**	3.88	**0.49252**	5.05				
Ln (K2)					**0.43676**	3.45	**0.46576**	4.69
Restricts			-0.416	0.6269			-0.31078	0.7103
Adj-R^2	0.6935		0.6979		0.6786		0.6837	
Substitution Elasticity L/K	1.01505		0.970521		0.887579		0.871818	
Function coefficient	0.91		1		0.93		1	

Table 7. Production function with previous production included(Dependent variable: 2000 production (loads/week) in logarithms)

	Model 3a		Model 3b		Model 4a		Model 4b	
Variable	**Coef.**	**t value**	**Coef.**	**t value**	**Coef.**	**t value**	**Coef.**	**t value**
Intercept	***-3.8757***	-3.12	***-5.2852***	-6.28	***-4.0292***	-3.04	***-5.3139***	-6.24
Ln (load1997)	***0.3770***	4.27	***0.3442***	3.97	***0.4022***	4.58	***0.3784***	4.39
Firm size	***-0.1614***	-1.83	***-0.2520***	-3.82	***-0.1596***	-1.79	***-0.2342***	-3.49
Machine Group	-0.0484	-0.59	0.0103	0.14	-0.0329	-0.39	0.0207	0.28
Product Group2	0.0661	0.49	0.0402	0.30	0.0483	0.35	0.0201	0.15
Product Group3	-0.0559	-0.46	-0.0635	-0.51	-0.0430	-0.35	-0.0487	-0.39
Ln (L)	***0.3461***	2.79	***0.4837***	5.61	***0.3758***	3.02	***0.4901***	5.72
Ln (K1)	***0.4242***	4.07	***0.5163***	5.99				
Ln (K2)					***0.4247***	3.91	***0.5099***	5.95
Restricts			-1.0338	-1.51			-0.8285	-1.25
Adj-R^2	0.78		0.77		0.77		0.77	
Substitution Elasticity L/MC	1.23		1.07		1.13		1.04	
LR elasticity of labor	0.5555		0.7375		0.6285		0.7885	
LR elasticity of ma-cost	0.6810		0.7872		0.7104		0.8203	
Function coefficient	1.2365		1.5247		1.3389		1.6088	

Note: Long-run elasticity is short-run elasticity divided by (1 – coefficient of ln(load1997).

Conclusions

The non-parametric tests confirm the difference in production between firm sizes although there is no statistically significant difference between firm sizes in either labor efficiency or machine cost efficiency. The statistical results also confirm that Alabama loggers who utilize newer machines will obtain more weekly loads and higher labor efficiency. Newer machines thus play an important role in the Alabama logging industry. The firms harvesting hardwood sawtimber appear to achieve a lower production in year 2000 relative to others but the statistical tests fail to find a significant difference in labor and machine efficiencies among the firms with different products. Coefficients estimated in production functions permit the derivation of unitary substitution elasticity between labor-days and machine costs. That means labor-days and machine costs have equal influence on production of Alabama loggers. However, when the dynamic behaviors of the logging firms from 1997 to 2000 are taken into account, the long run output elasticity of labor ranges from 0.56 to 0.79 while that of machine costs ranges from 0.68 to 0.82, indicating that machine costs were contributing more to the Alabama logging production during 1997-2000. The Alabama logging industry is also estimated to have decreasing returns to scale in 2000 but obtained increasing returns to scale if dynamic behaviors from 1997 to 2000 are considered.

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A HEDONIC PROPERTY VALUE MODEL OF ECONOMIC LOSSES FROM HEMLOCK WOOLLY ADELGID

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WHAT IS THE POTENTIAL FOR MARKETS FOR ECOSYSTEM SERVICES FOR ENHANCING WATER QUALITY THROUGH IMPROVED FOREST LAND MANAGEMENT IN THE SOUTH?

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Abstract

In response to concerns regarding the sustainability of provision of ecosystem services from forests, efforts are underway to develop market-based programs to encourage forest landowners to increase ecosystem services in three main areas: watershed protection and water quality improvement, sequestration of carbon for mitigation of global climate change, and enhancing the conservation and preservation of biodiversity. Successful market creation requires defining enforceable property rights for the environmental services (or appropriate proxies) and creating trading mechanisms that minimize risk and uncertainty while producing a sufficient number of buyers or sellers. One of the most important benefits of markets is their ability to distill information from many participants to define relative scarcity. Indeed, generating appropriate price signals is one of the most crucial roles for market based solutions to ecosystem services provision problems. However, since transactions costs involved in creating markets can be very large, the first step in initiating market-based institutions should be an analysis of whether or not the service is scarce enough to warrant the costs associated with market creation. In this paper, we examine the feasibility of market-based approaches for enhancing water related ecosystem service benefits from private forest lands in the U.S. South. Specifically, using a supply/demand framework we identify areas where scarcities in water quality and quantity combine with high priority needs for forest restoration and protection. We use the results from this analysis to discuss the potential for ecosystem services markets in the South, policies required to kick-start market-based solutions, and the role that governments may play in the process.

[Abstract Only]

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TAKING SHADOW PRICES SERIOUSLY: THE VALUE OF ENVIRONMENTAL AMENITIES IMPLIED BY NEOCLASSICAL ECONOMIC GROWTH THEORY

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Abstract

Neoclassical economic growth theory views social consumption and investment decisions as maximizing the present discounted utility of current and future consumption. When environmental amenities are included explicitly in this model, society maximizes the present discounted utility of consumption goods and environmental amenities by choosing a technology, which might be more or less environmentally harmful, in addition to consumption and investment. We empirically apply this model to forested regions of the southern United States, and obtain the non-market value of forested land implied by the tradeoff between preserving the land as forest and growth in aggregate consumption. The amenity value for 1 acre of the average forest in the region ranged from 1.0 cent per person (first quartile) to 2.3 cents per person (third quartile) at 1982 prices depending on the location within the region, or a total social value ranging from $6,280 per acre to $17,300 per acre.

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A MIXED LOGIT MODEL OF HOMEOWNER PREFERENCES FOR WILDFIRE HAZARD REDUCTION

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INFLUENCE AND EFFECTIVENESS OF FINANCIAL INCENTIVE PROGRAMS IN PROMOTING SUSTAINABLE FORESTRY IN THE SOUTH

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Abstract

Selected state agency foresters in each of the 13 southern states were surveyed about the financial incentive programs available to nonindustrial private forest owners. The foresters were asked to name and describe the public and private programs available in their state, to assess forest owners' awareness of each program, its appeal among the owners aware of it, its effectiveness in encouraging sustainable forestry and enabling owners to meet their objectives, and the percent of program practices that remain in place and enrolled acres that remain in forest over time. They also were asked to suggest ways to improve the programs. The Forest Stewardship, Forest Land Enhancement, and Forest Legacy Programs were among the top rated federal programs, scoring well for all measures and attributes. Programs sponsored by states and private organizations tended to be more narrowly targeted than federal programs, and scored well for specific attributes. The foresters' suggestions for program improvement centered largely on improving program visibility and availability, increasing and ensuring long-term consistency in program funding, and simplifying the application and approval process.

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Keywords: Financial incentives, private forest landowners, cost share programs, property taxes

Introduction

Policy tools such as education, technical assistance, regulation, and financial incentives influence the management and use of nonindustrial private forests. Increasing concern over loss of open space, forest fragmentation, and the impact of globalization of forest product markets has revived interest in financial incentives as tools to conserve forests and promote sustainable forestry (Sampson and DeCoster 2000; Wear and Greis 2002; Hutton and Leader-Williams 2003).
The scope of financial incentives is extensive and dispersed among numerous organizations. Most popular are cost-share programs for forest management practices and tax incentives. Most cost-share programs are funded by the federal government and administered by state forestry agencies. Both the federal and state governments provide tax incentives, the federal government primarily through provisions in the federal income tax, and states primarily through provisions in state property taxes. In some states, forest industry firms, state forestry associations, and non-governmental organizations also provide forestry-related incentive programs (Greene et al. 2005).

Financial incentives were first used in the 1940s to address policy concerns about timber supply. Since that time, however, the focus of most financial incentive programs has shifted toward forest sustainability issues, including forest stewardship, environmental services, and preservation of natural capital. Sustainable forestry – defined as managing forests for their ecological, economic, and social benefits such that those benefits do not diminish in quantity or quality over time (USDA Forest Service 2004) – has become the linchpin of the current forest policy agenda (Oliver 2003; Wear et al. 2007).

Extending from Virginia to Texas, the 13 states of the U.S. South provide an ideal site to study the effectiveness of financial incentive programs in encouraging sustainable forestry on nonindustrial private forests. The region is home to 33 percent of the nation's population and 42 percent of its more than 10 million nonindustrial private forest owners. It comprises 29 percent of U.S. forestland and 40 percent of commercial timberland (Butler and Leatherberry 2004). Moreover, 88 percent of forestland in the region is privately owned, compared with 57 percent nationwide (Smith et al. 2004).

This paper presents results for the South from a study to assess the effectiveness of currently available public and private financial incentive programs in encouraging sustainable forestry on nonindustrial private land. The study was nested within larger study to identify financial incentive programs with the potential to enhance the practice of sustainable forestry on nonindustrial private land (Greene et al. 2005; Kilgore et al. 2007; Straka et al. 2007).

Methods and Data

Data for the study were collected using a mail survey of state agency foresters in each of the 13 southern states selected for their overall knowledge of financial incentive programs. The appropriate individual in each state to receive the survey questionnaire was identified using a networking approach; in most cases it was the person who managed the Forest Stewardship Program.

The survey questionnaire asked the foresters to name and describe the public and private financial incentive programs available to nonindustrial private forest owners in their state, as well as any private programs in neighboring states that they were aware of. In follow-up questions they were asked to use a 4-point Likert scale to assess forest owners' awareness of each program, its overall appeal among the owners aware of it, and its effectiveness in encouraging sustainable forestry and enabling owners to meet their objectives of forest ownership. The foresters also were asked to estimate the percent of program practices that remained in place and enrolled acres that remained in forest over time, and to suggest ways to improve owner participation in the program and its administrative effectiveness.

Nine federal incentive programs were surveyed: the Forest Stewardship Program (FSP), Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP), Forest Land Enhancement Program (FLEP), Forest Legacy Program (FLP), Landowner Incentive Program (LIP), Southern Pine Beetle Prevention and Restoration Program (SPBPR), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentives Program (WHIP). Table 1 provides information about each program, including the year it was established, a summary of its provisions, and its administering agency or agencies.

Three types of non-federal financial incentive programs also were surveyed: state preferential property tax programs for forest land, other state-sponsored financial incentive programs, and privately-sponsored financial incentive programs. Every state in the region provides preferential property tax treatment for forest land. Each state takes its own unique approach, however, and even similar provisions are applied in widely divergent ways. Some states also sponsor other types of financial incentives, which typically are financed by forest tax revenues. Some are cost-share programs to fund timber management practices, while others focus on wildlife, riparian areas, or conservation easements. Forest industry firms account for the majority of financial incentives offered by private entities, although programs sponsored by state forestry associations, land trusts, or conservation organizations are available in a handful of states.

The survey questionnaire was developed, pre-tested with state agency foresters in each of the co-authors' home states, and refined using their feedback. The completed questionnaire was mailed out in March 2005, using the Dillman (1999) Tailored Design Method. Although the questionnaire was extensive – 89 questions on 30 pages – follow-up telephone calls and e-mails provided a 100 percent useable response. Numerical data, including the Likert scale ratings, were compiled and summarized. Tukey tests were used to identify statistically significant differences between program ratings for specific attributes. Forester comments and suggestions were compiled and categorized. The results of the analysis are summarized below.

Table 1. Federal financial incentive programs surveyed

Forest Stewardship Program (FSP) – Established in 1990 to assist private forest owners to keep forest land and resources in healthy condition and increase the economic and environmental benefits it provides. FSP is not a cost-share program; participating owners receive technical assistance to develop a Forest Stewardship plan, and must make a good faith effort to implement the plan. Administered by the USDA Forest Service.

Conservation Reserve Program (CRP) – Established in 1985 to promote conversion of highly erodible farmland and other environmentally sensitive land to a long-term resource conserving cover. Participating landowners receive annual payments for 10–15 years based on the converted land's agricultural rental value. They also can receive a cost-share of up to 50 percent of the cost of establishing the resource conserving cover. Administered by the USDA Farm Service Agency.

Environmental Quality Incentives Program (EQIP) – Established in 1996, EQIP combines features of four earlier programs. Its objective is to help farm and ranch owners address practices that pose a significant threat to soil or water resources. Participating owners receive technical assistance, cost-share, and incentive payments to implement conservation practices. Administered cooperatively by the USDA Natural Resources Conservation Service and Farm Service Agency.

Forest Land Enhancement Program (FLEP) – Established in 2002, FLEP combines two earlier programs. It promotes sustainable management of nonindustrial private forest land by providing technical, educational, and cost-share assistance to owners. A coordinating committee in each state determines how program funds will be used. Owners must have a written forest management plan to participate. Administered by the USDA Forest Service in partnership with state forestry agencies.

Forest Legacy Program (FLP) – Created in 1990 protect environmentally important private forest land threatened with conversion to nonforest uses. FLP operates primarily through the purchase of permanent conservation easements. Up to 75 percent of the total cost of protecting forest land can be federally funded. Administered by the USDA Forest Service in partnership with individual states.

Landowner Incentive Program (LIP) – Established in 2003 to help private landowners protect and restore habitat for at-risk plant and animal species. LIP provides funding for states to offer technical assistance and grants to participating owners to develop and implement habitat management plans. Administered by the USDI Fish and Wildlife Service in cooperation with state wildlife agencies. To participate, the states must provide a minimum 25 percent non-federal match for federal funding.

Southern Pine Beetle Prevention and Restoration Program (SPBPR) – Established in 2003, a coordinated program to help public and private landowners in southern states reduce the susceptibility of their forests to SPB attack and restore affected areas, and to fund research. Private landowners who participate receive educational assistance and cost-share payments to implement treatments such as thinning and hazard fuel reduction. Administered by the USDA Forest Service.

Wetlands Reserve Program (WRP) – Established in 1985 to encourage conservation of wetlands on privately owned land. Participating owners receive financial assistance to implement practices. All costs are reimbursed if the owner accepts a permanent easement; 75 percent of costs are reimbursed if the owner opts for a 30-year easement or cost-share agreement. Administered cooperatively by the USDA Natural Resources Conservation Service and Farm Service Agency.

The Wildlife Habitat Incentives Program (WHIP) – Established in 1996 to encourage the development and improvement of wildlife habitat on private land. Participating owners receive technical assistance to develop a wildlife habitat management plan, plus cost-share payments under an agreement lasting 5–10 years. Cost-shares cannot exceed 75 percent of the cost of the practices performed. Administered by the USDA Natural Resources Conservation Service.

Results

Program Catalog

The first result of the survey was a catalog of the public and private financial incentive programs available to nonindustrial private forest owners in each state. An examination of the catalog reveals that the full suite of federal incentive programs is more likely to be available in states in the South than in other regions. At the time of the survey, FSP, CRP, EQIP, FLEP and WHIP were available in all 13 southern states, FLP and WRP in 12 states, SPBPR in 10 states – and nowhere else in the U.S. – and LIP in 8 states. The number and variety of the state- and privately-sponsored financial assistance programs available to forest owners was greater in the South than in other regions. As well, states in the region hosted one of only two financial incentive programs sponsored by forestry associations and one of only two programs sponsored by non-governmental organizations (Greene et al. 2006).

Federal Programs

None of the foresters surveyed responded about LIP. This may be because that the program was relatively new at the time of the survey and is administered by an agency outside the U.S. Department of Agriculture. Because of this result, LIP was excluded from the analysis.

Table 2 summarizes the results for federal financial incentive programs as given by the state agency foresters. The first section of the table shows the foresters' mean rankings for forest owner awareness of each program, and its overall appeal among the owners aware of it. All eight programs scored in the middle ranges for both awareness and appeal, with appeal rated higher than awareness. FLEP scored highest in owner appeal, followed closely by CRP and FSP. The same three programs also scored highest in owner awareness, although the difference was not statistically significant (Table 2, Part a).

Part b of Table 2 summarizes the foresters' mean rankings for the programs in terms of their effectiveness in encouraging sustainable forestry among participating owners. FLP ranked highest overall, scoring well in all attributes of sustainability. CRP, FSP, and FLEP ranked next-highest. Compared with other programs, CRP scored particularly well for protecting soil productivity, protecting water quality, preventing conversion of forest land, and protecting wildlife and fish. By the same measure, FSP scored well for protecting water quality, encouraging forest management, and protecting wildlife and fish, while FLEP scored well for encouraging forest management and protecting wildlife and fish.

While WRP ranked third-highest, it is still solidly in the effective range. Compared with other programs, WRP scored among the highest for protecting water quality and protecting wildlife and fish; it scored lowest for encouraging forest management. WHIP, EQIP, and SPBPR ranked lowest in encouraging sustainable management. WHIP, however, scored quite well for protecting wildlife and fish, EQIP for protecting water quality and wildlife and fish, and SPBPR for encouraging forest management.

Table 2. Federal forestry incentive program attributes as reported by state program administrators

	Incentive Program							
Attribute	**FSP**	**CRP**	**EQIP**	**FLEP**	**FLP**	**SPBPR**	**WRP**	**WHIP**
a. Owner awareness and appeal								
Awareness [1,2]	2.69^{A}	2.62^{A}	2.40^{A}	2.58^{A}	1.89^{A}	2.00^{A}	1.75^{A}	2.14^{A}
Appeal [1,2]	3.31^{AB}	3.38^{AB}	2.50^{AB}	3.50^{A}	3.00^{AB}	2.75^{AB}	2.13^{B}	2.86^{AB}
b. Effectiveness in encouraging sustainable forestry								
Prevents conversion [1,2]	3.00^{ABC}	3.70^{A}	2.11^{C}	3.36^{AB}	3.89^{A}	2.83^{ABC}	3.00^{AB}	2.50^{BC}
Prevents parcelization [1,2]	2.85^{ABC}	3.27^{ABC}	2.11^{C}	3.18^{ABC}	3.89^{A}	2.67^{BC}	3.38^{AB}	2.50^{BC}
Maintains forest type [1,2]	3.00^{AB}	3.40^{AB}	2.40^{B}	3.27^{AB}	3.63^{A}	2.60^{AB}	3.25^{AB}	2.71^{AB}
Protects wildlife/fish [1,2]	3.77^{A}	3.31^{A}	3.30^{A}	3.36^{A}	3.67^{A}	2.17^{B}	3.38^{A}	3.86^{A}
Protects water quality [1,2]	3.92^{A}	3.77^{A}	3.70^{A}	3.36^{AB}	3.78^{A}	2.57^{B}	3.50^{A}	3.29^{AB}
Protects soil productivity [1,2]	3.54^{AB}	3.92^{A}	3.50^{AB}	3.45^{AB}	3.78^{A}	2.43^{C}	3.25^{ABC}	2.86^{BC}
Encourages forest management [1,2]	3.85^{A}	3.46^{ABC}	2.50^{CD}	3.91^{A}	3.56^{AB}	3.57^{AB}	2.25^{D}	2.71^{BCD}
Overall average	3.42^{AB}	3.44^{AB}	2.82^{CD}	3.42^{AB}	3.74^{A}	2.70^{D}	3.14^{BC}	2.92^{CD}
c. Effectiveness in helping owners meet their objectives								
Timber production [1,2]	3.54^{A}	3.00^{AB}	2.30^{BC}	3.82^{A}	3.13^{AB}	3.57^{A}	2.38^{AB}	1.86^{C}
Recreation [1,2]	3.23^{A}	2.67^{A}	2.30^{A}	3.00^{A}	3.25^{A}	2.17^{A}	2.75^{A}	3.29^{A}
Wildlife [1,2]	3.69^{A}	3.31^{A}	3.20^{AB}	3.55^{A}	3.50^{A}	2.43^{B}	3.38^{A}	4.00^{A}
Aesthetics [1,2]	3.38^{AB}	2.69^{AB}	2.70^{AB}	2.91^{AB}	3.50^{A}	2.43^{B}	3.00^{AB}	3.14^{AB}
Soil/water conservation [1,2]	3.38^{AB}	3.92^{A}	3.50^{AB}	3.64^{A}	3.75^{A}	2.86^{B}	3.25^{AB}	2.86^{B}
Invasive species control [1,2]	2.62^{A}	2.50^{A}	3.10^{A}	2.91^{A}	3.00^{A}	2.67^{A}	2.00^{A}	2.71^{A}
Overall average	3.31^{AB}	3.11^{ABC}	2.85^{BC}	3.30^{AB}	3.36^{A}	2.70^{C}	2.80^{C}	2.98^{ABC}
d. Over time								
Practices remain in place [1,2]	3.38^{A}	3.69^{A}	3.50^{A}	3.50^{A}	3.89^{A}	3.71^{A}	3.63^{A}	3.17^{A}
Acres remain in forest [1,2]	3.54^{A}	3.46^{A}	3.00^{A}	3.50^{A}	3.89^{A}	3.71^{A}	3.63^{A}	3.00^{A}

[1] Likert Scale ratings: 1 = Very ineffective, 2 = Moderately ineffective, 3 = Moderately effective, 4 = Very effective.
[2] Tukey's grouping across incentive programs for each respective program attribute. Alpha = 0.05. Means with the same letter are not significantly different.

Part c of Table 2 summarizes the foresters' mean rankings for the programs in terms of their effectiveness in helping nonindustrial private forest owners meet their objectives of forest ownership. Generally, the foresters scored the programs less effective in this area than in encouraging sustainable forestry. It should be noted that four programs scored in the moderately ineffective range for helping owners meet objectives related to recreation, and six scored in the moderately ineffective range for helping owners meet objectives related to invasive species control.

FLP again ranked highest overall, scoring well for all owner objectives. FSP and FLEP ranked next-highest. Compared with other programs, FSP scored particularly well for objectives related to wildlife, timber production, and recreation, while FLEP scored well for objectives related to timber production, soil and water conservation, wildlife, and recreation.

When grouped, CRP, WHIP and EQIP ranked third-highest overall. Compared with other programs, CRP scored well for objectives related to soil and water conservation and wildlife, but averaged in the moderately ineffective range for aesthetics, recreation, and invasive species control. WHIP received the highest possible score for owner objectives related to wildlife, but averaged moderately ineffective for soil and water conservation, invasive species control, and timber production. EQIP received high marks for objectives related to soil and water conservation, but averaged moderately ineffective for aesthetics, timber production, and recreation. WRP and SPBPR ranked lowest for helping forest owners meet their objectives. WRP, however, received solid scores for helping owners meet objectives related to wildlife, and SPBPR for timber production.

The final section of Table 2 (Part d) summarizes the foresters' mean rankings for program practices remaining in place and enrolled acres remaining in forest over time. All eight federal programs scored in the moderately to very effective range for these characteristics, with no statistically significant differences between the scores.

<u>Other incentive programs</u>

Table 3 summarizes the results for state and private financial incentive programs as given by the state agency foresters. The questionnaire sections relating to private incentive programs were streamlined to request only descriptions of the programs and ratings for their effectiveness in encouraging sustainable forestry and helping owners meet their objectives of forest ownership. No data were collected for owner awareness and appeal, or for practices remaining in place and acres remaining in forest over time.

The first section (Part a) of Table 3 shows the state agency foresters' mean rankings for forest owner awareness of each type of program, and its overall appeal among the owners aware of it. For owner awareness, state property tax and incentive programs rated higher, in general, than federal programs; for owner appeal, they rated about on a par.

Table 3. State- and privately-sponsored forestry incentive program attributes as reported by state program administrators

Attribute	Incentive Program			
	State Property Tax Programs	Other State Incentive Programs	Industry & State Assoc. Programs	Nongov'tal Organization Programs
a. Owner awareness and appeal				
Awareness [1,2]	3.00 [A]	2.70 [A]	N/A	N/A
Appeal [1,2]	3.25 [A]	3.14 [A]	N/A	N/A
b. Effectiveness in encouraging sustainable management				
Prevents conversion [1,2]	3.08 [A]	3.71 [A]	3.00 [A]	2.66 [A]
Prevents parcelization [1,2]	2.91 [A]	3.28 [A]	2.87 [A]	3.00 [A]
Maintains forest type [1,2]....................	3.00 [A]	3.28 [A]	3.14 [A]	3.33 [A]
Protects wildlife/fish [1,2]	2.81 [A]	3.14 [A]	2.50 [A]	3.33 [A]
Protects water quality [1,2]...................	3.00 [A]	3.42 [A]	3.12 [A]	3.33 [A]
Protects soil productivity [1,2]	2.83 [A]	3.43 [A]	2.87 [A]	3.33 [A]
Encourages forest management [1,2] ...	2.91 [A]	3.71 [A]	3.25 [A]	3.00 [A]
Overall average [1,2]	2.94 [B]	3.43 [A]	2.96 [B]	3.14 [AB]
c. Effectiveness in helping owners meet their objectives				
Timber production [1,2]........................	3.08 [A]	3.85 [A]	3.86 [A]	3.00 [A]
Recreation [1,2]	2.72 [A]	3.00 [A]	2.37 [A]	3.33 [A]
Wildlife [1,2]	2.75 [A]	3.28 [A]	2.62 [A]	3.33 [A]
Aesthetics [1,2]....................................	2.82 [A]	2.85 [A]	2.50 [A]	3.33 [A]
Soil/water conservation [1,2]................	3.00 [A]	3.57 [A]	3.25 [A]	3.66 [A]
Invasive species control [1,2]	2.30 [A]	3.14 [A]	2.43 [A]	2.67 [A]
Overall average [1,2]	2.79 [A]	3.28 [A]	2.85 [A]	3.22 [A]
d. Over time				
Practices remain in place [1,2]..............	3.66 [A]	3.00 [A]	N/A	N/A
Acres remain in forest [1,2]	3.66 [A]	2.25 [A]	N/A	N/A

[1] Likert Scale ratings: 1 = Very ineffective, 2 = Moderately ineffective, 3 = Moderately effective, 4 = Very effective
[2] Tukey's grouping across incentive programs for each respective program attribute. Alpha = 0.05. Means with the same letter are not significantly different.

Part b of Table 3 shows the foresters' mean rankings for each type of program in terms of its effectiveness in encouraging sustainable forestry. Among the state programs, incentive programs ranked higher than property taxes. Both types of programs received high scores for preventing conversion of forest land; incentive programs also scored high for encouraging forest management.

Among the private programs, incentives offered by non-governmental organizations (NGOs) ranked higher than those offered by industry firms and state forestry associations. Programs offered by NGOs received the highest scores for maintaining forest type, protecting wildlife and fish, protecting water quality, and protecting soil productivity, while programs offered by firms and associations received the highest scores for encouraging forest management.

Part c of Table 3 shows the foresters' mean rankings for each type of program in terms of its effectiveness in helping nonindustrial private forest owners meet their objectives of ownership. Although the differences were not statistically significant, state incentive programs again ranked higher than property taxes, and programs offered by NGOs again ranked higher than programs offered by industry firms and state forestry associations.

Both types of state programs received their highest scores for helping owners meet objectives related to timber production and soil and water conservation. State incentive programs also scored well for objectives related to wildlife. Both programs offered by industry firms and state forestry associations and programs offered by NGOs received high scores for objectives related to soil and water conservation. Programs offered by firms and associations also scored well for objectives related to timber production. Programs offered by NGOs also scored well for objectives related to recreation, wildlife, and aesthetics.

The final section (Part d) of Table 3 summarizes the foresters' mean rankings for program practices remaining in place and enrolled acres remaining in forest over time. Property tax programs ranked in the moderately to very effective range for both characteristics, while other state incentives ranked in the moderately effective to moderately ineffective range. The differences, however, were not statistically significant.

Incentive Program Improvement

State agency forester suggestions on ways to improve financial incentive programs centered largely on improving program visibility and availability, increasing and ensuring long-term consistency in program funding, and simplifying the application and approval process for both forest owners and program administrators. Specific suggestions included:

- Targeting forest lands and practices where the benefits would be greatest rather than distributing funds on a first-come, first-served basis.
- Designating a single agency in each state – ideally the forestry agency – as the point of contact for all forest-related financial incentive programs, to reduce the level of confusion among forest owners with respect to program availability, eligibility, and application procedures.
- Improving communication between state agency foresters and the USDA Natural Resources Conservation Service and Farm Service Agency, with the goals of establishing a process for foresters to become technical service providers for, and allowing for more funding of forestry practices in, the financial incentive programs administered by those agencies.
- Building flexibility into program objectives and requirements, so they can be applied to region- and state-specific concerns.
- Improving coordination between programs, such as requiring a written management plan for all programs, and linking financial incentives directly to stewardship practices.

The most frequently mentioned changes for improving preferential property tax programs included increasing funding and simplifying eligibility requirements, administrative procedures, objectives, guidelines, and valuation methods.

Conclusions

The findings presented here must be interpreted with respect to forest acres enrolled in the programs surveyed, not all nonindustrial private forest acres. In a phase of the study reported elsewhere (Greene et al. 2005; Kilgore et al. 2007), focus groups of forest owners noted that public and private financial incentive programs play only a limited role in promoting sustainable practices on nonindustrial private forest land. One reason is that funding of the programs limits the number of acres that can be enrolled. Another is that many forest owners remain unaware that the programs exist. Owner awareness of federal financial incentive programs, for example, peaked in the moderately ineffective range (Table 2, Part b).

The study results indicate there are clear differences between the incentive programs available to nonindustrial private forest owners. FSP, FLEP, and FLP were among the top rated federal programs by all measures, both overall and for individual attributes. All three programs stress multiple objectives, but their clientele is limited to forest owners. Other federal incentive programs have forestry emphases, but their clientele includes farmers and ranchers as well as forest owners.

Programs sponsored by states, industry firms, state forestry associations, and non-governmental organizations generally were more narrowly targeted than federal programs, and scored higher for specific attributes. Such targeted programs have the potential to outperform general conservation programs for regional concerns, emerging issues – for example, invasive species control – and where program funding is constrained.

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STATISTICAL EVIDENCE OF FIRE PREVENTION EFFICACY FROM FLORIDA

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Abstract

Millions of dollars are spent annually by state and federal agencies in the United States to help prevent forest fires. Efforts include public service announcements in various media, fire awareness programs in public schools, and homeowner fire risk reduction public meetings. These efforts are typically focused on debris burning and other preventable fire causes. We report statistical evidence, based on a unique fire prevention dataset and wildfire and prescribed fire records from Florida, 1981-2006, of fire prevention efficacy. Models employ instrumental variables methods and express prevention efforts at the fire district level and other variables at generally finer spatial scales. Model results suggest that certain kinds of efforts are more effective than other efforts at preventing fires, and some kinds of efforts work better at reducing the rates of fires of particular causes. Alternative models are reported, and alternative functional forms are compared. Results have implications for how state and federal agencies allocate their spending among fire suppression, prevention, and fuels management.

[Abstract Only]

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TIMBER! QUALIFIED GAINS OR LEGISLATIVE GAINS? EVIDENCE FROM THE 2007 SENATE: A PUBLIC CHOICE PERSPECTIVE

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Abstract

Public choice economists view the legislative process as a political market, in which individuals and interest groups demand beneficial legislation and politicians supply relevant legislation. In this context, bill co-sponsorship acts as a signal to interest groups that an elected legislator is working to secure their interests and thereby maximizes his/her payoffs (defined broadly to include votes) from such groups.

In this paper we examine whether public choice theory accurately explains co-sponsorship patterns in the U.S. Senate. Specifically, we examine empirically whether economic factors significantly explain co-sponsorship of Senate bill 402 (2007), a bill seeking to amend the Internal Revenue Code of 1986 to allow a deduction for qualified timber gains. The results indicate a Senator's bill co-sponsorship behavior is correlated with his/her seniority, Political Action Committee money donated by forestry interests, percent of total jobs in the Senator's state that are forestry related, and percent total of land in the state that is privately held.

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ASSESSING ROYALTIES FOR PROPAGATION RIGHTS: A CASE STUDY

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Abstract

Tree improvement programs in the southern United States formally began in the second half of the 20th century. The evolution of this process consisted of finding plus trees from wild tree populations that exhibited outstanding features such as volume, form, and health. These were relocated and propagated in seed orchards, usually by grafting. Progeny was tested to evaluate and rank parents. Trees with lower rankings were removed from the seed orchards, and thus, improved seeds were produced. Second generation selections were made in progeny tests. The best individuals were selected from offspring of the best parents and established in the Second Generation Seed Orchards. Using this recurrent selection process, producers currently harvest seed sufficient to produce over one billion seedlings annually. Along with improved intensive silviculture, these improved seeds have increased timber production by more than four times since the first round of tree improvement began.

Although these advanced generation seeds delivered increasingly higher volumes to forest landowners, their market price has not reflected their value. Especially with the advent of vegetative propagation techniques that are able to expedite and capture additional gains in volume and quality traits, the forest seed industry is challenged with how to recoup the investments devoted to developing these "miniature factories." The solution lies in understanding the combination of value creation and strategies to capture and protect the value of elite pine varieties.

This research follows the progress made in the agricultural field for protecting the value of genetic assets and examines available protections for developers, and discusses common valuation techniques for assessing royalties on tangible and intangible assets. A case study is presented that attempts to estimate royalty rates to capture the value created and intellectual property inherent in elite pine varietal seedlings when they are used for propagation rather than for reforestation. An analytical technique derived from the income approach was used to derive the royalty rates with a sensitivity analyses on three variables: levels of net profits, number of cuttings per mother plant, and payment time frames were further performed to allow the development of five payment mechanisms.

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In summary, this paper provides a background for valuation methods that may address the intangibles of genetic advances and for protecting intellectual property of biotechnology developers.

[Abstract Only]

U.S. SOUTH IN THE GLOBAL MARKETPLACE: HOW COMPETITIVE IS THE SOUTH IN 2008?

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Abstract

A review of global forest products markets is provided with emphasis on comparing southeast U.S. timber prices with other major global timber markets. This study focuses on a historical comparison with key international timber producers, price changes and international exchange rates.

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NEW PROGRESS IN PRIVATIZATION OF THE COLLECTIVE FOREST LAND IN CHINA: EVIDENCE FROM 9 VILLAGES

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Abstract

China started forest land tenure reform in the early 1980s. The household responsibility system (HRS) was usually referred to as reform even though various forms of reforms have been developed from region to region. More importantly, the approaches to reform have been evolving through time. A trend toward privatization became more apparent when the Central Government started a pilot experiment called new stage of forestland tenure reform recently. While this paper compares the various roads toward privatization and adopting market mechanisms, special attention is paid to new reforms by examining and comparing 9 villages (330 households) in 3 provinces in Southeast China where collective forest ownership is dominant. The impacts, public attitudes and response to the new reform are investigated, and some challenging questions are analyzed.

Keywords: land tenure, economic reform, farmers, forestland markets, privatization

Introduction

In the People's Republic of China, forestland ownership in the southern China had experienced land reform and economic recovery (1950-1952), primary collectivization (1953-55), advanced collectivization (1956-1958), and the People's Commune system (1958-1981). While not as early as farm land reform starting in 1978, forestland reform was initiated in 1981 when the Central

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Government proclaimed the policy document titled “The Decisions on the Issues of Forest Conservation and Forestry Development”. Unlike the agriculture sector, forestland reform adopted various forms largely because a large amount of people still believed that public ownership was superior to private ownership for forestry. In addition, the policy was more ambiguous at that time. There was wide concern about the potential of large-scale deforestation if collective land was distributed to household levels. The latter outbreak of forest destruction and deforestation at the early stage of reforms confirmed that the concern was right. Consequently, growing support was given to keep collective forestland intact with adoption of the so-called shareholding system that was practiced in Sanming, Fujian. Various forest management responsibilities were contracted to holding members in this system (for more details, see Song et al.1997 and Zhang et al. 1999).

After 20 years of forestland reform, a new stage of reform was called by the Central Government in the early 2000s. Like many other economic reforms, it was always implemented on a pilot scale in China. In 2003, Fujian and Jiangxi Provinces initiated a pilot experiment with a new round of reforms which indicated the start of new reform in forestry. The new reform essentially is full-scale of privatization of the forestland from many aspects. Not many reports about the new reforms have been made. This is the major motivation of this study and investigation.

Examining the 30 years of forestland reform, we can see that the roads were not so straight and more than one. More importantly, the approaches to forestland reform have been evolving. It is interesting to see that they are gradually heading to privatization even though “privatization” is still not used officially (instead, “non-public forestland ownership” is used). The so-called new reform has been promoted by the Central Government probably because it is believed further reform is necessary to promote the development and farmers’ income in rural and poor regions to catch up with the urban residents’ income (the ratio of average household income of the rural to the urban was from 2.71 in 1995 to 3.33 in 2007).

This paper compares the various roads toward privatization and market mechanisms by examining and comparing 9 villages (330 households) in 3 provinces in the Southeast China where the collective forest ownership is dominant. The impacts, attitudes and response to the new reform are reported, and some challenging questions are analyzed. Our findings reflect a general picture of forest land reform in the southern China.

First we will describe data collection, especially village selection. Then the characteristics, processes and types of the new reforms and households’ responses to the reform are compared among the villages. Finally, conclusions and suggestions for future policy are discussed.

Methods

Collective forest ownership (accounting for 57% of the total forestland) is concentrated in10 provinces, especially in Zhejiang, Fujian and Jiangxi. In each province, we selected 3 counties considering their geography, forest resource condition, economic development level and forestry dependence. In each county, one village was selected. The selection of villages also took full consideration of location, household economic level, forest resource condition, types and impact of collective forestry property rights after consulting the county (municipality) forestry bureau. The general information of the 9 villages is given in Table 1.

Table 1. The 9 selected villages (2005)

Province	**Village/ County**	**Area (ha)**	**Forestland (ha) (%)**	**Forestland per capita (ha)**	**Population (persons)**	***Income per capita (yuan)***
Zhejiang	Xikou/Longyou	943	895 (95%)	0.70	1280	*5539*
	Junjian/Lin'an	555	446 (80%)	1.36	328	*5462*
	Niaoxi/Pujiang	598	584 (98%)	0.51	1150	*5024*
Fujian	Yangcuo/Nanping	854	683 (80%)	0.44	1565	*3620*
	Hongtian/Yong'an	1548	1261(81%)	2.10	877	*5269*
	Gaonan/Shaowu	1579	1372(87%)	1.73	792	*3500*
Jiangxi	Yongfeng/Tonggu	1600	915 (57%)	1.52	602	*2870*
	Shangyuan/Suichuan	1406	1353(96%)	1.30	1040	*2220*
	Longgui/Chongyi	*1000*	*868 (87%)*	*1.96*	*442*	*2900*

Sources: Authors' collection from various statistical sources.

General economic and forestry data were collected from the forestry and statistical departments. Our data collection about the history of the reform, especially the new reforms, was conducted through participatory discussions with representatives from the local government, especially forestry department and local forest enterprises. We organized 36 focus group meetings. During the participatory group interview, 4 groups of village officials, women, elders and adults were selected to conduct participatory group interviews.

A separate questionnaire was used to collect the data on characteristics, social and economic variables of households, such as household size and ration of labor, education of the household head, gender distribution, forestland holdings and household income and ration of non-agriculture, the willingness to accept the new reforms. A total of 330 households as a random sample were investigated with 101 from Zhejiang, 106 from Fujian, and 123 from Jiangxi.

Roads toward Privatization

Our results and evidence from the 9 villages further showed that current reform is essentially toward privatization especially for the new stage reform of collective forestland tenure. However, while China is continuing privatization and adopting market mechanisms in general, the similarities and variances of the reforms among the villages as well as household response to the new reforms still exist.

To summarize the roads toward privatization among the 9 villages in 3 provinces, we can identify some similarities and variances of the roads toward privatization. Based on our survey and information gathered from the 9 villages, the various roads to privatization can be distinguished.

Zhejiang

Zhejiang distributed the collective forestland to local farmers during the HRS in the early 1980s. About 76% of the collective forestland was managed by households in 1986. Such a policy has been kept comparatively consistent. The scale and intensity of privatization in Zhejiang has been higher than in other provinces. Largely influenced by the more developed market economy and market awareness and perception in Zhejiang, forestland use rights were allowed to be traded and transferred much earlier. For example, in Xikou and Niaoxi villages local farmers started to contract with and buy collective forestland use rights as early as the mid-1980s. Household forestland use rights were traded among households, and collective forestland invited public bidding in the early and mid-1990s. The household forestland use right was extended by 50 years to 2055. Only in Junjian village were the household owned timber-production oriented forest lands taken back to village ownership in the early 1990s.

In 2001, Junjian village was assigned as a pilot experiment for new reform in Zhejiang Province probably because Junjian had withdrawn some household forestland to the village in the 1990s. Xikou and Niaoxi villages, like most other villages in Zhejiang, maintained private use rights since the beginning of the reform. Therefore, the new reform in these two villages was extended use rights for another 50 years to 2055 and gave more formal forestland use certificates that further confirmed the legal use right of collective forestland.

The government takes additional measures in the new reform, such as reducing taxes and adjusting logging policies. In Zhejiang province, the agriculture special product tax was removed in 2003.

Fujian

Fujian province has taken a very different road toward privatization. Only very small amounts of collective forestland were distributed to the households in the early 1980s. Gaonan and Hongtian villages also followed the Share Holding System model (or so-called Sanming Model) in the mid-1980s. In the mid-1990's Hongtian village had not started to distribute the collective forestland to households. The reform adopted was first allocating land to small groups, then from small groups to households. Joint forest management (combining multiple households' forestland) was encouraged and widely practiced.

Gaonan village adopted leasing and cooperative management among the households or between households and forest industry by pooling different resources (the households contribute the land and labor, while the forestry industry provided the capital). In addition, Gaonan village initiated a different system in which the villages contracted out the forestland to only a few households by casting lots in 2000. It was proposed that a new run of contracting will be conducted at the end of first round. Yangcuo village distributed forestland to small groups or farmers but combined them again into joint forest management in the mid-1990s. Hongtian village, as the pilot experimental village in Fujian, began to distribute forestland to households and carried out some other complementary reforms in 2003.

Since Fujian Province had not distributed collective forestland to households in the early 1980s, the new reforms since 2001 essentially made up the missing step of distribution (transferred the collective forestland to households) that was completed earlier in other regions, or issued more formal, legal certificates of use rights if the distribution was carried out earlier. For example, Yangcuo village distributed 400 ha of commercial forestland to households. Gaonan village allocated 530 ha of collective forestland to households. Hongtian village evaluated the existing collective forest and granted 787 ha with 1001 m^3 of forest to local farmers.

Another big change in the new reform is rent collection. For example, Hongtian village collected 100,000 Yuan per year from contracting out village-owned forestland in recent years. The rent shows an increasing trend over time. The rent is primarily used for public infrastructure such as roads and electricity access. Table 2 is an example of rent collected in Hongtian village. Apart from forestland tenure change, the tax and fee imposed on timber products have been dramatically reduced, e.g., from 40-50% to 26% in Hongtian.

Table 2. Forest income distribution in Hongtian village

Resources	**Village share**	***Farmer's share***
Initial Volume	70%	*30%*
Increment volume	20%	*80%*
Second generation or newly planted forest Classes I and II land	1.2 m^3	*The remaining part*
Class III land	1 m^3	*The remaining part*
Classes IV and above	0.8 m^3	*The remaining Part*

Jiangxi

Jiangxi, like Zhejiang, also distributed collective forestland to households in the early 1980s. More than 60% of total collective forestland area was managed by household in 1983. But the villages took back most of the distributed forestland and applied village share-holding integrated management, like in Sanming, Fujian. However, Longgui village allowed trading forestland among households in the early 1990s.

In Jiangxi, the three villages (Yongfeng, Longgui and Shangyuan) restarted new reforms in 2004, adjusting forestland allocations based on the initial HRS conditions and changing situations. They further clarified the share of the benefit from the transfer of forestland. The principle of fairness was strongly emphasized by distributing or redistributed the forestland equally. For example, three villages in Jiangxi have adjusted forestland allocations according to the willingness of local farmers. The tax reduction is another important aspect of the reform like in many other provinces. Due to the reducing the tax, the average tax and fee on timber have decreased from 56% to 15% in Jiangxi.

Impacts by and Attitudes to the Privatization

The new reforms are essentially a further privatization of forestland tenure. Unlike the early HRS in forestry that had mixed impacts and attitudes, the new reform has more consistent impacts and received greater support and confidence of farmers based on the survey of the 9 villages (Table 3).

Table 3. The impacts of income and investment by the new reform

		Total income per household (yuan)			**Forest income per household (yuan)**			**Forest Investment per household**		
Village	#	2000	2005	Change	2000	2005	Change	2000	2005	Change
Zhejiang										
Xikou	33	16579	29333	77%	4462	5481	23%	596	1495	151%
Junjian	33	21256	23094	9%	2565	3303	29%	1181	1763	49%
Niaoxi	35	19506	25005	28%	1096	971	-11%	131	171	31%
Fujian										
Yangcuo	37	17830	25219	41%	1755	4731	170%	2071	3017	46%
Hongtian	38	38747	55882	44%	4203	20325	384%	2983	10574	254%
Jiangxi										
Yongfeng	39	11636	18113	56%	3581	10457	192%	4480	7555	69%
Shangyuan	50	12105	14698	21%	1496	2400	60%	1580	3660	132%
Longgui	34	11715	15342	31%	5582	9080	63%	3000	3020	1%

In all villages except Gaonan village (where the data were not available) our results indicated that the reforms increased income from forestry and its share of the total income from 2000 to 2005. The villages from Fujian and Jiangxi have higher rates than those from Zhejiang. From 2000 to 2005, the forest income as a percentage of the 6 villages showed an increasing trend.

The two villages from Zhejiang showed a decreasing trend probably because there are rich bamboo resources and many bamboo enterprises in Xikou village. The income from these enterprises was not included in the forest income. In Niaoxi village, the percentage of income from working outside is 88.9%. Overall, the reform improved total income.

Data from the 8 villages showed that the investment in forestland was increased from 2000 to 2005. For example, the farmers in Hongtian village have reforested 67 ha of logged-over land from their own financial sources. The villages in Fujian and Jiangxi indicated a higher growth rate in Zhejiang, probably because the investment was promoted by the new reform in Fujian and Jiangxi, while in Zhejiang the reform was implemented in the early 1980s because of less dependence on forestry with a smaller land area per capita.

Unlike the early forestland tenure reform in the early 1980s, the results from our survey indicate the new reform received great support from farmers (Table 4). All farmers in 5 villages from Fujian and Jiangxi support the new reform. However, the farmers from Zhejiang comparatively show some variety probably because the farmers might have some negative lessons after experiencing longer reform with more than 20 years. But as a whole, more than 90% support the reform, indicating the success of privatization of collective forestland tenure after 20 years of practice.

Table 4. Attitudes to the new reform

Villages	households (#)	Having confidence in the use rights (%)	Supporting the new reforms (%)
Zhejiang			
Xikou	33	100	100
Junjian	33	79	78.8
Niaoxi	35	91	62.9
Fujian			
Yangcuo	37	87	100
Gaonan	31	90	81
Hongtian	38	90	100
Jiangxi			
Yongfeng	39	82	100
Shangyuan	50	84	100
Longgui	34	97	100

The destruction or deforestation which occurred in the early 1980s was largely due to doubt and uncertainty the farmers had when they received forestland use rights. However, our results show this would not be the case now. About 90% the farmers felt they have confidence in their right to forestland.

Our findings also showed that the reforms accelerated democracy development in mountainous rural regions. The scheme of the reforms in all villages, such as whether to reform or not, how to reform, was made by representative farmers which improved the traditional decision-making ways, namely from "top to bottom" to "bottom to top". Our results from the questionnaire indicate that an average of 88.2% farmers think they participated in the process of reforms and their opinions were considered. Therefore, to some extent, the reforms are a kind of collective action.

Challenges

The evidence clearly demonstrates that collective forestland has been greatly transitioned toward privatization. However, there are still a few challenging aspects indicating unfinished business.

Logging quota system

The logging quota system which was initiated in 1987 has been adjusted many times, but it is still a restricting factor on household forest management. For example, "Regulations of plantation forests development in Fujian Province" issued in December, 2002 allows newly planted forests (beginning in 1998) to be self-determined for the harvesting plan, but there is still the need to apply for harvesting permits from the local government. Only households having more than 66.7 ha of plantation area or more than 1,333 ha of forests used to supply industrial materials can be exempted from the quota. Therefore for small households, it is still an important restriction, especially for villagers who still produce timber as their major management objective.

Our survey results indicated that 44.3% of farmers regarded logging quota systems as obstacles to forestry development. Comparing three Provinces, the farmers in Fujian and Jiangxi regarded it as the biggest obstacle. This is not a surprise since Fujian and Jiangxi have a much larger proportion of forestland used for timber production. Only for those villages where timber is not their major output, is the quota system not a big issue. For example, the energy source has changed from firewood to natural gas after economic development in Zhejiang. So, the farmers have shifted to non-timber products with higher market values. Hence, the logging quota system has little effect on local farmers.

Taxes and Fees

Prior to the new reform, the forestry tax and fee accounted for 30-50% of timber income in southern collective forest areas. The new reform has largely reduced the tax and fees in forestry. However, it is still an issue. Our results from the survey indicated that 12.5% of farmers still regarded heavy forestry tax burdens as obstacles to forestry development. In order to increase the farmers' income, government has removed the agriculture and forestry special product tax. In spite of that, the forestry tax and fee on the timber products is higher than other agriculture and forestry products.

Production Forest vs. Ecological Forest

In some villages, especially in Zhejiang and Jiangxi, the collective forestland was distributed to households in the early 1980s when the two kinds of forests were not clearly specified. Due to increasing concerns and awareness of the ecological function of forests, the Central Government started to specify ecological forests that would not be used for timber production in 11 Provinces in 2001. The specification of ecological forests was implemented in Zhejiang in 2001 and in Jiangxi in 2002. Consequently, conflict emerged. The results from our survey show that 27.3% of forestland in Junjian village from Zhejiang and 62% of household forests in Longgui village from Jiangxi was destined for ecological forests. Even though the governments provide compensation, but amount of compensation for ecological forests is much lower that profits generated from production uses.

Discussion and Conclusions

China's forestland reform has existed more than three decades. Some general conclusions can be drawn from our investigation of 9 villages in 3 provinces.

First, the reform is not straightforward. Zhejiang province largely allocated the collective forestland to households in the early 1980s and has kept land tenure constant since then. Fujian primarily adopted a quite different approach, i.e., a share-holding system for about 15 years before allocating forestland to households. Jiangxi initially distributed the forestland to households, but returned it to the villages after experiencing wide-spread deforestation. It eventually redistributed to households again. The recently initiated new reforms show more similarities, indicating a trend in privatization of collective forestland. Moreover, the trading of use rights of collective forestland is similar from region to region. Differences in stages of development lead to differences in the impacts and households' response to the reforms that could be found in Zhejiang, Fujian and Jiangxi.

Secondly, there is no clear line between collective-owned or managed and private owned or managed forests. It is more continuous, from share-holding land to responsibility-land, contracted-land to allocated-lands if we try to arrange them by the order of degree of privatization. Even for the allocated-land, households still only have use rights not land ownership. The beauty of the China's economic reform in general and land reform in particular is that the reform is so pragmatic. Various names were created to avoid some controversy in ideology in which many people were and are still not willing to accept capitalism as the social and political institutions. Officials in China are still reluctant to use private forestland. Instead, non-public forestry is found in various official documents and encouraged. That does not matter: property rights essentially are the rights to receive the flow of the benefits or economic rights. When the use right is long enough and tradable, it is your ownership in practice (Zhang and Kant 2005).

Third, economic reform must consider public perception and political willingness. The problems of the share-holding system, such as unnecessary bureaucracy and lack of incentive were obvious, but it had its merits at the time. Its evolution into a more market-oriented system is unavoidable when the socio-economic environments change. However, the governments should follow and study the situation and make timely adjustments along the process to privatization.

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EXPLORING THE COMPARATIVE ADVANTAGE OF NON-TIMBER FOREST PRODUCTS – THE CASE OF ZHEJIANG PROVINCE, CHINA

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Abstract

Non-timber forest products (NTFPs) play an important role in rural economic growth and farmers' revenue increase. A key issue in NTFP development is the competitiveness of different products or the same product in different regions. Using production data for main NTFPs, such as citrus, bamboo shoots, waxberry and green-tea in Zhejiang, this paper estimates the Efficiency Advantage Index (EAI), Scale Advantage Index (SAI), and Aggregated Advantage Index (AAI) of different regions. It is found that there exist tremendous variations among these regions, suggesting that NTFPs should be chosen according to the regional conditions.

Keywords: Comparative advantage, non-timber forest products, Zhejiang province, China

Introduction

China is a mountainous country, hills and mountains account for about 69% of the terrain. Many farmers are still very poor in rural areas, especially in mountain areas, even though China's economy has grown rapidly since the country decided to open to world trade at the end of the 1970s. Development of mountainous areas is key to increasing farmers' revenues and achieving China's economic sustainability. Non-timber forest products (NTFPs) play an important role in rural economic growth and farmers' revenue increase since the income from timber has decreased due to the implementation of Natural Forest Protection Program (NFPP) and Sloping Land Conversion Program (SLCP) in China. A key issue in NTFP development is the competitiveness of different products or the same product in different regions. Furthermore, owing to mountainous terrain and booming economic development, Zhejiang province has become the most advanced in developing NTFPs. The lessons and experiences of Zhejiang can be beneficial to other provinces in China and other developing countries all over the world. Therefore, it is interesting to study the comparative advantage of NTFPs in the Zhejiang province.

Several previous studies have evaluated the comparative advantage in agricultural production. Pearson and Mayer (1974) evaluated comparative advantages of the four main coffee growing countries of Africa. The study focused on calculating the Domestic Resource Cost (DRC) per

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unit of foreign exchange earned or saved. Findings showed that Uganda, Ethiopia, and Tanzania all had strong comparative advantages in coffee production, with very little deviation among each country's respective indices. The study was one of the first to attempt to address the complexity of comparative advantages among four countries. The scope was relatively small and demonstrated a need for more data collection among producing regions.

Carter and Zhong (1991) used data on land productivity and empirical analysis to test for regional comparative advantage, providing empirical evidence on provincial comparative advantage in cotton versus grain production in China.

Grossman and Helpman (1990) analyzed a dynamic, two-country model of trade and growth, finding that long-run productivity gains stem from the external trading environment as well as trade and industrial policies.

Zhong et al. (2000) studied the comparative advantages in grain production across different regions of China. Several indicators--Net Social Profitability (NSP) and DRC, are used to measure price advantages or disadvantages, and Efficiency Advantage Index (EAI), Scale Advantage Index (SAI), and Aggregated Advantage Index (AAI)--were used. It found that advantages in main grain crops varied across different regions in China, and there was a potential to improve grain production efficiency in China through the reallocation of natural resources and restructuring of the grain sector. It concluded that China can still compete in grain production even if the country as a whole was at a disadvantage in a particular crop production.

Tuan et al. (2001) studied the trade competitiveness of major agricultural products in China. Several indicators, such as DRC, DRC coefficients (DRCC), NSP, Effective rate of protection (ERP) and Regional CAI (RCAI), were used to measure comparative advantages. The former two were used in varieties analysis while the latter two were used in region analysis.

Morgan and Langemeier (2003) examined sustained competitive advantage for a sample of Kansas farms by using whole-farm data for 224 farms with continuous data from 1982-2001. Overall efficiency was computed for each farm and year. Sixty farms exhibited significantly above average overall efficiency levels (top category) or had a competitive advantage. Farms in the top category were significantly larger, received relatively more of their gross farm income from dairy and swine production, had significantly lower expense ratios, and had significantly higher profit margins.

Bernhofen et al (2005) provided an empirical assessment of the comparative advantage gains from trade argument. Using Japan's 19^{th}-century opening up to world commerce as a natural experiment, they answered the counterfactual question: "By how much would real income have had to increase in Japan during its final years of autarky (1851-1853) to afford the consumption bundle the economy could have obtained if it were engaged in international trade during that period?" Then, using detailed historical data on trade flows, autarky prices, and Japan's real GDP, they obtained upper bounds on the gains from trade of about 8-9 percent of Japan's GDP.

Young et al. (2006) evaluated the comparative advantage of upland cotton production in different districts within Texas by using three different indices: EAI, SAI, and AAI. The study revealed that the comparative advantage in upland cotton production varied considerably across the state. It would help to understand the performance and advantages of upland cotton production in different regions, and the disparities among different regions.

These are the earlier studies about the comparative advantage in a specific crop production. However, few have studied the comparative advantage in NTFPs, even though competitiveness is a key issue in NTFPs development. Therefore, our study focuses on NTFPs in the Zhejiang province.

Study site and data

Zhejiang is located in the southern wing of the Yangtze River Delta on the southeastern coast of China. It lies between 27º12´and 31 º31´ north latitude and 118º00´and 123º00´ east longitude, on the south of Shanghai, the largest city in the country. It covers a total continental area of 101.8×10^3 km^2, which is 1.06% of the country. The province possesses varied topography. Hills and mountains account for 70.4% of the total area in the province, plains and basins make up 23.2%, and the remaining 6.4% is water area composed of rivers and lakes. Arable land only accounts for 20.817 thousand square kilometers. Forest is 6679.7 thousand square hectares, which covers 57.4% of the province's total area and is listed among the front ranks in China. Zhejiang has 11 municipalities with 90 counties. It has a population of 46.47 million. According to the statistical bulletin of Zhejiang state economic and social development 2007, per capita gross domestic product is $4883 (middle rate is 7.604). Urban per capita disposable income is $2706 and rural per capita net income is $1087, both the highest in China.

Based upon its multi-mountain area and the fact that it is a comprehensive area of high output, many Zhejiang products, especially non-timber forest products (NTFPs), occupy important positions nationwide including citrus, tea, bamboo shoots and waxberry productions. NTFPs play an important role in rural economic growth and farmers' revenue increase. For example, the output value of bamboo shoots is more than 20% of gross agricultural output value in Lin'an since 2000(Lin'an Forestry Bureau, 2006). More than 50% of rural farmers' net income comes from citrus in Linhai county and Huangyan county. Farmers in Yuyao county obtain more than 30% income from waxberry while Kaihua farmers obtain more than 50% net income from tea. A key issue in NTFPs development is the competitiveness of different products or the same product in different regions.

Citrus has the largest growing area and production. Tea is one of the most important characteristic products of Zhejiang. Bamboo shoots are the most famous products while Waxberry is a special local product of Zhejiang that has had rapid growth in recent years. Thus, this paper will analyze these four productions. Table 1 is a summary of the main NTFPs in Zhejiang province.

Table 1. The quantities and ranks of Zhejiang's main NTFPs (thousand tons, %)

	Citrus	Tea	Bamboo shoots	Waxberry
Total	14057.60	823.40	4312.25	-
Zhejiang	1725.03	138.58	1480.50	242.50
Ratio	12.27	16.83	34.33	-
Rank	3	2	1	1

Source: China's Agricultural yearbook and Zhejiang's rural yearbook, 2003-2006
Note: the data are averages of yields among 2002-2005; the total yield of waxberry in China is absent.

Data used for the estimation comes from various sources. They include:

a. The output of NTFPs production from the publication entitled Zhejiang Noncun Tongji Nianjian (Zhejiang Rural Yearbook) and Statistic Yearbooks of the local counties 2003-2006.
b. The areas of NTFPs production. The total area of Zhejiang from Forest Assessment Report of Zhejiang, the others from Statistic Yearbooks and Forestry Bureau of the local counties.

In order to reduce the impact of weather and other random disturbances, 4-year (2002-2005) averages of yield and growing areas are used in calculating EAI, SAI and AAI. Table 2 shows the analyzed NTFPs and their counties.

Table 2. NTFPs and the counties

NTFPs	**Counties**
Citrus	**26 counties**: Linhai, Changshan, Kecheng, Qujiang, Xiangshan, Liandu, Huangyan, Jiande, Sanmen, Chun'an, Wenling, Jiangshan, Lanxi, Qingtian, Jindong, Longyou, Ninghai, Songyang, Yuhuan, Wucheng, Yueqing, Jiaojiang, Fenghua, Ouhai, Tiantai, Beilun
Tea	**34 counties**: Shengzhou, Chun'an, Zhuji, Anji, Shaoxing, Xinchang, Kaihua, Songyang, Suichang, Yuyao, Jiande, Lin'an, Wuyi, Tonglu, Taishun, Yuhang, Pan'an, Changxing, Ninghai, Shangyu, Dongyang, Jinyun, Pujiang, Wucheng, Fuyang, Tiantai, Jiangshan, Longyou, Lanxi, Xiangshan, Beilun, Fenghua, Yiwu, Deqing
Bamboo shoots	**27 counties**: Anji, Lin'an, Longquan, Qingyuan, Suichang, Fuyang, Qujiang, Deqing, Longyou, Yuhang, Yinzhou, Fenghua, Shengzhou, Tonglu, Liandu, Wuxing, Yuyao, Songyang, Ninghai, Pingyang, Chun'an, Shaoxing, Xinchang, Zhuji, Kaihua, Changxing, Shangyu
Waxberry	**24 counties**: Xianju, Xiangshan, Qingtian, Yuyao, Huangyan, Cixi, Rui'an, Dinghai, Linhai, Ninghai, Yongjia, Lanxi, Yueqing, Wenling, Jinyun, Shangyu, Longwan, Pingyang, Ouhai, Fenghua
Total	**60 counties**

Methods

The NSP, DRC and DRCC only use production and cost data. They do not consider many factors, such as social and cultural factors, which may have some impact on producers' decisions and hence should be considered as a part of regional comparative advantage. For a small region, these factors are not important as a certain degree of homogeneity is likely to exist. But this cannot be assumed to hold for the Zhejiang province. Therefore, this study uses a set of comparative advantage indices, which include Efficiency Advantage Index (EAI), Scale Advantage Index (SAI), and Aggregate Advantage Index (AAI) to measure the relative yield, scale and overall advantage of NTFPs within Zhejiang province, China.

Efficiency Advantage Index (EAI)

EAI is an indication of how efficiently an NTFP grows in one specific region. It is calculated by using the relative yield of a specific NTFP in a region divided by the average yield of all NTFPs in that same region, over the province's average yield for that specific NTFP divided by the province's average yield for all NTFPs. The EAI equation is expressed as:

$$EAI_{ij} = \frac{Y_{ij} / Y_i}{Y_{nj} / Y_n}$$

Where:
EAI_{ij} = the Efficiency Advantage Index of the *j*th NTFP in the *i*th region;
Y_{ij} = the yield of the *j*th NTFP in the *i*th region;
Y_i = the average yield of all NTFPs in the *i*th region;
Y_{nj} = the provincial average yield of the *j*th NTFP;
Y_n= the provincial average yield of all NTFPs.

If $EAIij > 1$, then the yield of the *j*th NTFP in the *i*th region, relative to all other NTFPs growing in that same region, is higher than that of the provincial average. It can be interpreted that, in the *j*th region, there is a yield or an efficiency advantage in growing the *i*th NTFP, and vice versa. It can be interpreted, as in the *j*th region, that there is no yield or efficiency advantage in growing the *i*th NTFP.

By assuming a competitive market structure, no significant barriers for technology diffusion, and adoption in agricultural production in the country, EAI*ij* can be taken as an indicator of relative efficiency due to natural resource endowments and other local economic, social and cultural factors. As such, it could be used as an indicator of comparative advantage as well (Zhong et al, 2000).

Scale Advantage Index (SAI)

The SAI indicates the extent of concentration of a certain NTFP growing in a region, relative to that of the same NTFP growing in the province. The equation for SAI is expressed as:

$$SAI_{ij} = \frac{S_{ij} / S_i}{S_{nj} / S_n}$$

Where:
SAI_{ij} = the Scale Advantage Index of the *j*th NTFP in the *i*th region;
S_{ij} = the grow area of the *j*th NTFP in the *i*th region;
S_i = the total grow area of all NTFPs in the *i*th region;
S_{nj} = the total grow area of the *j*th NTFP in the province;
S_n= the total grow area of all NTFPs in the province.

If the SAI_{ij} >1, then the degree of concentration of the specified NTFP growing in that certain region is higher than the average concentration ratio in the province. It is an indicator that producers in that region prefer to grow more of that specific NTFP compared to other producers in the province, and vice versa.

Assuming a competitive market structure is in place and producers are able to adjust their NTFP mix quickly to respond to market prices as well as cost changes, the concentration level is determined by economic and profit level factors of a certain NTFP's growth in the region.

A low SAI value implies producers are not willing to increase their share of that NTFP's production in that region. This may be because the NTFP is less profitable than others or the region may be restricted by natural or other conditions. On the other hand, a high SAI value implies producers want to increase their share of that NTFP's production in that particular region.

Aggregate Advantage Index (AAI)

The AAI is an aggregate indication of the overall comparative advantage of a certain NTFP in a specific region, relative to the province average. It can be calculated as the geometric average of the EAI and SAI. The equation is expressed as:

$$AAI_{ij} = \sqrt{EAI_{ij} * SAI_{ij}}$$

If AAI_{ij} >1, the certain NTFP in that specific region is considered to have an overall comparative advantage over the province average, while AAI_{ij}<1 indicates that the NTFP production in a specific region does not have an overall advantage over the province's average (Young, 2006).

Results

<u>Regional comparative advantages for citrus</u>

Figure 1 is a summary of the calculation of comparative advantages for citrus. There are 7 counties which citrus share in growing areas increased more than 4% in the 26 analyzed counties.

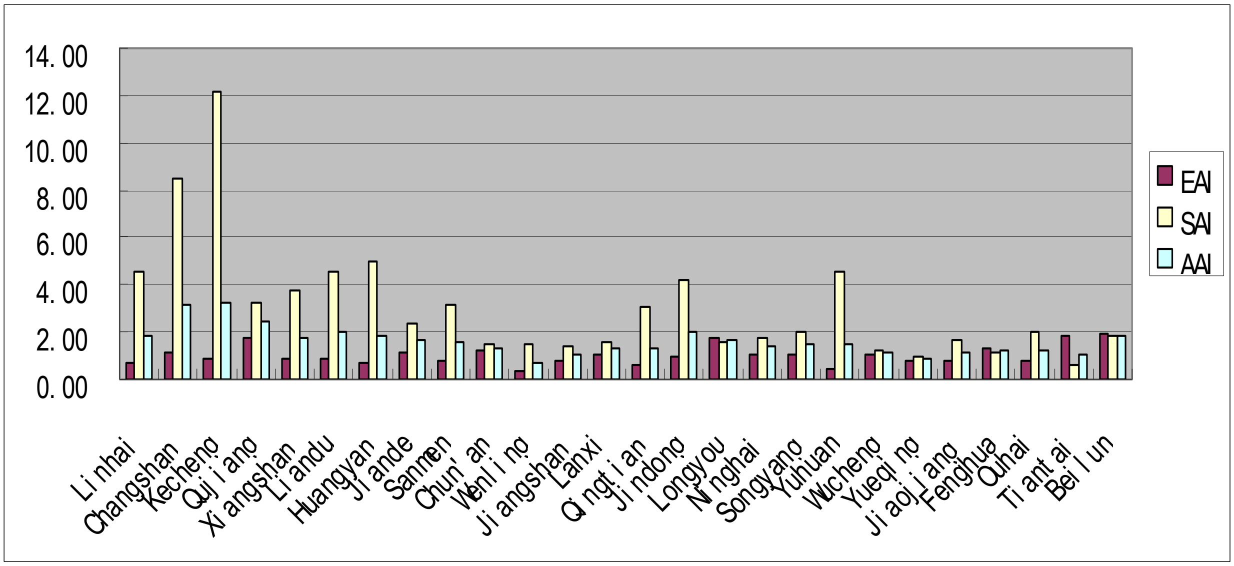

Figure 1. The comparative advantages for citrus

Source: Zhejiang's rural year book, 2003-2006 and some data from local forestry bureaus.
Note: the data are averages of outputs and grow areas among 2002-2005.

Among the 7 major counties, Changshan and Qujiang have comparative advantages as their EAI, SAI and AAI values all exceed 1. Although the other 5 major counties (Linhai, Kecheng, Xiangshan, Liandu and Huangyan) have scale advantages and aggregate advantages, their EAI values are lower than 1. It seems that these counties have some problems in improving their efficiency.

Among the other 19 counties, 9 counties (Jiande, Chun'an, Lanxi, Longyou, Ninghai, Songyang, Wucheng, Fenghua and Beilun) have comparative advantages as their EAI, SAI and AAI values all exceed 1 (see figure 1 for details). Owing to the citrus having the widest spread production, 14 among the 26 analyzed counties are not efficient with EAI values less than 1. Kecheng has the highest SAI and AAI, in spite of the EAI being low. Beilun has the highest EAI due to the low share in growing areas. Yueqing has no available comparative advantage.

<u>Comparative advantage in tea</u>

Because tea production is widespread in Zhejiang, there are only 4 counties where the growing areas exceeded 4% of the provincial total. Figure 2 shows a summary of the calculations of comparative advantages for tea. It can be seen that, of the top 10 counties, 8 of them (all except Kaihua and Yuyao) have comparative advantages. In the 26 counties which have aggregate advantage, the highest is Shengzhou with an AAI of 2.52. The highest efficiency region is Longyou with an EAI of 3.38, which is 2.38 times higher than the provincial average. At the same time, Longyou is one of the lowest scale advantage regions with an SAI of 0.57. Xinchang is the number 1 in scale advantage with an SAI of 3.64 (see Figure 2 for details).

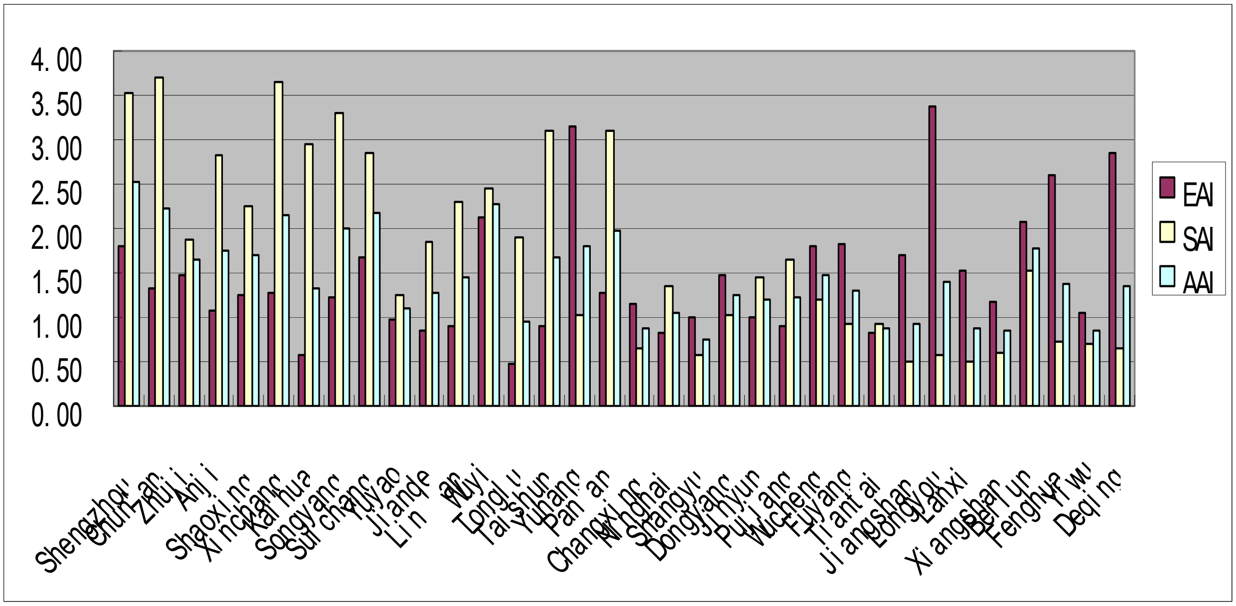

Figure 2. The comparative advantages for tea.
Source: Zhejiang’s rural year book, 2003-2006.
Note: the data are averages of outputs and grow areas among 2002-2005.

<u>Comparative advantage in bamboo shoots</u>

The comparative advantage in the Zhejiang province’s bamboo shoots production is rather significant, with 16 counties that have comparative advantages. Longquan also has a comparative advantage as its SAI and AAI values are greater than 1 and its EAI value is very close to 1. But there are still 3 (Qingyuan, Qujiang and Longyou) among 10 top producing counties that do not have comparative advantages. 19 counties among the 27 producing regions are considered to have an overall comparative advantage over the province average due to an AAI value of greater than 1 (see Figure 3 for details). Fenghua is the leading county in bamboo shoots production with an EAI of 2.74 and an AAI of 2.10, both of which are the highest indices. Meanwhile, Pingyang has the highest scale advantage with 1.66.

<u>Comparative advantage in waxberry</u>

Taking Zhejiang as a whole, waxberry production is obviously at an aggregate advantage as 21 counties have comparative advantages, with their AAIs being greater than 1 (see Figure 4 for details). There are 11 counties which have an efficiency advantage and 19 counties which have a scale advantage. When all the 3 indices are considered, only 8 counties – Huangyan, Cixi, Linhai, Yongjia, Lanxi, Yueqing, Pingyang and Fenghua – have comparative advantages. Although Anji County has the highest EAI, it does not have an obvious advantage due to its small growing area.

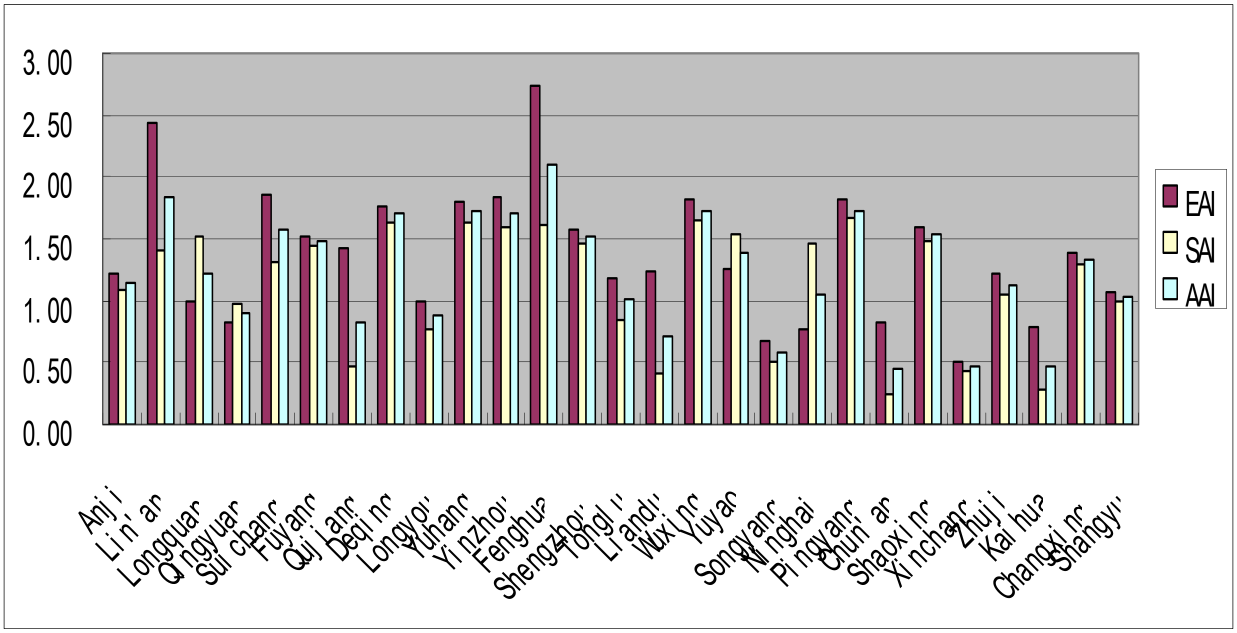

Figure 3. The comparative advantages for bamboo shoots.
Source: the output and areas of bamboo shoots are from Statistic Yearbooks and the Forestry Bureau of the local district and counties.
Note: the data are output and grow areas 2005.

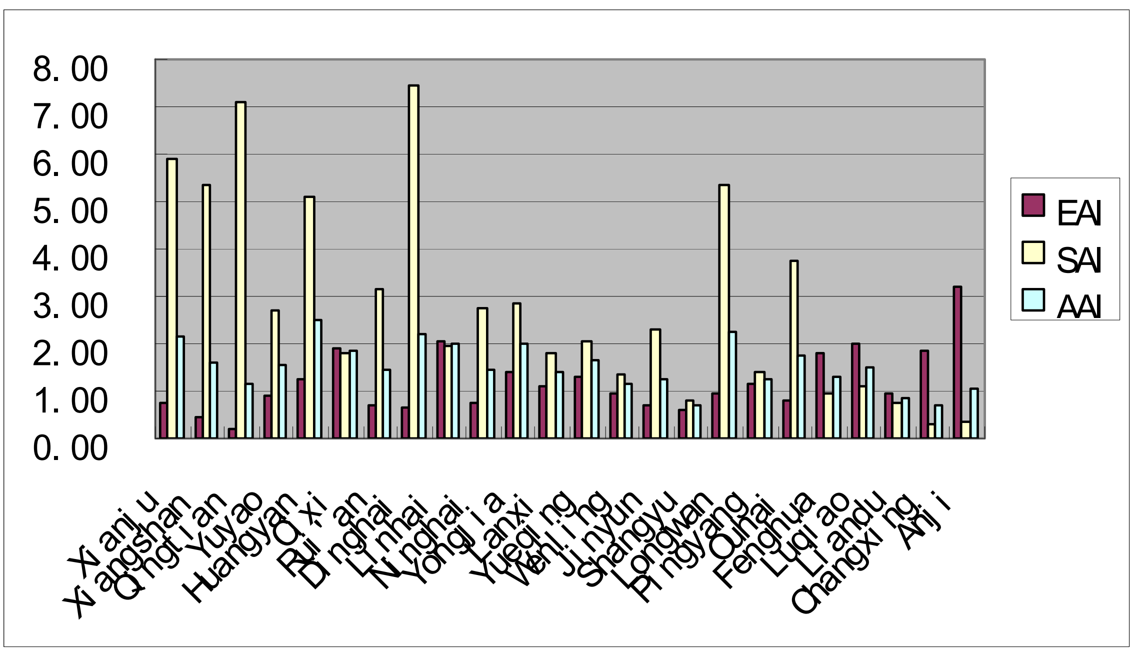

Figure 4. The comparative advantages for waxberry.
Source: Zhejiang's rural year book, 2003-2006 and some data from local forestry bureaus.
Note: the data are averages of outputs and grow areas between 2002-2005.

Conclusions

The above analysis clearly indicates that the comparative advantages in main NTFPs vary significantly across the Zhejiang province of China. It implies that there exists great potential to improve resource allocation and production efficiency.

The analysis also indicates that many counties in the Zhejiang province have a clear comparative advantage, even if some of them have a disadvantage in producing some NTFPs. This implies that they can take full advantage of their natural resources to enhance production and profits.

Owing to different data sources, especially the growing areas of bamboo shoots production, derived from different local forestry bureaus, the calculated results may not be very accurate. It only reflects the production with its source, which may have several uncontrollable factors that may cause the variability of these indices.

There are two topics that need to be considered in the future. One is what determines comparative advantage and the other is the advantage variation in these NTFPs between Zhejiang and the other provinces in China.

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AN ECONOMIC PERSPECTIVE ON THE DETERMINATION OF DUMPING IN THE US-CANADA SOFTWOOD LUMBER TRADE

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Abstract

The possibility of dumping by Ontario softwood lumber producers in the U.S. market, during the period of April 1996 to September 2006, is investigated from an economic perspective. The export softwood lumber market price to the Great Lakes region of the U.S. and the home market price of softwood lumber in Toronto, Ontario, are used for the analysis. When the price differentials fall between the upper and lower bounds of the Extra Transaction Cost (ETC), they are at the parity bounds, which implies that Ontario softwood lumber producers did not dump SPF lumber in the U.S.; when the price differentials fall below the lower bounds of the ETC, they are inside the parity bounds, which suggests that the market price in the Great Lakes is less than the market price in Toronto; and when the price margins fall above the upper bounds of the parity bounds model, they are outside the parity bounds, which implies that Ontario softwood lumber producers charged a higher price in the Great Lakes than in Toronto. The Enhanced Parity Bound Model (EPBM) is used to calculate the probabilities of these three parity regimes: at the parity bounds; inside the parity bounds; and outside the parity bounds, and the average positive/negative dumping margin. The analysis indicates that the industry gained considerably more profit from the U.S. market than from the home market, and the Ontario softwood lumber industry did not dump softwood lumber into the U.S. market during the study period.

[Abstract Only]

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DYNAMIC PATTERNS IN THE U.S.-CANADA FOREST PRODUCT TRADE

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Abstract

Forest products are an important component of the U.S. economy through consumption, investment, and trade. With rapid economic growth in several regions of the world and new trade liberalization policies, the volume and value of U.S. forest product trade has been increasing. The exchange rate has been commonly perceived as the most important macroeconomic variable affecting trade flows of forest products. U.S. forest industries competing internationally have argued strongly for depreciation policies, as this would presumably improve their competitiveness in the world markets. This study reports that deviations in the U.S. exchange rate contemporaneously affect exports and trade balances in selected forest product trade, while imports do not respond simultaneously to exchange rate innovations. However, a shock in the exchange rate has long-lasting effects on future forest product trade components. A shock in exports does not affect imports in the short run, but slightly affects import levels in the long-run. A shock in imports affects current and future exports with the re-exporting patterns.

Keywords: Vector autoregression, exchange rate, impulse response functions, lumber trade

Introduction

Forest products (e.g., wood, wood pulp, paper and paper board) are one of the important components of the U.S. economy through consumption, investment, and trade. With rapid economic growth in parts of the world, and with new trade liberalization policies, the volume and value of the U.S. forest product trade has been increasing. In this paper, I define forest product trade using Harmonized Schedule (HS) code 44 (Wood), 47 (Pulp of wood), and 48 (Paper and paperboard). Baek (2007) defines forest product trade based on the Bulk, Intermediate, and Consumer-Oriented (BICO) code. The different definitions yield different data and results associated with U.S. forest product trade. The exchange rate has been commonly perceived as the most important macroeconomic variable affecting trade flow of forest products. The U.S. forest industries competing internationally have argued strongly for depreciation policies, as this would presumably improve their competitiveness in the world markets. As quoted in Bolkesjø and Buongiorno (2006), representatives of the U.S. forest industries have called forcefully for policies that would decrease the value of the U.S. dollar. In fact, the U.S. forest product trade has been in a deficit since 1989 while the value of the U.S. dollar, on

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average, increased against the Canadian dollar in 1992-1995, 1997-1999, and 2000-2002. However, with the fall in the value of the U.S. dollar since 2002, the U.S. trade deficit in forest products has broadened to its peak in 2005 at about $17 billion dollar, up 56.14% from 2002. Therefore, the U.S. forest industry may slightly grasp the price advantage from depreciation exchange rate policies or there might be exogenous factors affecting the industries' competitiveness rather than the exchange rate.

Previous studies on the relationship between exchanges rates and international forest product trade have found different results. They mainly focus on the impacts of exchange rate changes on forest product trade volume and prices. The earliest empirical studies defined import price elasticity as the elasticity of import with respect to exchange rates (Adams et al. 1986; Buongiorno et al. 1979; Wisdom and Granskog 2003). Employing the vector autoregression (VAR) model, the previous studies have experienced no exchange rate effect on U.S. lumber imports from Canada between 1974 and 1985 (Buongiorno et al. 1988), only some short term exchange rate effects on Swedish and Finnish forest products exports to the U.S. (Uusivuori and Buongiorno 1990) and both short- and long-run exchange rate effects the U.S. forest product trade (Bolkesjø and Buongiorno 2006). With a descriptive method, McCarl and Haynes (1985) explain that exchange rates influence the softwood lumber trade between the U.S. and its trading partners. The authors summarize that an increasing exchange rate encourages imports and discourages exports into the country, which acts as an implicit import subsidy (tax) for foreign (domestic) producers.

Sarker (1993) finds no short-term effect, but a significant equilibrium relationship between Canadian lumber exports and the Canada–U.S. exchange rate. Jee and Yu (2001) include exchange rates in a multivariate cointegration model of U.S. demand for Canadian newsprint, and they find a significant long-run exchange-rate elasticity of -1.46, using monthly data from May 1988 to December 1996. Wisdom and Granskog (2003) conclude that exchange rates are an important determinant of southern pine exports because changes in exchange rates affect southern pine exports by changing the cost of southern wood in the foreign market. Only two studies have investigated the effect of changes in exchange rate on the U.S. forest product trade balance. Based on a descriptive method, Kaiser (1984) finds that the depreciation of the U.S. dollar is one of the most effective trade policies to increase U.S. forest products exports and thus to stabilize the U.S. trade balance. Baek (2007), on the other hand, adopts the autoregressive distributed lag (ARDL) approach to cointegration, which is to estimate quarterly bilateral trade data between the U.S. and Canada from 1989 to 2005. He also finds that in the short run a change in the value of the U.S. dollar is not a significant factor influencing the U.S. trade in forest products. To our knowledge, there is no related study discovering dynamic patterns of the forest product trade rather than offering the long run exchange rate effects on the U.S. trade value (Bolkesjø and Buongiorno 2006) or offering no exchange rates effects on the U.S. trade balance (Baek 2007).

This paper hypothesizes that there is a relationship between forest product trade (i.e. imports and exports or trade balance) and exchange rate. There are also interrelationships between imports and exports in forest products. This paper differs from those mentioned above in that the objective is to observe dynamic patterns of forest product trade using a structural model of disaggregated trade value. Because different categories of forest products may behave in different ways, analysis by category is important. In addition, an exchange rate shock may have an effect that plays out over several years. If so, then cross-section models without lags will underestimate the total effect of change in exchange rate. To mitigate this problem, we estimate VAR models for six selected categories of U.S.-Canada forest products imports, exports, and trade balance. Using various trade shocks and exchange rate shocks, this article exhibits impulse response functions (IRFs) that describe the response of imports, exports, and trade balance to exogenous shocks over several periods. Implications of this study could help policy makers to better understand the dynamic patterns in each forest product market. The remaining sections present the data, model, empirical results, and implications.

Data

The trade data employed in this article are monthly U.S.-Canada export and import values (in $1000 U.S. dollars) of selected forest products, from January 1989 to May 2007 (221 observations in each series), gathered from the database of Foreign Agricultural Service, United States Department of Agriculture (USDA). We selected the U.S.-Canada imports and exports in six categories based on the 4 digit Harmonized Schedule (HS). The detail of selected forest products is presented in Table 1. The exchange rate data, or value of Canadian currency in U.S. dollars, are monthly averages, compiled from the Federal Reserve Bank of St. Louis and Board of Governors of the Federal Reserve System. The exchange rates vary considerably from January 1989 to May 2007. In the model, the data are converted to a natural logarithm form.

To produce consistent estimates, the data must be stationary across time. Therefore we performed the Augmented Dickey-Fuller (ADF) unit root test for stationary testing. All data series are difference stationary where the error term in each series has white-noise properties tested with Ljung-Box’s Q statistics.

Model

The VAR model treats all variables as jointly endogenous. Each variable is allowed to depend on its past realization and the real past realizations of all other variables in the system. In addition, the most basic form of a VAR treats all variables symmetrically without making reference to the issue of dependence versus independence (Enders 2004). Although this VAR is not derived from any theoretical model, its tools (i.e. Granger causality, impulse response analysis, and variance decompositions) can be helpful in understanding the interrelationships among economic variables and in the formulation of a more structured economic model.

Table 1. Descriptive statistics regarding the data used in the analysis

Variable		Mean ($1000)	S.D. ($1000)	Min ($1000)	Max ($1000)
Wood sawn or chipped lengthwise, sliced or peeled (HS 4407)	Exports	36,516.62	7,769.62	17,767	55,814
	Imports	442,741.80	140,977.90	146,541	722,963
Sheets for veneer, for plywood or for similar laminated wood and other wood, sawn lengthwise (HS 4408)	Exports	7,697.55	4,533.36	1,251	16,534
	Imports	19,883.23	8,193.37	6,322	39,542
Particle board, oriented strand board (OSB) and similar board of wood or other ligneous materials (HS 4410)	Exports	4,873.08	2,143.37	1,198	10,971
	Imports	97,412.63	74,824.80	7,846	351,199
Chemical woodpulp, soda or sulfate, other than dissolving grades (HS 4703)	Exports	6,703.31	2,292.82	2,788	14,293
	Imports	159,512.60	33,376.79	96,307	261,258
Newsprint, in rolls or sheets (HS 4801)	Exports	1,529.17	1,023.28	184	4,300
	Imports	292,025.10	47,192.98	190,445	449,625
Uncoated kraft paper and paperboard, in rolls or sheets, other than that of heading 4802 or 4803 (HS 4804)	Exports	18,786.74	9,794.86	2,050	47,028
	Imports	25,151.01	9,335.72	3,222	42,997
Exchange rate (CAD/1 $U.S.)		1.3349	0.14	1.0951	1.5997

Suppose we have three variables, we can let the time path of each variable be affected by current and past realizations of each variable sequence. Consider the simple system with one lag:

$$x_t = b_{10} - b_{12}y_t - b_{13}z_t + \gamma_{11}x_{t-1} + \gamma_{12}y_{t-1} + \gamma_{13}z_{t-1} + \varepsilon_{xt} \quad (1)$$

$$y_t = b_{20} - b_{21}x_t - b_{23}z_t + \gamma_{21}x_{t-1} + \gamma_{22}y_{t-1} + \gamma_{23}z_{t-1} + \varepsilon_{yt} \quad (2)$$

$$z_t = b_{30} - b_{31}x_t - b_{32}y_t + \gamma_{31}x_{t-1} + \gamma_{32}y_{t-1} + \gamma_{33}z_{t-1} + \varepsilon_{zt} \quad (3)$$

where it is assumed that all left hand side (LHS) variables are stationary. The error terms, ε_{xt}, ε_{yt}, and ε_{zt}, are white-noise disturbances with standard deviations of σ_x, σ_y, and σ_z respectively and are uncorrelated white-noise disturbances.

Equations (1)-(3) are the structure of the system incorporating feedback. The LHS variables are allowed to contemporaneously and continuously (long run effect) affect each other. ε_{xt}, ε_{yt}, and ε_{zt}, are pure innovations (or shocks) in x_t, y_t, and z_t respectively. In addition, for example, ε_{xt} could have an indirect contemporaneous effect on y_t and/or z_t if b_{12} and/or b_{13} are not equal to zero.

Using matrix algebra, we can write the system in the compact form:

$$\begin{pmatrix} 1 & b_{12} & b_{13} \\ b_{21} & 1 & b_{23} \\ b_{31} & b_{32} & 1 \end{pmatrix} \begin{pmatrix} x_t \\ y_t \\ z_t \end{pmatrix} = \begin{pmatrix} b_{10} \\ b_{20} \\ b_{30} \end{pmatrix} + \begin{pmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{pmatrix} \begin{pmatrix} x_{t-1} \\ y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \\ \varepsilon_{zt} \end{pmatrix}$$

or $\mathbf{Bv_t} = \mathbf{\Gamma_0} + \mathbf{\Gamma_1 v_{t-1}} + \boldsymbol{\varepsilon}_\mathbf{t}$

where $\mathbf{B} = \begin{pmatrix} 1 & b_{12} & b_{13} \\ b_{21} & 1 & b_{23} \\ b_{31} & b_{32} & 1 \end{pmatrix}$, $\mathbf{v_t} = \begin{pmatrix} x_t \\ y_t \\ z_t \end{pmatrix}$, $\mathbf{\Gamma_0} = \begin{pmatrix} b_{10} \\ b_{20} \\ b_{30} \end{pmatrix}$,

$\mathbf{\Gamma_1} = \begin{pmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{pmatrix}$, $\boldsymbol{\varepsilon}_\mathbf{t} = \begin{pmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \\ \varepsilon_{zt} \end{pmatrix}$

Premultiplication by $\mathbf{B^{-1}}$ allows us to obtain the VAR model in standard form

$$\mathbf{v_t} = \mathbf{A_0} + \mathbf{A_1 v_{t-1}} + \mathbf{e_t} \tag{4}$$

In this paper, we estimate

$$\mathbf{v_t} = \mathbf{A_0} + \mathbf{A_1 v_{t-1}} + \mathbf{A_2 v_{t-2}} + \ldots + \mathbf{A_T v_{t-T}} + \mathbf{e_t} \tag{5}$$

where $\mathbf{v_t}$ is defined as the vector of variables with first difference of natural logarithms, and T is the total number of lags used in the model.

We test for the number of lags using Akaike's Information Criterion (AIC) and Schwarz's Information Criterion (SIC). The optimum lag length is twelve lags, which are necessary and sufficient to satisfy the requirement of independent and identical distribution in regression. In addition, a 12 month lag is enough to account for seasonal variations in trade. Therefore, we lose 13 observations for each data series by using 12 lags, so our final regressions are based on 208 observations. With the assumption of $\mathbf{e_t}$ and unrestricted VAR, we estimate the system of equations by ordinary least squares (OLS) equation by equation, which yields the same estimates as maximum likelihood method (Hamilton 1994). Briefly, six unrestricted VAR models were estimated with twelve lags of each variable and a constant term.

After estimating six VARs, we apply impulse response analysis to quantify and graphically depict the time path of the effects of typical shocks on imports and exports. In equation (5), a VAR can be written in the vector of Moving Average ($\boldsymbol{MA}(\infty)$) form as

$$\mathbf{v_t} = \boldsymbol{\mu} + \boldsymbol{\varepsilon}_\mathbf{t} + \mathbf{\Psi}_1 \boldsymbol{\varepsilon}_\mathbf{t-1} + \mathbf{\Psi}_2 \boldsymbol{\varepsilon}_\mathbf{t-2} + \ldots \tag{6}$$

A plot of the row i, column j element of $\mathbf{\Psi}_s$,

$$\frac{\partial v_{t+s}^{i}}{\partial \varepsilon_t^{j}} \tag{7}$$

as a function of s is called the impulse response function. It is a practical way to visually represent the behavior of each series in response to the various shocks. It describes the response of y^i_{t+s} to a one-time impulse in y^j_t with all other variables dated *t* or earlier held constant including whether it converges back to its long run trend, and if so, whether it converges smoothly or with oscillation (Hamilton 1994).

Empirical Results

Our task is to observe the behavior of forest product trade in each category in response to the various shocks using VAR and its application. An impulse response function traces the effect of a one standard deviation shock to one of the innovations on current and future values of the endogenous variables. Therefore, we could determine the impact multiplier (short-run effect) and the long-run multiplier (long-run effect) as the dynamic patterns in each endogenous variable. Because the variables in the VAR are stationary, a shock in the system would cause variables differentiating (if any) from the initial level. We hypothesize that a shock in the exchange rate that suggests an increasing exchange rate (CAD/ 1 $U.S.) from the initial level would discourage exports and encourage imports at least in the short-run, unless there are some factors more important than the effect of exchange rate to offset the response. The response of the exchange rate, exports, and imports to its own positive shock theoretically must be positive in the short-run.

This paper allows a shock in exports to affect imports and vice versa in order to observe the relationship between product transactions. Since the passage of NAFTA, international transactions between U.S.-Canada should be higher than in the past. Re-exporting behavior is expected in the short-run for some products. The notation of trade transaction variables includes the following: DLB1 = the different import value of product 1 in natural logarithms; DLS1 = the different export value of product 1 in natural logarithms; and DLEX = the different value of exchange rate in natural logarithms.

We impose a one standard deviation shock in each variable, which directly affects its own variable and is also transmitted to all of the endogenous variables through the dynamic structure of the VAR. In this paper, we compute all dynamic patterns in the disaggregated forest product trade response to various shocks as impulse response functions.

A shock to the exchange rate (Figure 1) shows that there is a positive short-run effect about 1.2% in the first month and then the different dynamic patterns with oscillatory long-run effect before adjusting to the steady state after 22nd month.

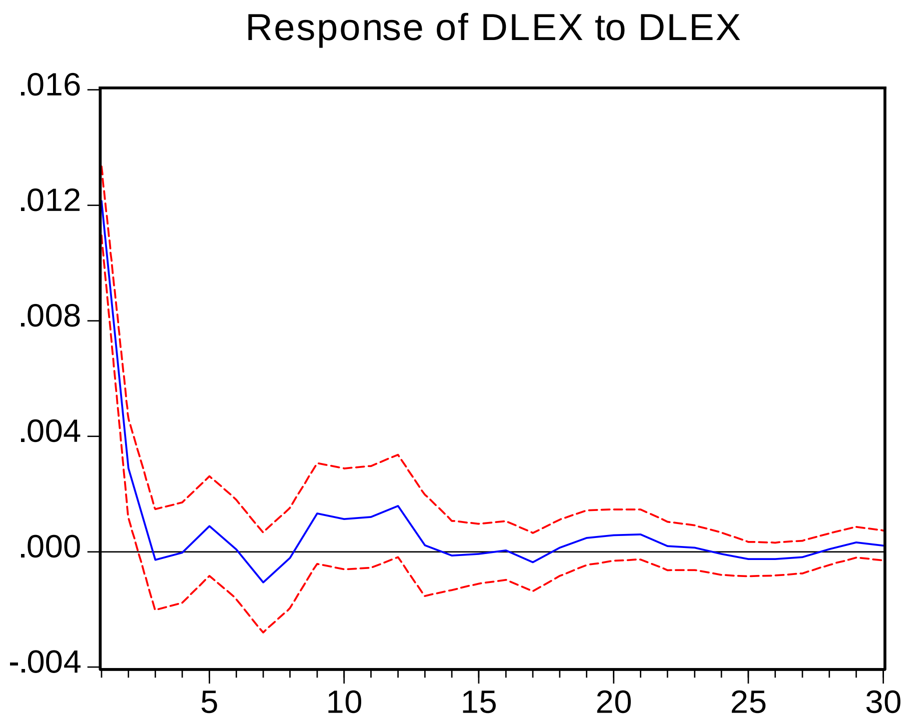

Figure 1. Impulse response functions in exchange rate

In this study, we find that a shock in exchange rate has no effect on imports in the short-run in all observed markets. These results are consistent to Bolkesjø and Buongiorno (2006), who found no statistically significant difference from zero for the same product estimated in the short-run. In addition, a shock in exports affects nothing in the level of imports. It means that any export promotion policies would not reduce significantly in the imports amount. In contrast, a positive shock in imports does affect a positive change in exports, which explains the availability of re-export pattern in the forest products industries.

Sawn wood or chipped wood market

In the sawn wood or chipped wood market, an own shock of imports or exports affects contemporaneously about 10% in the relative change for value of imports and about 8% for the value of exports. A positive shock in exchange rate would affect exports negatively about 1.2% in the short run. Impulse response functions present interesting information when we observe a shock in imports to exports and vice versa. In the short-run, there is no response from the imports to a shock in exports, while we observe about 4% change of exports response to a shock in imports. The pattern of re-export in this market confirms our hypothesis.

In the longer run, the effect to its own shock would be lower with no seasonal effects in the imports, but we observe seasonal effects in the exports even though they would be lower over time. The steady state could be reached after 30 months. The effects of the shock in exchange rate would take place in both trade transactions with different patterns. For the imports, we observe high fluctuation in the value for a year and the patterns will turn to the steady state after

18 months. We find slight oscillation patterns along the 30 months period response to a shock in exchange rate. For the cross shocks of imports and exports, there is a seasonal pattern for imports without the steady state trend, while a seasonal pattern for exports could be observed with diminishment in the relative change over time.

Veneer sheets and sheets for plywood

In the veneer sheets and sheets for plywood market, imports and exports response to its own shock is about 8% and 11% respectively. There is no short-run effect from the imports to a shock in exchange rate, while there is tiny short-run effect (less than 0.04%) from the exports to a shock in exchange rate. We observe no short-run effect from trade response to exchange rate in this market. A shock in imports shows the re-export patterns as the positive response to the shock of 2.7% however, imports did not respond to a shock in exports.

The long-run effects response to its own shock of imports and exports are quite similar, containing seasonal patterns and diminishing the effect over time. A shock in exchange rate would affect imports less than an oscillation of 1%, and there would be steady state (if any) beyond the 30 months period. For exports, the oscillation with seasonal effect could be observed and the effect would reduce over time with the expected steady state. The seasonal patterns would be lower after 24 months in the case of a shock in imports to exports, and there would be some fluctuation over time in the imports after a shock in the exports also.

Particle board market

In the particle board market, imports and exports respond to their own shock more than 12% in the short-run. A shock in exchange rate does not affect imports, but slightly decreases exports by about 0.3%. A shock in exports does not affect imports in the short-run, while a shock in imports supports a slight increase in the exports about 0.9%.

Imports and exports respond to their own shock. They all decrease below the initial level in the first 5 months before having oscillation patterns and tending to the steady state after 30 months. In the case of a shock in exchange rate, there would be some fluctuation in the imports and exports over time. The imports tend to reach a steady state after 30 months, and exports tend to reach a steady state after about 22 months. Both imports and exports respond to the cross shocks in the oscillation patterns, and tend to become steady after 30 months.

Chemical wood pulp market

There would be a positive response to an increase in various shocks, but there is no effect in the imports to a shock in exchange rate and exports. Each individual shock would increase imports and exports by more than 8% and 15% respectively. A shock in exchange rate would increase only exports by about 1%. A shock in imports again, confirms the re-export hypothesis with an increase of about 7.4% of exports.

Even though the response to its own shock of imports takes about 22 months to become steady, imports and exports, in general, tend to reach a steady state after 15 months responding to the shocks. The dynamic patterns in this market are the shortest period among the markets in this study.

Newsprint, in rolls or sheets market

In this market, imports and exports respond contemporaneously to their own shock at about 5% for imports and almost 30% for exports. There is no effect in the short-run for imports if we impose either a shock in exchange rate or a shock in exports. We observe a negative short-run effect on exports when we impose a shock in exchange rate, but a positive short-run effect when we impose a shock in exports.

The dynamic patterns for an import's response to its own shock contain lower seasonal effect over time and could reach a steady state after 30 months. The dynamic patterns for exports show no evidence of seasonal effect, and a steady state could be reached after 30 months. We observe the steady state in exports after a shock in exchange rate or a shock in imports. The effects from either shock last about 15 months. For imports, the long-run effect reaches a steady state after 30 months with different patterns. We find more oscillation patterns of import response to exports than response to exchange rate.

Uncoated kraft paper and paper board, in rolls or sheets market

In the kraft paper and paper board market of the study, imports and exports respond simultaneously to their own shock about 10% of the time. Imposing a shock in exchange rate or exports has no effect on imports in the short-run, but there is a positive effect in exports response to each shock of about 0.4% and 3% respectively. We observe the re-export pattern in this market.

For its own shock, imports and exports oscillate positively and negatively at 2% of the initial level for 16 months before reaching the steady state. In the response to a shock in exchange rate/imports/exports, imports and exports would turn to a steady state faster than other markets, with the starting point at 15 months.

U.S. trade balance

To examine the dynamic effects of exchange rate changes on the U.S. trade balance, we can simplify equations (1)-(5) from 3 dimensions (e.g., a 3×3 matrix) into 2 dimensions (e.g., a 2×2 matrix). We define the U.S. trade balance as the ratio of imports to exports for each product group with Canada. Because the U.S. trade balance in each period informs us about a trade deficit, we observe the dynamic patterns between the trade deficit in each market and the exchange rate. Then, using a similar method of estimation, we can plot the IRFs for the trade balance in each product to the shock of exchange rate. With the VAR, we could observe contemporaneously and continuously the responses of trade deficit and exchange rate in each market. However, we do not know a priori that how much the trade surplus would be after a shock in the case that we have a positive relationship in the short-run for each VAR. We could observe only the direction of the responses not the quantified amount. All information is presented in Figure 2.

In the short-run, imposing a shock in exchange rate, we find that there contain positive and contemporaneous effects in every market. The observed positive direction means that a positive shock in exchange rate would deteriorate the trade deficit. On the other hand, depreciation policies would slow down the problem of trade balance deficits in some levels. However, these results could not guarantee the competitiveness of the industries under depreciation policies. Based on the previous computation, the improved short–run trade balance deficit came from the positive side of exports extension only. Therefore, there is no evidence that depreciation policies would improve the competitiveness in the forest product trade, but only reduce the trade deficit in the first five markets or increase some value of exports. In the long run, all dynamic patterns would alternate in sign and start turning to a steady state at 15 months, except for sawn wood at 30 months.

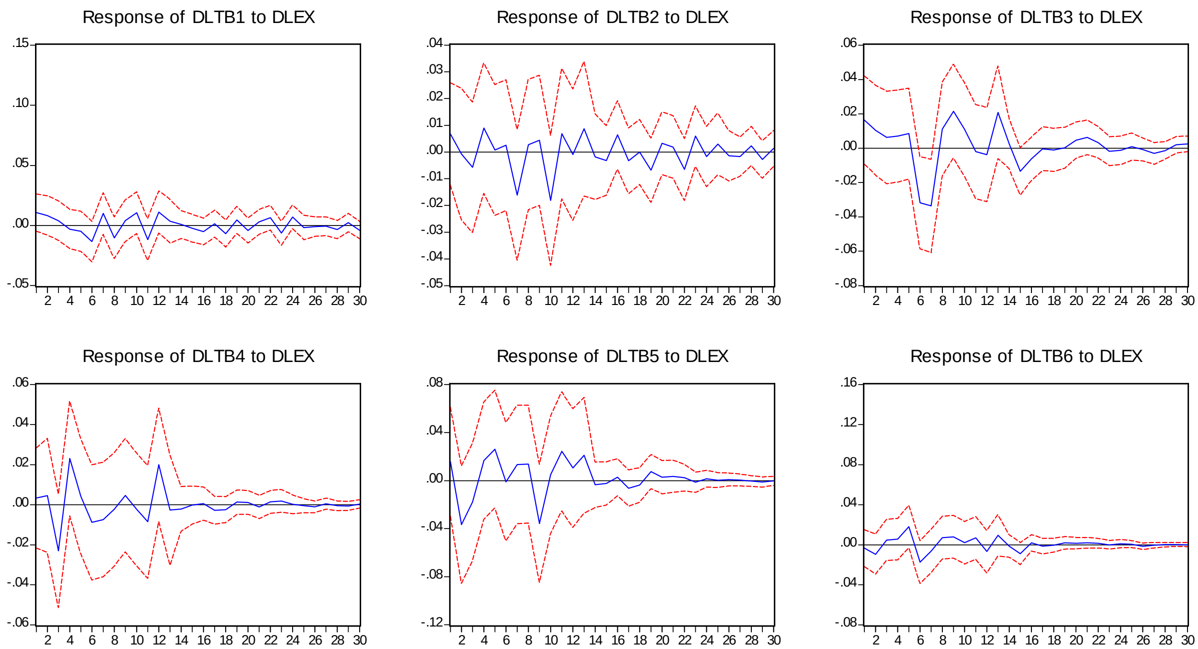

Figure 2. Impulse response functions of the U.S. trade balance

Implications

In this article, we consider the possibility that changes in exchange rate, imports, and exports affect trade transactions in forest product markets, not only contemporaneously but also over time. We present impulse response functions (IRFs) that describe the response of imports, exports, and trade balance deficits to exogenous shocks in exchange rate and related components. Because various categories of forest product trade may behave differently, analysis by category is important; aggregation may obscure significant responses within categories. We examined six forest product trades, sawnwood, veneer sheets, particle board, chemical pulp, newsprint, kraft paper, and paper board, under the Vector Autoregression (VAR) using the monthly data of U.S.-Canada bilateral trade.

We find that these data series are different stationary, suggesting that shocks to exchange rate or endogenous variables do not lead to permanent changes in the imports or exports. Our IRFs reveal significant dynamic responses to changes in exchange rate or trade components as those variables return to their initial levels following a shock. Furthermore, the effects persist for several years. These dynamic responses suggest that theoretical models of international trade or related policies may be incomplete if they cannot explain the dependence of current trade components on the history of past exchange rate as well as on past imports, exports, or the trade balance.

In the case of the imports and exports model, we find that exchange rate does not affect U.S. imports in the short run. This finding substantiates the results of Buongiorno et al. (1988) and Bolkesjø and Buongiorno (2006). In contrast, exchange rate affects U.S. exports in the short run. This information is consistent with Bolkesjø and Buongiorno (2006). In addition, we discover the latest information that exports do not affect imports in the short-run, while imports affect exports. It implies that there is re-exporting patterns in the U.S. forest product trade. For the trade balance, we find little positive effect of the U.S.–Canada trade in five forest products, which is in contrast to Baek (2007). This implies that, in the short-run, a change in the value of the U.S. dollar slightly influences the U.S. trade in forest products, but is not a major factor to improve trade balance or competitiveness. This study finds that the exchange rate plays an essential role in determining the long-run behavior of the U.S. trade in forest products. This result substantiates the results of Kaiser (1984), Adams et al. (1986), Sarker (1993), Bolkesjø and Buongiorno (2006), and Baek (2007). These results yield two conclusions: 1) past information or lag of forest product trade variables matters to predict current and future forest product trade variables, and 2) the dynamic patterns of these intertemporal patterns may assist policy makers and decision-makers in better understanding the future effects of current decisions especially for depreciation policies or trade protection policies.

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EXCHANGE RATE VOLATILITY IMPACTS ON EXPORT VOLUME AND PRICE OF U.S. FOREST PRODUCTS

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Abstract

We estimated the relationship between exchange-rate volatility and export volume and prices with an Autoregressive Distributed Lag (ADL) model using monthly bilateral U.S. export data of eight forest products to nine countries. The exchange-rate volatility was measured as a GARCH (1, 1) process. The impact of exchange rate volatility on export volume and prices was measured by short-run and long-run multipliers. The exchange rate volatility tended to have a negative effect on the export volume and prices when the exchange rate volatility of the importing country was large within the study period. The effect was mainly positive when the volatility was small.

Keywords: GARCH, conditional variance, international trade, forest sector

Introduction

Exchange rate fluctuations bring uncertainty to international traders, thus they might influence the volume and prices of forest products. Many theoretical and empirical papers deal with the effects of increased exchange-rate volatility on international trade, but fail to reach a consensus (Bahmani-Oskooee and Hegerty 2007).

The earlier theoretical models generally assume that higher exchange-rate risk lowers the expected revenue from trade and that risk-averse international traders respond to exchange-rate risk by favoring the domestic market. Therefore, an increase in exchange rate volatility reduces the volume of international trade (Clark 1973).

Ethier (1973) showed that in the presence of well-developed forward markets, if firms have knowledge, their revenues depend on the future exchange rate. Thus by adjusting the forward contrast cover, the effect of the exchange rate volatility could be negligible.

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Export can also be considered as an option held by firms (Franke 1991). The value of the real option to export can rise with volatility. Higher exchange rate volatility increases the potential gains from trade, therefore the trade volume increases.

Hooper and Kohlhagen (1978) suggests that the effect of exchange rate volatility on price depends on who bears the risk. The exchange rate risk has a positive effect on the price when the trading contract is invoiced in the importer's currency so that it is the exporter who bears the exchange rate risk; and a negative effect when the contract is invoiced in the exporter's currency so that it is the importer who bears the exchange rate risk.

Autoregressive conditional heteroskedastic (ARCH) models are useful to measure exchange rate volatility (Diebold and Nerlove 1989). Bollerslev (1986) extends the ARCH model to a multivariate generalized autoregressive conditional heteroskedastic (GARCH) model, which involves the lagged variance as well as lagged squared residuals.

There are few such studies on the effects of exchange rate risk within the forest sector. Yet, it is worth investigating trade by sectors because each sector reacts differently (Rapp and Reddy 2000). A greater understanding of this relationship for forest products could provide useful information for analysts and decision-makers.

Most studies within the forest sector have focused on the effect of the exchange rate level on trade. But, Sun and Zhang (2003) address the impact of exchange rate volatility on total U.S. exports of four forest commodities. They find that exchange rate volatility has a negative effect on U.S. exports in the long term, but short-term dynamics vary by commodity. They measure exchange rate volatility by the standard deviation of the growth rate of real effective exchange rate of the U.S. dollar.

The objective here was to test the effect of exchange rate volatility on export volume and prices of exports of many different forest products from the United States to several countries.

Methods

For each forest commodity and country, the following Autoregressive Distributed Lag (ADL) models were developed:

$$\ln p_t = a_0 + \sum_{i=0}^{n} d_{pi} \ln h_{t-i} + \sum_{i=1}^{n} a_{pi} \ln p_{t-i} + \varepsilon_{pt} \quad (1)$$

$$\ln x_t = b_0 + \sum_{i=0}^{n} d_{xi} \ln h_{t-i} + \sum_{i=1}^{n} b_{xi} \ln x_{t-i} + \varepsilon_{xt} \quad (2)$$

where x_t is the U.S. export quantity of forest products during time period t; p_t is the export price; h_t the time-varying conditional standard deviation of the exchange rate. The ε's are white noise. n is up to 12 months.

Exchange rate volatility takes a form of GARCH(1,1) model (Kroner and Lastrapes 1993):

$$\Delta \ln s_t = c\sum_{i=1}^{m}\Delta \ln s_{t-i} + \varepsilon_{st}$$

$$\varepsilon_{st} \mid \varepsilon_{st-1} \sim N(0, h_t^2)$$

$$h_t^2 = \gamma_0 + \gamma_1 \varepsilon_{st-1}^2 + \gamma_2 h_{t-1}^2 \qquad (3)$$

where s_t is the foreign currency price of the U.S. dollar; ε_{st} is normally distributed with mean zero and a time dependent conditional variance; the γ's and c are parameters to be estimated.

Equations 1 and 2 were estimated by Ordinary Least Squares (OLS). Equation 3 was estimated by Maximum likelihood. The number of lags in (1) and (2) was such that the residuals were white noise according to the Ljung-Box Q statistic. The Q test was also applied test for serial correlation in the mean and variance equation (3). Equation (3) was also tested for excess skewness and kurtosis.

Nominal, rather than real, exchange rates were used, but the results are not sensitive to this choice (Mark 1990). Valid inference using the GARCH model requires that the variables in the system be stationary (Greene 2003). If the series were found to have a unit root, they were made stationary by differencing.

The short-run, static, or impact multiplier of exchange rate volatility on, say, export volume shows the instantaneous effect of past and current changes in exchange rate volatility on volume. This short run multiplier is:

$$SRM_x = \sum_{i=0}^{n} d_{xi} \qquad (4)$$

The short-run multiplier of the price equation was obtained in a similar fashion.

The full long-run impact of change in exchange rate volatility on exports, denoted by LRM_x was derived from equation 2:

$$LRM_x = \frac{\sum_{i=0}^{n} d_{xi}}{1 - \sum_{i=1}^{n} b_{xi}} \qquad (5)$$

The standard error of the long-run multipliers was obtained from the variance-covariance matrix of the parameters.

Data

The export volume and export prices were for eight forest products at SITC-4 digit level, from January 1989 to November 2007, from the U.S. International Trade Commission (USITC) database. The importing countries were Canada, Mexico, Japan, Italy, Korea, Germany, the Netherlands, U.K. and Spain. Together, they account for 64% of total U.S. exports at 2007 export values in U.S. dollars. Among them, Canada, Mexico and Japan were the most important trade partners. The exchange rates were monthly averages of daily noon buying rates in New

York City, from the Federal Reserve Bank of St. Louis. For the European currencies that were replaced by the Euro in 2001, the Euro/U.S. dollar exchange rate was transformed to the original currency level with the conversion rates of 1999.

Results

All exchange rates series were nonstationary, and the first differences were stationary. For the exchange rate conditional standard deviation series, the ADF test results were mixed. The series with a unit root were differenced to achieve stationarity. Thus, all series in the estimation of equations 1 and 2 were stationary.

Table 1 shows the GARCH equation of the Canadian dollar exchange rate. In the mean equation, the exchange rate level is an AR (1) process. The conditional variance equation is an ARMA (1,1) process. Most of the GARCH estimations of other countries' exchange rate volatility take a similar form. For all the countries, there are significant GARCH and/or ARCH effects in the conditional variance equation. For some countries, the exchange rate level equation takes an AR(p) process (p>1). The obtained skewness and kurtosis of the standardized residuals and the standardized squared residuals from the mean equation show that all the residuals are normally distributed.

Table 1. GARCH (1,1) model of the Canadian dollar exchange rate

$\Delta \ln s_t = 0.22 \ \Delta \ln s_{t-1} + \varepsilon_{st}$	$Q(10) = 7.08$
$(0.07)^{***}$	$Q^2(10) = 20.09^{**}$
$h_t = 0.00002 + 0.17\,\varepsilon^2_{st-1} + 0.74\ h_{t-1}$	Skewness = -0.17
$(0.00001) \quad (0.08)^{**} \quad (0.12)^{***}$	Kurtosis = 0.26

***, **, *: significant at 1%, 5% and 10% significance level, respectively.

Figure 1 shows the graph of the Canadian dollar exchange rate volatility estimated from the GARCH model. The residuals from the mean equation of equation 3 are bounded by plus or minus the conditional standard deviation, h_t. These bands quantify the changing volatility of the exchange rate series residuals over time. After 2003, the conditional standard deviation bands are wide, indicating considerable volatility in the exchange rate regression error and thus considerable uncertainty about the resulting exchange rate forecasts. Therefore h_t is an appropriate measurement of the exchange rate volatility.

The exchange rate volatility of Canada was the smallest. The largest volatitity was observed for Mexico and Japan.

Table 2 shows the statistically significant short-run and long-run multipliers of the Canadian dollar exchange rate volatility on the volume and price of U.S. exports to Canada. The price multipliers are all positive, suggesting that exchange rate volatility increases prices, especially in the long-run. The effect of volatility on volume is strongest for uncoated paper and paperboard (641.2) in the long run. For a one percent permanent increase in the exchange rate volatility, the export volume of U.S. uncoated paper and paperboard exports to Canada increased by 2.13

percent in the long run. The negative effect on non-coniferous sawnwood was negative, but not economically significant.

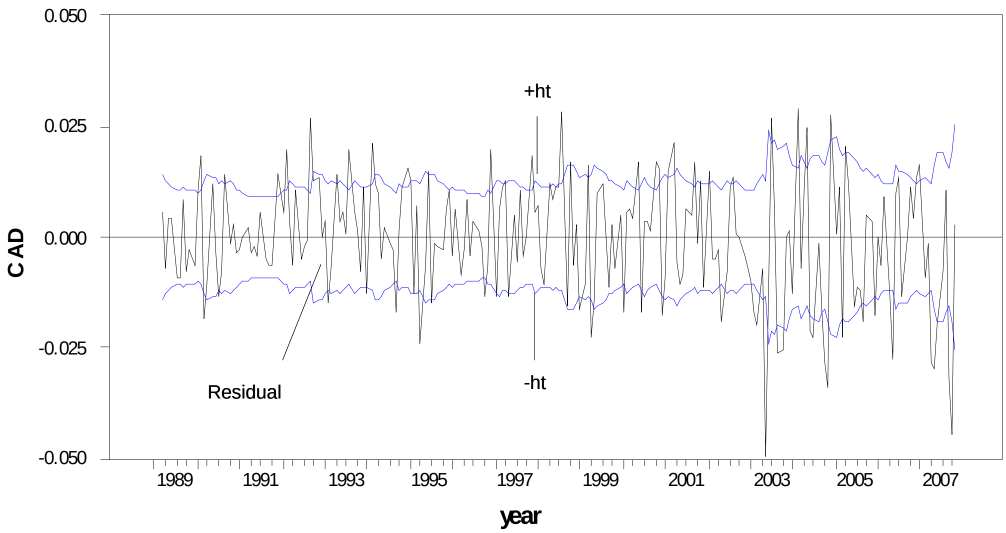

Figure 1. Residuals from the exchange rate level equation and GARCH (1,1) bands

Table 2. Short run and long run multipliers of the exchange rate volatility on the volume and prices of U.S. exports to Canada, for selected commodities

	Volume			**Price**	
Products (SITC code)	**SRM**	**LRM**		**SRM**	**LRM**
Coated paper, paperboard (641.7)				0.03*	0.02*
Coniferous wood in the rough (247.4)	1.35**				
Non-coniferous sawnwood (248.4)	-0.07**	-0.03**		0.03*	0.33**
Uncoated paper and paperboard,	0.14***	2.13***		0.03**	0.31**
for writing, printing (641.2)					

For the other two largest importers of forest products from the United States, Mexico and Japan, the SRMs and LRMs were mainly negative for both volume and prices. So were the results of Italy, South Korea, U.K. and Spain. Germany and the Netherlands were the two other countries besides Canada for which the multipliers were mainly positive, for both volume and prices.

Summary and Conclusions

The effects of the exchange rate volatility on the export volume and prices of U.S. forest products were studied with ADL models. The model was estimated with monthly export data of eight forest products exported to nine countries. The volatility of each country's exchange rate was measured with a GARCH (1, 1) model. The effect of the exchange rate volatility on export volume and prices were measured with short-run and long-run multipliers.

In many cases, the coefficients of lagged exchange rate volatility were significant. This suggests that exchange rate volatility does affect trade, with some delay. The time lag could stretch up to six months.

Exchange rate volatility tended to have a negative effect on export volume and prices to a country if that country's exchange rate had large volatility, such as for Mexico and South Korea. On the other hand, the exchange rate volatility tended to have a positive effect on export volume and prices to a country with relatively small exchange rate volatility, such as Canada, Germany and the Netherlands.

Acknowledgments

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LIFE CYCLE AND COST BENEFIT ANALYSES OF ETHANOL PRODUCTION FROM SLASH PINE (*PINUS ELLIOTTII)* PLANTATIONS

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Abstract

This paper considers potential cellulosic ethanol production from Southern slash pine (*Pinus elliottii*) plantations. The net energy balance (NEB), emissions and associated environmental impacts, unit cost of ethanol production, and associated changes to forest land values are calculated and preliminary results are given. The NEB is found to be positive at 2.2, meaning that for every unit of energy input to the system, 2.2 units of energy are obtained through the ethanol produced. Associated impacts are significant, but less so than the corn starch to ethanol production process. The unit cost of ethanol produced in the manner considered, a two stage dilute sulfuric acid hydrolysis, was found to be $0.44 per liter, greater than the current cost of production of ethanol from corn. The forestland values, demonstrated to increase under various degrees of ethanol production, were found to be negative under the maximum ethanol production scenario.

Keywords: Bioenergy, net energy balance, non-industrial private forests, two stage dilute sulfuric acid hydrolysis, unit cost

Introduction

By the year 2020, the total world energy consumption is projected to grow by 77% over 1990 levels, from 347.3 quadrillion BTUs in 1990 to 613.0 quadrillion BTUs in 2020 (EIA 2006). Over 85% of our energy supply comes from fossil fuel based energy resources like oil, coal, and natural gas (EIA 2006). The use of these fuels is linked to a host of environmental, economic, and political concerns. As outlined in the most recent report of the Intergovernmental Panel on Climate Change (IPCC), the occurrence of global climate change is considered to be driven by

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human influence through the release of carbon dioxide and other greenhouse gases (GHGs) into the atmosphere through the combustion of fossil fuels (IPCC 2007). The subsequent need for novel energy sources which can substitute for transport fuels like gasoline and diesel has driven much research in the area of renewable agriculture and forest based biofuels such as ethanol. Energy consumption by the transportation sector in the U.S. accounted for about 28.4% of total energy consumption in the country in 2006 (EIA 2006). In order to be a viable energy source and displace such fossil based transport fuels such as gasoline and diesel, biofuels must provide a significantly high energy yield and should be economically competitive with current fossil based alternatives.

Biomass currently represents nearly half of the renewable energy production in the United States, producing about 3% of the nation's total energy supply (EIA 2006). The potential for biomass to develop into a major energy source has been documented recently by the United States Department of Agriculture, which estimated that enough biomass is grown annually in the country to offset one third of current demand for transport fuels without interrupting food, feed, and export supplies (Perlack et al. 2005). Several studies have been conducted analyzing the environmental and economic impacts of utilizing various biomass sources for bioenergy production. Most of these suggest that, if managed properly, biomass sources hold the potential to meet a significant portion of our energy supply while achieving meaningful reductions in greenhouse gases (GHGs) and other pollutants as well as enhancing rural economies (Hill et al. 2006, Childs and Bradley 2008).

Based on this rationale, several government initiatives have been passed at the state, federal, and international levels encouraging the production of biofuels from various agricultural and forestry feedstocks. At the national level, President Bush signed the Energy Independence and Security Act of 2007, which includes a Renewable Fuels Mandate, calling for an increase in the supply of renewable fuel to 36 billion gallons by 2022 (EISA 2007). Although the policies discussed above are aimed towards increasing energy security and environmental benefits over fossil fuels, there is debate within the scientific community as to what extent biomass based fuel sources are beneficial towards these goals. The majority of biofuel in the U.S. is currently produced from corn starch. This scenario has led to concern over increasing corn prices and the so-called "food vs. fuel" debate. Additionally, the energy ratio of corn starch based ethanol has been questioned, being reported as 0.71 by Pimentel and Patzek (2005) and marginally greater by Hill et al. (2006) at 1.25. More recently, the impacts of land use change have been considered in calculating the net GHG emissions from biofuel production, indicating that the conversion of grasslands, peatlands, tropical forests, and other intact ecosystems to grow energy feedstocks far outweighs the GHG offsets of burning biofuels rather than fossil fuels (Searchinger et al. 2008). For these reasons, alternative ethanol feedstocks and conversion processes are under consideration to meet the goals set out by the President and U.S. government within the Renewable Fuels Mandate. In particular, the bill calls for 21 billion gallons of cellulosic ethanol production by 2022 (EISA 2007). Cellulosic ethanol can be produced from a wide variety of plant biomass, including species capable of growing on lower quality, also known as marginal, lands, crop residues, and woody biomass. This feedstock flexibility represents an opportunity to utilize lower valued materials for biofuel production without accelerating the conversion of intact ecosystems or increasing GHG emissions. This opportunity may also provide landowners with an expanded market for their agriculture and forest products.

The South is estimated to have more than 214 million acres of forest land, 91% of which is designated as timberland, land with enough productivity to make timber production possible (Weir and Greis 2002). In Florida, slash pine (Pinus elliottii) is the dominant forest species, covering approximately 5.1 million acres, or 34% of the total forestland in the state (Carter and Jokela 2002). Due to the diminished returns from thinnings and other small diameter wood, there can be less incentive for landowners to conduct this management practice. This leads to a situation in which forests can become overstocked, increasing the risk of wildfire, pest outbreak, and disease, while simultaneously decreasing the value of the dominant trees through competition for the nutrient resources of the soil (Nebeker et al. 1985). One alternative use of small diameter wood is as a cellulosic ethanol feedstock. The use of small diameter forest biomass in the U.S. Southeast region represents an additional opportunity to increase the health and profitability of forestlands, particularly for NIPF owners, as well as potentially provide a significant amount of feedstock for ethanol production.

This study addresses the potential of forest based biomass as a feedstock for ethanol production based on the net energy balance (NEB), total system emissions and associated environmental impacts, unit cost of ethanol production, and associated valuation of forestlands in the face of a biofuels market. Data for the analysis is based on current practices of nonindustrial private forest (NIPF) owners in the U.S. South and the two-stage dilute sulfuric acid conversion process of wood chips to ethanol. Results for the analyses are preliminary.

Methods

Life Cycle Analysis: Net Energy Balance

The ethanol production process was divided into the ten steps of: 1) Seed Orchard Management, 2) Transportation of seeds to Nursery, 3) Nursery management, 4) Transportation of seedlings to the plantation site, 5) Site preparation before planting, 6) Planting and plantation management (including thinning), 7) Harvesting, 8) Transportation of wood chips to ethanol mill, 9) Ethanol production at ethanol mill, and 10) Transportation of ethanol to gas station (Figure 1).

The total energy inputs in the form of diesel, gasoline, machinery and plant construction, propane, electricity, and chemicals required to produce one functional unit of ethanol at 10 identified steps were summed up to calculate total energy inputs of the system. The calorific value of ethanol (21.13 MJ/l) was multiplied with the total quantity of ethanol produced (1000 L) to calculate the total energy output of the system. Using the formula, [NEB = Output Energy/Input Energy], the required ratio was calculated for the system.

In the seed orchard stage, the processes considered were: collection of cones from the seed orchard, drying of cones in a two stage process, seed preparation through the various processes of de-winging, cleaning, size sorting, and weight sorting, and storage for 7 days in a cooler before they are transported to the nursery. At the nursery, the seeds are stored in a cooler for about 240 hours, then the stratification starts for which water use for the required number of seeds was calculated. Then seeds are kept in a cooler once again for 14 days, after which seeds are treated with fungicide and bird repellant, and finally the seeds are stored once more in a

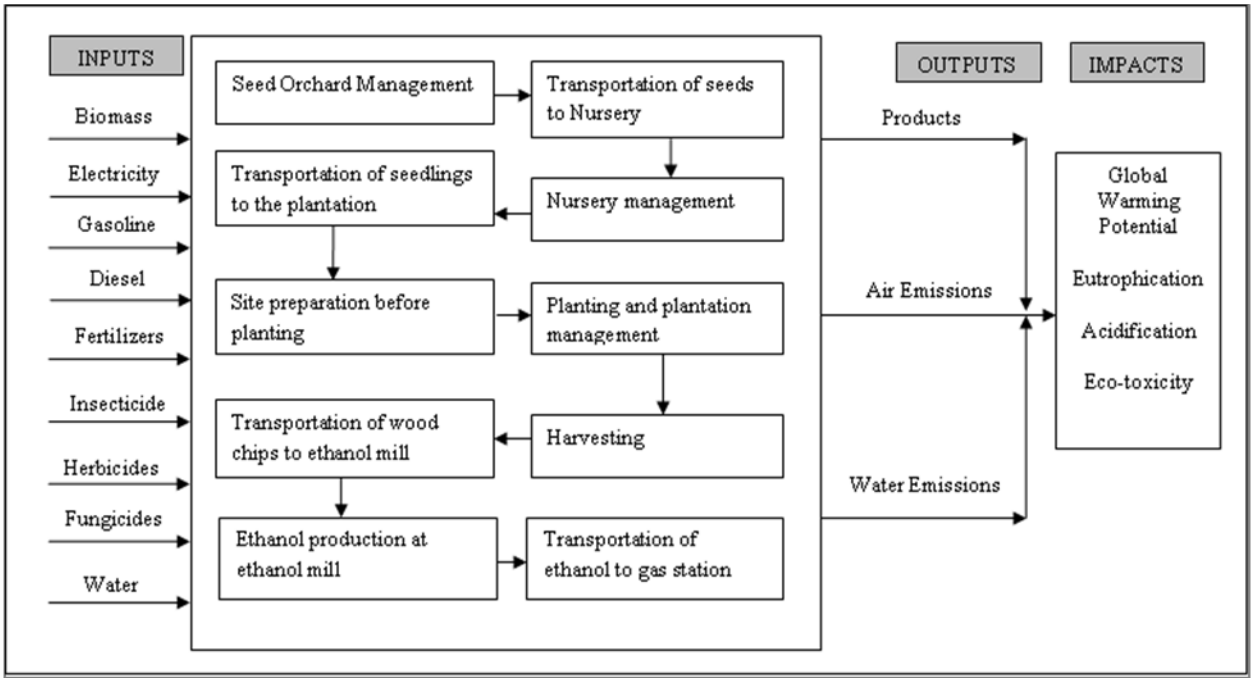

Figure 1. System boundary for life cycle analysis

cooler for 10 days before planting. The activities of site preparation, identified by interviewing stakeholders, were chopping, piling, burning, disking, bedding, and herbicide application. It was found that herbicide was used once to remove weeds before planting seedlings. The operations included in planting and plantation management are: seedling planting, fertilizer application, insecticide application, herbicide, prescribed burning and thinning.

Using a CRIFF model, the biomass availability at the time of thinning was found to be about 19 tons per acre. Assuming that only pulpwood and harvesting residues obtained at the time of thinning will be utilized for ethanol production, their available quantities on a dry mass basis per acre of land was calculated. Based on the total availability of dry biomass at the time of thinning, the total acreage required to produce sufficient quantities of wood chips for ethanol production was found. Total consumption of diesel and gasoline was calculated based on the total acreage required, fuel consumption, and machine use rates. It was assumed that wood available from the different forest products will be chipped on the site of harvesting/thinning once the required moisture content is achieved.

The technology used for converting slash pine wood chips into ethanol was a two stage dilute sulfuric process. The inputs and outputs associated with the production of ethanol from sugarcane bagasse are given by Kadam (2000). These ratios were used and were adjusted for slash pine to calculate quantities of total inputs and outputs. As the quantities of sugar that can be hydrolyzed to produce ethanol are different for different cellulosic feedstocks, the ethanol yield was found to be 236.7 l/dry ton of slash pine biomass at 15% moisture content for slash pine biomass. Lignin is produced during the conversion process of wood chips into ethanol. Lignin has a high calorific value (19.22 MJ/kg) and can be used in boilers for producing heat. The total electricity consumption required during the conversion process was subtracted from the total potential of electricity to calculate net electricity consumption of the ethanol mill. The total life time of an ethanol mill was considered to be 15 years (Solomon et al, 2007) and the capacity of a mill was taken to be 50 million gallons/year.

The total distance traveled by a tanker for making a round trip was taken as 300 miles or 480 km (*i.e.* 240 km for each direction). An assumption has been made that 70% of the gross weight of all machines is made up of steel. Average use rates and the fuel consumption rates for all the machines have been recorded after discussions with stakeholders. The total weight of the steel was allocated to the one functional unit. After allocating the exact steel used for every machine used in a step, the sum of the allocated steel was found for a particular step by summing allocated steel for each individual machine.

Life Cycle Analysis: Emissions and Environmental Impacts

Assuming that all the energy required for producing different materials will be in the form of electricity, the net emissions of the system due to energy and material use have been determined separately. The total electricity used was assumed to be supplied by the national grid. The production mix of the national grid, about 49%, 2%, 20% and 2.5% of the total electricity in U.S., is produced using coal, petroleum, natural gas and other renewable resources, respectively. The total energy consumed due to use of diesel and gasoline at every step was multiplied by the emissions factors. Similarly, total electricity consumption for every step was identified and was then multiplied by the emissions factors, with due adjustment to electricity mix of the nation. In this way, the total quantities of different pollutants generated due to energy use in the system were quantified.

Emissions of pollutants due to material use were also quantified. For fertilizer use, it was assumed that 5% of the total quantities of nitrogen, phosphorus and potassium fertilizers used in the system will end up as nitrate, phosphates and potash ions, causing water pollution. Similarly, fumigants, fungicides, herbicides and insecticides were also considered to be sources of pollutants. Biogas methane and carbon dioxide produced at the ethanol mill were also considered for quantifying emissions. Finally, emissions generated due to burning of lignin were included in the analysis. In this way, the total quantities of different pollutants generated due to material use in the system were quantified. Finally, both types of emissions were added to quantify the total quantities of different pollutants generated in the system. Based on the aggregated values of different pollutants, different environmental impacts of global warming, eco-toxicity, acidification and eutrophication, the impact factors of different pollutants as given by TRACI (Tool for the Reduction and Assessment of Chemical and other environmental Impacts) database were used (Bare et al., 2003).

Cost Benefit Analysis: Unit Cost Analysis

In order to assess the economic viability of ethanol produced from forest biomass, the cost of production per unit of ethanol was calculated. For the purposes of this analysis, the costs of production considered are ethanol mill construction costs (annualized over the lifetime of the plant), wages for all labor employed, delivered biomass feedstock, fuel, water, chemicals, and disposal of ash. The plant output capacity is assumed to be 50 million gallons per year (MGPY) with a production life of 15 years. The costs for feedstock, fuel, water, chemicals, and disposal are calculated based on the amounts of each input necessary per year to meet the plant capacity of 50 MGPY. The amounts of each input per 1000 L of ethanol produced are given in Table 1.

Table 1. Material and energy inputs and outputs per 1000 L of ethanol produced

Inputs	**Quantity**	**Units**	**Cost** ($/unit)	**Outputs**	**Quantity**	**Units**	**Cost** ($/unit)
Biomass	4.66	Ton	33.87	Ethanol	1000.00	L	varies
Hydrated lime	54.92	Kg	0.08	Gypsum	131.50	kg	0.03
Water	15171.36	L	0.00				
NH_3	105.62	kg	0.37				
Diesel	5.25	gal	2.88		NPV =	0.00	
H_2SO_4	202.79	kg	0.03		Rate =	0.10	
Electricity	1468.60	MJ	0.03				
Ash disposal	326.63	kg	0.02				

Delivered feedstock costs include stumpage value to NIPF owner, harvesting and chipping, transportation, and profit to logger. Stumpage value of harvest residues was estimated based on published rates (Perez-Verdin et al. 2008, Petrolia 2006) and through personal communication with Timber Mart-South at $5.00 per green ton. The total delivered cost based on these base case values was therefore determined to be $33.82 per green ton. This value is consistent with other estimates of delivered costs for small diameter pulpwood and fuel chips (Perez-Verdin et al. 2008, Petrolia 2006). The value of gypsum produced was considered as a co-product to be sold at the market rate of $30.00 per ton.

All costs and benefits were scaled up to the 50 MGPY capacity of the plant over the 15 year life of the plant to calculate the net present value (NPV) of the project. The NPV was calculated with the following formula:

$$NPV = \sum_{t=1}^{15}[(B_t * e^{-r*t}) - (C_t * e^{-r*t})]$$

where t is the year in which benefits (B) and costs (C) are incurred, and *r* is the discount rate. In this case a real discount rate of 10% was chosen based on Short et al. (1995). The unit cost of ethanol was computed by means of the Excel Solver software; the cell with the NPV output is constrained to equal $0.00 by allowing the input cell of the price of ethanol per liter to vary, which is linked in the Excel spreadsheet. Thus the "break even" cost of production per unit of ethanol was determined.

Cost Benefit Analysis: Forestland Valuation

Forest biomass calculations for above and below ground biomass were calculated. From these calculations the income to the forest owner was calculated based on the revenues from timber harvest and sale of biomass for ethanol production. Forest stand data were simulated using the growth and yield simulation program GaPPS 4.20. The total outside bark green weight was divided into the 4 product classes of residues, pulpwood, chip and saw, and sawtimber based on small end diameter (0.1", 2.0", 6.0", 8.0"), minimum length (0.1', 5.0', 8.0', 8.0'), and length increment (0.1', 1.0', 4.0', 8.0'), respectively.

Total costs (see Table 2) were based on Smidt et al. (2005), Andrew's Nursery, and personal communication with Natural Resource Planning Services, Inc. Costs were discounted to present values (PV) using the continuously discounted formula of:

$$FV = FV * e^{-r*t}$$

where FV is the future value, *e* is the base of the natural logarithm, *r* is the discount rate, and *t* is the year in which the costs are incurred. In this case a real discount rate of 5% was used. Values were then accumulated to arrive at a cumulative present value of costs every year from year 0 to 30.

Table 2. Costs associated with intensive slash pine plantation management in the U.S. South

	No.	Price	Cost	Year
Site prep	1	$323.00	$323.00	0
chopping/shearing	1	$50.00	$50.00	0
piling	1	$48.00	$48.00	0
burning piles	1	$60.00	$60.00	0
bedding	1	$105.00	$105.00	0
herbicides	1	$60.00	$60.00	0
seedlings	720	$0.06	$41.76	0
planting	1	$45.00	$45.00	0
fertilizer	1	$49.23	$49.23	5
herbicide	1	$62.04	$62.04	6
burning	1	$30.00	$30.00	11
tax rate (per year)	1	$7.00	$7.00	All

The value of the timber benefits to the land owner was determined using current South-wide averages for stumpage values per ton of pulpwood ($8.11), chip and saw ($18.88), and sawtimber ($36.59) obtained from Timber Mart-South (2008). The growth and yield data provided by GaPPS was divided into the four size classes shown in Table 1 for each year of the plantation from year 5 to year 30. The value of harvesting the stand for purely timber benefits was calculated in each year from year 5 to year 30 as well by multiplying the current price for the particular product class by the outside bark green weight contained within that size class as obtained through GaPPS. These values were summed with the costs associated with site preparation and silvicultural treatments to obtain the cumulative NPV of the stand in every year from zero to 30.

Land valuation was conducted for varying scenarios of biofuel feedstock production as a proportion of the total timber harvest, harvest residues and thinned material available in any given year. A stumpage value of $5.00 per ton was assumed for all biomass delivered to the ethanol mill. Six biofuel feedstock production scenarios were considered separately under each of the three stands: 1) no biofuel feedstock, 2) harvest residues only, 3) one quarter of pulpwood plus residues, 4) one half of pulpwood plus residues, 5) all pulpwood plus residues, and 6) full harvest plus residues. All pulpwood, chip and saw, and sawtimber not considered as biofuel feedstock are assumed to be sold in the market at the stumpage rates. The NPV in each year was then used to calculate the land expectation value (LEV), which returns the value of the stand under consideration assuming perpetual rotations. LEV was found by solving the following formula:

$$\text{LEV} = \frac{\text{NPV}}{1 - e^{-r*t}}$$

Where *e* is the base of the natural logarithm, *r* is the discount rate, and *t* is the rotation length. The LEVs were used to compare the different scenarios.

Preliminary Results

Life Cycle Analysis: Net Energy Balance

The net energy ratio was found to be 2.2 implying that for every joule of energy spent in producing ethanol, there is a net gain of 2.2 joules of energy. This is a higher net energy ratio than that achieved from ethanol production from corn grain (energy ratio of corn is 1.67) as reported by Shapouri and McAloon (2005). The total biomass required to produce one functional unit of ethanol was found to be 4224.83 kg. The distribution of total consumption of energy in the form of electricity, diesel, gasoline and propane for the whole system was analyzed and results are shown in Figure 2.

As observed from Figure 3, maximum electricity consumption occurs at ethanol production (Production) followed by the planting stage (Planting). Energy use due to diesel consumption was found to be highest for the transportation step TR-II followed by the Production step. The total energy due to gasoline and propane consumption was found to be approximately 1 and 1.5 MJ, respectively (gasoline is used only in the Planting and Site-prep steps while propane is used only in the Orchard step). This signifies that maximum energy is used at the Production step and least in the TR-IV step. When the obtained NEB was compared with other energy crops, the NEB from slash pine was quite impressive. For example, ethanol produced from corn and corn stover has an NEB of approximately 1.1 and 1.7, respectively (Lavigne and Powers 2007), which is significantly lower than the NEB of ethanol derived from slash pine.

Life Cycle Analysis: Emissions and Environmental Impacts

The total amount of carbon dioxide generated during the whole process was about 5970 kg, and nearly all (97.5%) was generated at the Production step. Total quantity of biomass required was about 4,225 kg and assuming that the biomass has 50% carbon, the total carbon sequestered in the above ground biomass was found to be 2112.4 kg. The total carbon present in produced carbon dioxide was about 163 kg. This implies that net carbon sequestered in the system is positive.

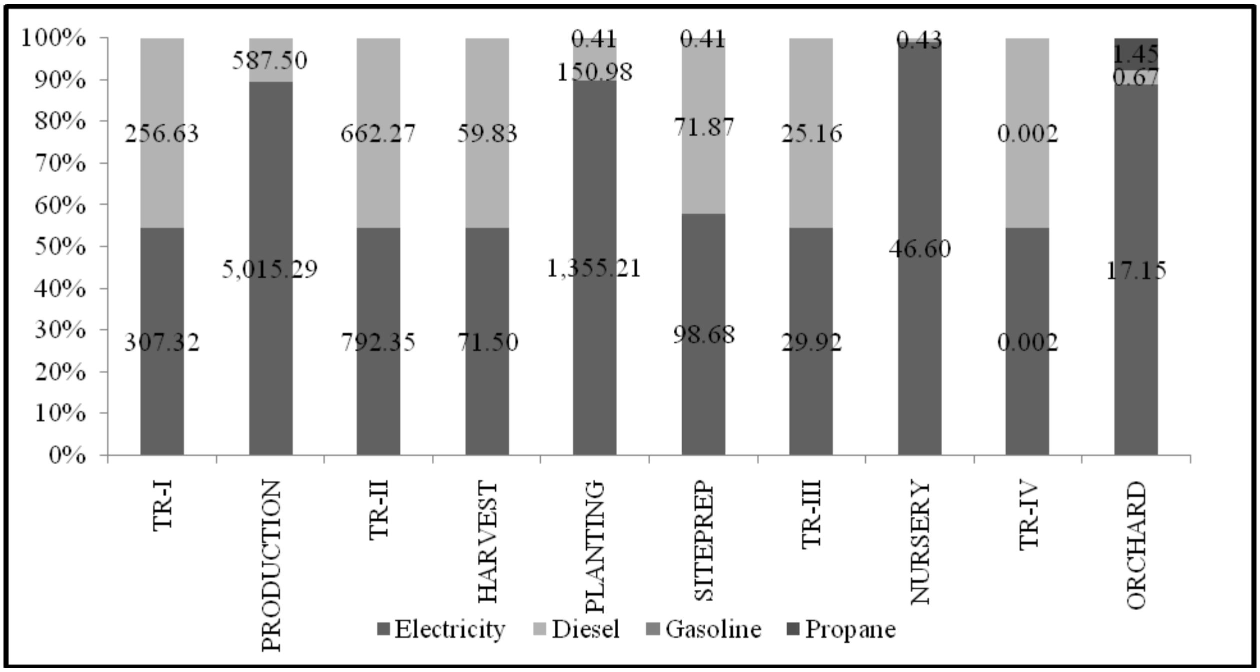

Figure 2. Energy use at different steps of the system.

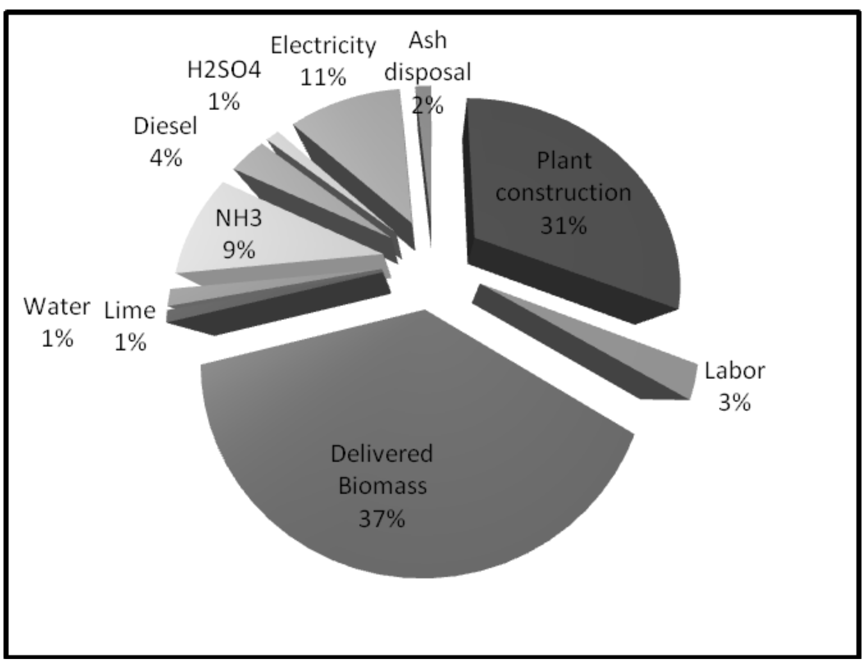

Figure 3. Ethanol unit production cost breakdown.

The quantities of pollutants generated due to energy and material use were multiplied with the impact factors, given in TRACI database, for quantifying selected environmental impact. The maximum global warming is caused due to production of greenhouse gases like carbon dioxide and methane during the Production step. Similarly, maximum acidification potential was also found associated with the same step. This was primarily due to the use of lignin for heat production and importing of electricity from the grid. Similarly, the maximum contribution for eutrophication and eco-toxicity was found associated with the Planting step. This was due to the use of fertilizers and other chemicals.

Cost Benefit Analysis: Unit Cost Analysis

The unit cost of ethanol was calculated to be $0.44 per liter or $1.67 per gallon using the mean delivered feedstock cost of $33.87 per ton. Based on the lower energy content of ethanol relative to gasoline, the cost of an energy equivalent liter (EEL) and gallon (EEG) of ethanol were calculated to be $0.65 per liter and $2.47 per gallon, respectively. The largest single contribution to this cost is the cost of the biomass feedstock, which represents 37% of the unit cost of ethanol production. Plant construction, electricity use, and ammonia represent the next three largest contributors at 31%, 11%, and 9%, respectively (Figure 3). Electricity costs are offset in large part due to the combustion of lignin, a byproduct of the acid hydrolysis, which provides 85% of the total energy consumption of the plant.

Cost Benefit Analysis: Forestland Valuation

Land expectation values were found to be positive for all scenarios except the biofuel feedstock production only (scenario 6) at some point during the simulated rotation, indicating a profitable venture for the forestland owner. The highest LEV obtained from the biofuel feedstock production scenario of harvest residues (scenario 2), peaking in year 23 of the rotation at $298.20 per acre. The lowest yielding scenario was the maximum biomass production scenario, reflecting the higher values for wood products than for biofuel production. The highest yielding scenario was the biofuel feedstock production scenario of residues only going to bioenergy production (Scenario 2), followed by the scenario with 25% pulpwood plus residues (Scenario 3), then the 50% of pulpwood plus residues (Scenario 4), followed by timber only production (Scenario 1), 100% of pulpwood plus residues (Scenario 5) and finally, the use of all harvested trees as an ethanol feedstock (Scenario 6).

Discussion

The preliminary results of these analyses further indicated that the potential of Southern NIPF lands as a source of feedstock for cellulosic ethanol. With an NEB higher than that of corn starch based ethanol, which currently provides the majority of the ethanol produced in the U.S., the use of forest based thinnings and harvest residues may be an attractive option for bioenergy production. Although the environmental impacts are significant, they remain favorable in comparison to those of corn based ethanol. Though energetically and environmentally advantageous, the economic criterions of ethanol produced from woody biomass grown on Southern NIPF lands are only partially fulfilled. The unit cost of this ethanol is greater than that of corn based ethanol, rendering it a less viable alternative from a financial viewpoint. There is, however, an increase in the modeled land value to the NIPF owner, which may lend to societal welfare by allowing these lands to remain in forest management, preserving their associated environmental services, and enhancing the rural sector of the economy.

Further research to enhance these analyses would include exploring other commercial forestry species for ethanol production and examining alternative conversion technologies. Furthermore, alternative biomass production scenarios and/or cropping systems might lend more insight into optimal solutions. One primary concern that must also be addressed is how to appropriately develop the forest and agricultural bioenergy sectors without impacting existing product sectors, such as the food, feed, and fiber markets.

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AN OVERVIEW OF WOODY BIOMASS SUPPLY POTENTIAL FOR ENERGY IN TEXAS

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Abstract

This study evaluates woody biomass supply potential in Texas from several sources: logging residue, mill residue, and pre-commercial thinning in East Texas and harvest of woodland species from West Texas. The study summarized the forest biomass inventory in Texas and annual production potential from each source. Logging residue was evaluated based on forest inventory data and wood utilization study. Mill residue was evaluated by surveying primary wood product mills. Pre-commercial thinning and woodland species harvesting scenarios were evaluated for their biomass production potential. Landowner characteristics of West Texas were discussed in relationship to their brush control practices and woody biomass production potential. Finally, total annual woody biomass production potential in Texas was discussed with regards to electricity power generation capacity that it could support.

[Abstract Only]

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AVAILABILITY, PRODUCTION COSTS, AND IMPLICATIONS OF BIOENERGY DEVELOPMENT IN MISSISSIPPI

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Abstract

This research evaluated woody biomass from logging residues, small-diameter trees, mill residues, and urban waste as a feedstock for bioenergy conversion in Mississippi. Supplies and production costs of woody biomass were derived from the Forest Inventory Analysis (FIA) database, a recent forest inventory conducted by the Mississippi Institute for Forest Inventory, and other sources of local information. Given the variability of cost information, Monte Carlo simulations were performed to estimate the marginal costs of each woody biomass type.

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According to our analysis, about 4 million dry tons of woody biomass is available for production of up to 318 million gallons of ethanol each year in Mississippi. The feedstock consists of 69% logging residues, 21% small-diameter trees, 7% urban waste, and 3% mill residues. Logging residues can be produced and delivered for $40 per dry ton; small-diameter trees for $49 per dry ton; mill residues for $31 per dry ton; and urban waste for $36 per dry ton. Sensitivity analysis indicates that current technological efficiency, stumpage prices, and procurement distances are factors with the largest impacts on biofuel costs. The results provide a valuable decision support tool for resource managers and industries interested in the development of bioenergy in Mississippi.

[Abstract Only]

CHANGES IN CONCENTRATION OF THE TENNESSEE HARDWOOD SAWMILL INDUSTRY, 1979 TO 2005

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Abstract

This paper examines changes in sawmill concentration and hardwood lumber production for Tennessee between 1979 and 2005. In 1979, less than 25 percent of the lumber manufactured in Tennessee was produced by mills with capacities of 5 million board feet annually. By 2005, such mills produced more than 60 percent of the lumber. The greatest change occurred in the eastern region where large mills accounted for 75 percent of the production in 2005. Examination of lumber prices found no discernable long-term difference in value trends between regions. Examination of saw log prices showed lower log costs in the eastern region, which facilitated the construction of seven large mills since 1979. Construction of these mills also was facilitated by relatively low delivered log prices and improved highway systems. Such changes seem to follow a model of industry concentration that occurred during the timber boom of the early 20th century -- if timber can be economically transported it will be "severed and sawn." Just as the Shay locomotive allowed large mills to be constructed in mountainous areas in the early 1900s, improved roads have allowed timber to be economically transported over longer distances to larger mills in eastern Tennessee.

Keywords: Hardwood lumber, sawmills, production

Introduction

The forest products industry is important to the Tennessee economy (Young et al. 2007). Still, this industry is dynamic as demonstrated by changes in the hardwood sawmill sector and hardwood lumber production. In 1979, Tennessee was home to more than 600 hardwood sawmills with a annual combined production of more than 650 million board feet (mmbf) of lumber. Most of this lumber was manufactured by mills producing less than 3 mmbf per year (Table 1). In 2005, fewer than 325 hardwood sawmills produced nearly 850 mmbf of lumber, of which 40 percent was produced by very large mills defined as having annual capacities of 10 mmbf or more. In this paper, sawmills are classified into 5 size groups: very small mills producing less than 1 mmbf annually, small mills producing 1 to 2.99 mmbf, medium mills producing 3 to 4.99 mmbf, large mills producing 5 to 9.99 mmbf, and very large mills producing

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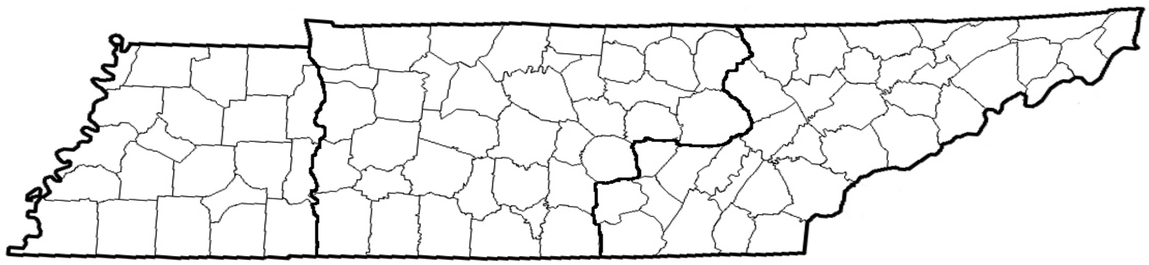
10 mmbf or greater. The greatest change occurred in the eastern region where more than 60 percent of the lumber was manufactured by very large mills by 2005.

Table 1. Percent of total annual production for Tennessee hardwood sawmills by mill size and year for each region and entire state, 1979-2005

	Mill Size				
	Very small < 0.99 mmbf	**Small 1 to 2.9 mmbf**	**Medium 3 to 4.9 mmbf**	**Large 5 to 9.9 mmbf**	***Very large 10 mmbf+***
Western region	---*percent*---				
1979[a]	7	52	20	21	*0*
1984[a]	7	43	27	23	*0*
1989[a]	5	32	21	18	*24*
1999[b]	3	20	17	39	*21*
2005[c]	4	13	26	32	*25*
	Very small < 0.99 mmbf	**Small 1 to 2.9 mmbf**	**Medium 3 to 4.9 mmbf**	**Large 5 to 9.9 mmbf**	***Very large 10 mmbf+***
Central region	---*percent*---				
1979[a]	16	37	16	27	*4*
1984[a]	11	32	25	16	*16*
1989[a]	6	19	24	20	*31*
1999[b]	6	15	18	18	*43*
2005[c]	6	14	17	24	*39*
	Very small < 0.99 mmbf	**Small 1 to 2.9 mmbf**	**Medium 3 to 4.9 mmbf**	**Large 5 to 9.9 mmbf**	***Very large 10 mmbf+***
Eastern region	---*percent*---				
1979[a]	28	49	17	6	*0*
1984[a]	21	50	24	5	*0*
1989[a]	15	36	27	10	*12*
1999[b]	8	9	8	20	*55*
2005[c]	6	9	10	12	*63*
	Very small < 0.99 mmbf	**Small 1 to 2.9 mmbf**	**Medium 3 to 4.9 mmbf**	**Large 5 to 9.9 mmbf**	***Very large 10 mmbf+***
Entire state	---*percent*---				
1979[a]	15	44	17	22	*2*
1984[a]	12	37	25	16	*10*
1989[a]	7	24	24	18	*27*
1999[b]	6	15	16	23	*41*
2005[c]	*6*	*13*	*17*	*23*	*41*

[a]Developed from TN Dept. Conserv. 1991
[b]Developed from TN Dept. Ag. (2001)
[c]Developed from TN Dept. Ag. (2006)

Concurrent with regional changes in Tennessee's sawmill concentration have been inconsistent changes in regional lumber production. In 1979 the western, central, and eastern regions (Figure 1) produced 202, 348, and 114 mmbf, respectively (Table 2). Twenty years later, production in the western region had declined to 186 mmbf, while production in the central and eastern regions had increased to 535 and 176 mmbf, respectively. These production increases were facilitated by a doubling of sawtimber inventories in the central and eastern regions during this 20-year period (USDA Forest Service 2007).



Western Central Eastern

Figure 1. Tennessee's hardwood production regions

Table 2. Regional and state-wide hardwood lumber production in Tennessee in 1979, 1984, 1989, 1999, and 2005 in millions of board feet (mmbf) and regional percentage market share

Year	Western		Central		Eastern		*State*
	mmbf	Percent	mmbf	Percent	mmbf	Percent	
1979[a]	202	30	348	52	114	17[d]	*664*
1984[a]	146	22	397	61	104	16[d]	*647*
1989[a]	186	22	536	63	126	15[d]	*848*
1999[b]	186	21	535	60	176	20[d]	*897*
2005[c]	*187*	*22*	*463*	*55*	*196*	*23[d]*	*846*

[a] Developed from TN Dept. Conserv. 1991
[b] Developed from TN Dept. Ag. (2001)
[c] Developed from TN Dept. Ag. (2006)
[d] Does not add up to 100 percent due to rounding error.

The objective of this paper is to discuss changes in sawmill concentration and hardwood lumber production for the western, central, and eastern regions of Tennessee. We also will discuss how sawtimber inventories, lumber and timber prices, localized markets conditions, and forces exogenous to the hardwood market have influenced these changes.

Production Regions and Sawtimber Inventory

The three regions defined in the Tennessee Forest Products Bulletin (TN Dept. Conserv. 1980 to 1991) are shown in Figure 1. The western region is comprised primarily of timberland under 1,000 feet in elevation with flat to moderate slope (USDA Forest Service 2007). The major components of the forest in this region are red and white oak species, sweetgum, yellow-poplar, and hickory. In 1979, this region had major hardwood flooring operations in Shelby and Madison counties and several sawmills producing cross ties and flooring lumber. At the same time this region produced more than 200 mmbf with small mills accounting for 52 percent of this volume (Tables 1 and 2). The ratio of hardwood sawtimber volume to annual log production (relative utilization) was 44 years in 1980. While this ratio can be difficult to interpret, any value below the number of years that it takes a tree to reach harvestable size (50 to 60 years in the south) is indicative of relatively high rate of timber utilization (Table 3).

Table 3. Regional hardwood sawtimber inventories and rates of relative utilization in Tennessee in 1980, 1989, and 1999

Sawtimber volume *(mmbf)*			
Year	Western	Central	*Eastern*
1980	7410	12178	*11624*
1989	8946	17509	*16419*
1999	*11249*	*24212*	*23030*

Relative utilization (years)			
Year	Western	Central	Eastern
1980	44	32	98
1989	48	33	130
1999	61	45	131

The central region of Tennessee is primarily comprised of timberland under 2,000 feet in elevation with slopes ranging from 0 to 40 percent. Red and white oak species, yellow-poplar, and hickory species comprise the forest in this region with select white oak species accounting for nearly 20 percent of sawtimber volume in 1989. Whereas 31 percent of the 348 mmbf of lumber produced in this region in 1979 was manufactured by larger mills, small mills and very small mills (production under 1 mmbf) accounted for 50 percent of sawmill capacity during this year. This region contained 39 percent of the state's sawtimber volume in 1980. The relative utilization of the sawtimber inventory was 32 years, a very high timber utilization rate (Table 3).

Nearly 60 percent of the timberland in the eastern region of Tennessee is at elevations greater than 1,000 feet and nearly one-third of this land has slope in excess of 40 percent (USDA Forest Service 2007). The topography is the primary reason why the interstate system was not completed in this region until the late 1970s. The major components of the forest are red and white oak species, yellow-poplar, and hickory, with yellow-poplar accounting for nearly 20 percent of sawtimber volume in 1989. In 1979, 75 percent of the lumber manufactured in this region was produced by small and very small mills. In 1980 the relative utilization of the sawtimber inventory was 98 years indicating a low sawtimber utilization.

<u>Changes in Lumber and Saw log Prices</u>

Tennessee's forest composition is relatively uniform across regions, with the majority of land being in the oak-hickory forest-type group. But, there are considerable differences in the type of oak among these regions, with the eastern region having a high volume of less desirable chestnut oak. In an effort to examine the dual impact of inflation-adjusted (real) lumber prices, as reported in the Hardwood Market Report from 1979 to 2004, and forest composition in 1989 (USDA Forest Service 2007), a relative timber value index was developed adjusting for yield by species and log grade using data developed by Hanks et al. (1980). An examination of this index indicates no discernable long-term difference in value trends between regions between 1979 and 2005; even though the index seems to have trended lower in the eastern region in recent years, the regional indexes have moved in the same direction (Figure 2).

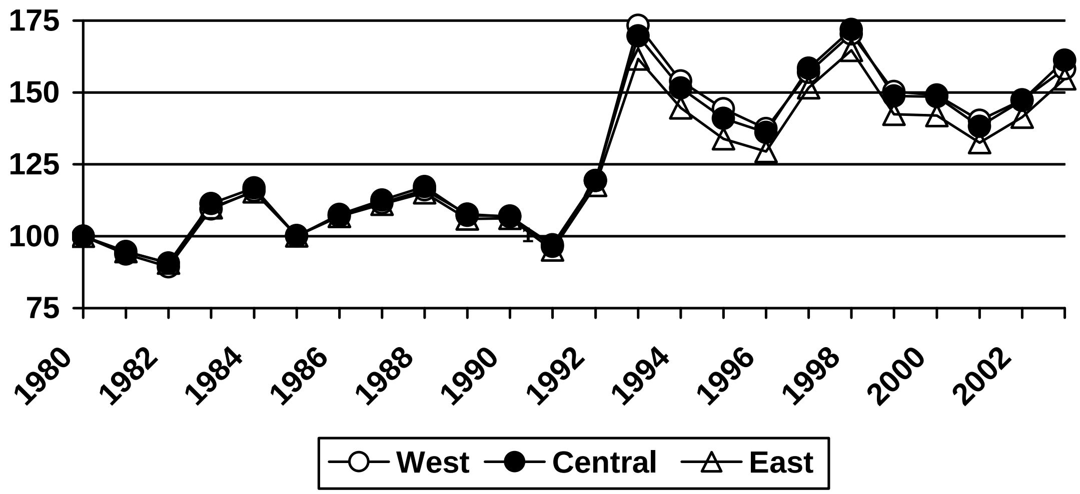


Figure 2. Index (1980=100) of hardwood lumber prices weighted for sawtimber composition and quality for the eastern, central, and western regions of Tennessee, 1980 to 2003

We have observed increasing real prices of delivered logs, but considerable variations exist among regions. In the early 1980s, prices in the western region remained high while prices in the central and eastern region declined (Figure 3). During the mid- and late-1980s, log prices fell and rose erratically but prices in the eastern region were clearly lower. Between 1989 and 1999, log prices increased erratically among the regions with the greatest growth occurring in the central region. Since 1999 log prices have decreased in the western and eastern regions, while remaining high in the central regions.

Results and Discussion

The Tennessee hardwood lumber industry changed between 1979 and 2005 with respect to typical sawmill size and volume of lumber produced. In 1979, more than 50 percent of the lumber produced was manufactured by small and very small operations producing less than 3 mmbf per year. Fifty-nine percent of the production in the western region and 77 percent of the production in the eastern regions was manufactured by smaller mills. The central region had the largest mills in the State, while the eastern region and western region did not have any mills producing 10 mmbf or more.

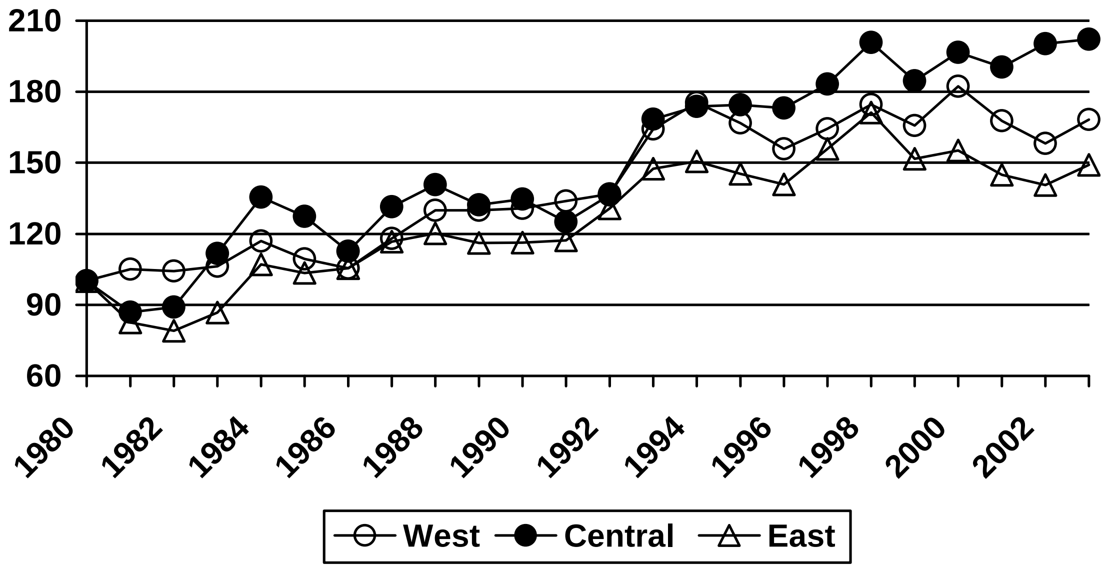


Figure 3. Index (1980=100) of hardwood log prices weighted for sawtimber composition and quality for the eastern, central, and western regions of Tennessee, 1980 to 2003

In 2005, 25 percent of the production in the western region and 63 percent of the production in the eastern region was manufactured by very large sawmills, but the reasons for these trends differ. Hardwood lumber production in the western region declined between 1979 and 1989 and remained nearly constant between 1989 and 2005.

The only very large mill built in this region was by a publicly held company whose primary product was wood pulp. This mill was subsequently sold to a private consortium that operated mills in several other states. Most of the increase in concentration was by existing mills that had increased capacity over time, supporting the “expand or exit” explanation of industrial concentration--that is, the relatively low volume of sawtimber relative to hardwood lumber production and higher log price forced remaining mills to increase their efficiency by becoming larger or exit the market.

While sawtimber inventory may have influenced prices of delivered logs in the central and western regions, the relatively low ratio of inventory to production in the central region did not inhibit increased production. In fact, the relative utilization coefficient increased in all three regions between 1980 and 2005. However, nearly all the increase in production in the central region was due to existing mills increasing in size. By contrast, the abundant volume of sawtimber in the eastern region may have helped keep delivered log prices lower and probably influenced the construction of new mills there.

In 1979, eastern Tennessee contained 37 percent of the sawtimber volume but was responsible for only 17 percent of the lumber produced. This low level of production might be partially explained by the result of the large volume of less desirable species, but was primarily the result of rough topography and a rudimentary highway system. In 1979, the interstate system of highways was just completed and other highways were being upgraded. This combination of roads and lower priced timber attracted the capital to build modern sawmills with large capacities.

Of the eight very large mills in this region in 2005, seven were newly built as large mills. Furthermore, these mills reside in separate counties whereas large and very large mills elsewhere in the state tend to be clustered in a small number of counties.

The greatest change in the sawmill industry in the central region of Tennessee occurred between 1984 and 1989. During this 5-year period, lumber production increased by 35 percent and the volume produced at large and very large mills increased by more than 110 percent. Almost all the increase in production occurred in counties on the southern and northern borders of the state and the eastern portion of the central region as existing mills increased capacity. It is conjectured that this increase was the result of the high demand for the quality red and white oak that grows in this region, thus allowing existing mills to expand production. This supposition is supported by the fact that the decrease in hardwood lumber production between 1999 and 2005 was confined to this region and was associated with a precipitous decline in oak lumber price but not oak sawtimber price (Hardwood Market report 1979-2004, Tennessee Department of Agriculture 1992 - 2003)

Conclusions

Over the past quarter century hardwood lumber production has increased in Tennessee, but there is no unifying reason for increases among regions. In 1979, both the western and central regions had high levels of timber utilization. However, while lumber production in the western region has not increased during the past 25 years, the volume of select white oak in the central region has driven increased production. By contrast, lower timber prices in the eastern region and lower levels of timber utilization influenced the construction of new sawmills with large or very large production capacities.

Also, there does not appear to be a unifying reason for changes in sawmill concentration across the three regions. The "expand or exit" explanation appears to be supported in the western and central regions of the state; however, the reason for increased concentration in the eastern portion of the state appears to follow a much older explanation that if timber can be economically transported it will be "severed and sawn". Just as the Shay locomotive allowed timber to be harvested and then converted into lumber by large sawmills in West Virginia in the early 20th century (Clarkson 1964), the improvement of transportation systems allowed large mills to be built in eastern Tennessee in the late 20th century.

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ELASTICITIES OF U.S. HARDWOOD LUMBER DEMAND AND SUPPLY IN THE LONG-RUN AND SHORT-RUN

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Abstract

The long cycle of hardwood lumber production causes lagged response of supply, and lag effects can considerably affect the coefficients of simultaneous equations models in the long-run. This paper estimates a dynamic simultaneous equations model that represents the delayed response of demand and supply of U.S. hardwood lumber with lags of variables. The results show the hardwood lumber supply is price elastic in the long-run but price inelastic in the short-run. The price elasticity of lumber demand is inelastic in both the long-run and short-run.

Keywords: ECM, hardwood lumber, elasticity, short-run, long-run

Introduction

Hardwood lumber is an important industrial material. Unlike softwood lumber, which is primarily used in housing construction, hardwood lumber is used in manufacturing a variety of products such as furniture, cabinets, wood flooring, windows, doors, pallets, railway crossties, and many other miscellaneous items. There are a few studies published on the demand and supply of the U.S. hardwood market (e.g. Luppold 1984; Adams and Haynes 1996). Similar to most of the early models (Buongiorno et al. 1979, Adams and Haynes 1980, Newman and Wear 1993, Lewandrowski et al. 1994), past hardwood lumber models, from which the elasticities were obtained, failed to account for lag effects of the long-run coefficient. Such omissions could significantly alter the long-run coefficients.

Recently, Hsiao (1997a, 1997b) showed that a dynamic simultaneous equations model can be estimated by 2SLS or 3SLS technique consistently if sufficient cointegration relations exist. An error correction modem (ECM) representing long-run and short-run relations can be obtained by transforming the estimated dynamic model.

The purpose of this study is to determine the long-run and short-run price elasticities of U.S. hardwood lumber demand and supply by transforming the estimated dynamic model into a restricted ECM following the method suggested by Hsiao (1997a, 1997b). The theoretical demand and supply equations will be derived with Cobb-Douglas technology and estimated simultaneously.

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Methods

With simultaneous equations, the 2SLS technique will be applied. When the exogenous variables in a structural model are nonstationary, the model that generates the endogenous variables can be a vector of restricted autoregressive linear equations

$$\mathbf{\Gamma}(L)\mathbf{y}_t + \mathbf{B}(L)\mathbf{x}_t = \boldsymbol{\varepsilon}_t, \quad (1)$$

where $\mathbf{\Gamma}(L)$ and $\mathbf{B}(L)$ are matrixes of functions of the lag operator L. Some elements of matrixes are zeros as restrictions for the structural model. $\mathbf{y}_t$ and $\mathbf{x}_t$ are vectors of 2 endogenous (lumber production and price) and K exogenous variables respectively. $\boldsymbol{\varepsilon}_t$ is a 2 dimension vector of stationary error terms with mean zero. The corresponding error correction model for model (1) is

$$\mathbf{\Gamma}^*(L)\Delta\mathbf{y}_t + \mathbf{B}^*(L)\Delta\mathbf{x}_t + \mathbf{\Gamma}(1)\mathbf{y}_{t-1} + \mathbf{B}(1)\mathbf{x}_{t-1} = \boldsymbol{\varepsilon}_t. \quad (2)$$

In this model $\mathbf{\Gamma}^*(L)$ and $\mathbf{B}^*(L)$ are matrixes including short-run coefficients. $\mathbf{\Gamma}(1)$ and $\mathbf{B}(1)$ are calculated from $\mathbf{\Gamma}(L)$ and $\mathbf{B}(L)$ when $L = 1$. $\Delta\mathbf{y}_t = \mathbf{y}_t - \mathbf{y}_{t-1}$, $\Delta\mathbf{x}_t = \mathbf{x}_t - \mathbf{x}_{t-1}$, and $\Delta = 1-L$. When the roots of $|\mathbf{\Gamma}(L)| = 0$ lie outside the unit circle, the inverse $\mathbf{\Gamma}(L)^{-1}$ exists (Hamilton 1994). Therefore, $\mathbf{y}_t$ is a function of $\mathbf{x}_t$, and

$$\mathbf{y}_t = -\mathbf{\Gamma}(L)^{-1}\mathbf{B}(L)\mathbf{x}_t + \mathbf{\Gamma}(L)^{-1}\boldsymbol{\varepsilon}_t. \quad (3)$$

When $\boldsymbol{\varepsilon}_t$ is stationary and $\mathbf{\Gamma}(L)^{-1}$ exists, the error term $\mathbf{\Gamma}(L)^{-1}\boldsymbol{\varepsilon}_t$ of the above equation are stationary. Equation (3) represents long-run relations at equilibrium, and $-\mathbf{\Gamma}(L)^{-1}\mathbf{B}(L)$ produces a matrix of long-run coefficients.

Models

In 2002, about half of the hardwood lumber was used in manufacturing wood products such as pallets, crossties, and other miscellaneous uses, and the other half of hardwood lumber was used in manufacturing furniture and other home related wood products. Therefore, the manufacturing industry covers almost all of the wood products and is the driving force of hardwood lumber demand. In recent years, the international market for hardwood lumber has become more and more important. The percentage of exported hardwood lumber increased from 1.5% in 1965 to 10.4% in 2002. As such, export has to be taken into account, and domestic consumption is obtained by taking out net hardwood export from hardwood lumber production.

With Cobb-Douglas technology for the manufacturing industry, the lumber demand equation derived by applying the Shephard lemma to the Cobb-Douglas cost function can be transformed into a log-linear equation (Rockel and Boungiorno 1982, Adams et al. 1992). The elasticities are constant with such a technology. Therefore the elasticities estimated with such a model are for the whole historical data period rather than current elasticities. The derived hardwood lumber demand (Lum_t) will be a function of the hardwood lumber price ($P_{lum,t}$), prices of substitutes and complements, and the manufacturing output (Mf_t). The prices of substitutes and complements are the price of plastic ($P_{pla,t}$) for non-wood materials, price of hardboard, particle board and fiber board products ($P_{boa,t}$) for wood substitutes, price of electricity ($P_{ele,t}$) for energy, and interest rate

($P_{cap,t}$) for capital. Metal is another common substitute for wood in many cases. However, with a correlation coefficient of 0.98 between the prices of metal and plastic for the data period, metal price is excluded. The plastic price is used as a proxy for non-wood substitutes including metal. The log-linear equation for lumber demand derived from Cobb-Douglas can be written as:

$$ln\,Lum_t = \alpha_0 + \sum_j \alpha_j \, ln\,P_{j,t} + \alpha_{mf} lnMf_t + \alpha_1 lnLum_{t-1} + \alpha_T t + \varepsilon_{d,t}\,, \tag{4}$$

where Lum_t is the lumber consumption at time t, α_0, α_j, α_{mf}, a_1, and α_T are parameters, and subscript j = *lum*, *pla*, *ele*, *boa*, or *cap*. Term $\alpha_T t$ represents technological progress over time. The $\varepsilon_{d,t}$ is an error term. One lag of the lumber consumption is included to eliminate possible autocorrelation. As a demand function, the above equation has to be homogeneous of degree zero in prices of hardwood lumber and other inputs of the manufacturing industry, non-increasing in own-price, and non-decreasing in outputs. These conditions require

$$\sum_j \alpha_j = 0, \quad \alpha_{Lum} \leq 0, \quad and\ \alpha_{mf} \geq 0.$$

The lumber supply function can be derived by applying the Hotelling's lemma to the profit function of lumber production with a Cobb-Douglas technology. The log transformed lumber supply equation can be expressed as

$$lnLum_t = \beta_0 + \beta_{lum} lnP_{lum,t} + \beta_{lum1} lnP_{lum,t\text{-}1} + \sum_k \beta_k lnP_{k,t} + \beta_l lnLum_{t-1} + \beta_T t + \varepsilon_{s,t}\,, \tag{5}$$

where 'β's are coefficients, and $\varepsilon_{s,t}$ is a stationary disturbance term. $P_{k,t} = P_{lg,t}$, $P_{ele,t}$, $P_{cap,t}$, or $P_{ws\,t}$ with $k = lg,\ ele,\ cap,\ or\ ws$ representing the prices of logs, electricity, interest rate, or wage rate of sawmills respectively. The sawmill inventory of lumber fluctuates with changes in current production and shipment which are determined by the lumber price when other variables are held constant. Therefore, inventory is endogenous and its effect can be covered by lagged price and supply of hardwood lumber. The lag terms will eliminate the possible autocorrelation caused by inventories and other factors. In the long-run the supply equation (4) is homogeneous of degree zero in prices, and a restriction

$$\beta_{lum} + \beta_{lum1} + \sum_k \beta_k = 0$$

will be imposed when the supply equation is estimated.

Equations (4) and (5) will be estimated simultaneously. In this simultaneous equations model the hardwood lumber production Lum_t and the lumber price $P_{lum,t}$ are endogenous variables, and all other variables are exogenous variables that will be used as instrument variables for the 2SLS estimation. The rank condition described by Hsiao (1997a, 997b) is the same as those in textbooks (Greene 2002, Chapter 15), so the conventional rank condition is used to identify supply and demand equations. Since each equation has its unique variables that are not included in the other equation, the rank condition is satisfied, and both equations (4) and (5) are identified. According to Hsiao (1997a, 1997b), when a dynamic model is identified, its corresponding equation in ECM is also identified. Thereby, the equations in the form of equation (2) derived from dynamic equation (4) and (5) are also identified.

Estimation

Annual data from 1965 to 2002 are used to estimate the simultaneous equations model. Data are mainly from Howard (2003), U.S. Department of Labor, Department of Energy Energy Information Administration, and the U.S. Federal Reserve Bank of St. Louis. The observed value for the hardwood lumber consumption (Lum_t) is the U.S. "final hardwood production" by Howard (2003) minus the net export that is the difference between the export and import. The hardwood stumpage price is used as a proxy for the price of logs. The USDA miscellaneous publication No. 1357 is used as the sawmill labor price. The price data are first transformed into real prices by producer's price index PPI_t if they are current prices. All the real prices, nominal interest rates, and quantities are then transformed by logarithm.

Augmented Dickey-Fuller and Phillips-Perron unit root tests with the transformed data showed that all the transformed data series used in equations (4)—(5) have unit roots and therefore, are non-stationary. With hardwood lumber price and production as the endogenous variables and the others as the exogenous variables, a cointegration test with a partial model (Johansen 1992) showed that the data series used in the simultaneous equations model have two cointegration relations. This result implies that it is possible to estimate equations (4) and (5) consistently with the 2SLS technique. Restriction of homogeneous of degree zero in prices is applied to both of the equations. The estimated coefficients are shown in Table 1.

The price of electricity and capital (interest rate P_{cap}) in the supply equation are restricted to be zero since the significant levels of these two coefficients are close to 1 when they are not constrained. χ^2 tests for the restrictions on these equations show that the hypotheses on these restrictions cannot be rejected.

All the estimated coefficients of the demand equation are significant at 5% level, and all the estimated coefficients of the supply equation but that of sawmill wage rate are significant at 1% level. The coefficient of the sawmill wage rate in the supply equation is significant at 14% level.

The corresponding **B**(L) is the transpose of the coefficient matrix of the predetermined variables from $lnP_{pla,t}$ down to lnt ($P_{lum,t}$ is not a predetermined but an endogenous variable) in Table 1. There is no lags of these predetermined variables, so there is no L in **B**(L); therefore, **B**(1) = **B**(L). **Γ**(L) is formed by coefficients of endogenous variables. These coefficients are functions of L whenever lags of the corresponding endogenous variable exist. The roots of equation $|\Gamma(L)| = 0$ are 1.311 and 5.172 that are outside the unit circle. These roots imply that the lag structure of the estimated model is stationary.

The coefficients of each variable and its lag are first summed to obtain an element in Γ(1) and B(1), then the coefficients of $lnLum_t$ in both equations are normalized to -1 to get the estimated long-run demand and supply equations corresponding to equation (4) and (5). The long-run coefficients are presented in Table 2.

Table 1. Estimated results with the 2SLS technique

	Demand ($\ln Lum_t$)		Supply ($\ln Lum_t$)	
Variables	**Coefficients**	**Significant level**	**Coefficients**	**Significant level**
$lnP_{lum,t}$	-0.241	0.00	0.740	0.00
$lnP_{lum,t-1}$			-0.546	0.00
$lnP_{lg,t}$			-0.052	0.00
$lnP_{pla,t}$	0.102	0.04		
$lnP_{ele,t}$	-0.131	0.00		
$lnP_{boa,t}$	0.335	0.00		
$lnP_{cap,t}$	-0.064	0.05		
$lnP_{ws,t}$			-0.142	0.14
$lnMf_t$	0.646	0.00		
Constant	4.476		1.603	0.01
T	-0.0091	0.00	0.0043	0.00
$lnLum_{t-1}$	0.265	0.00	0.813	0.00
R^2	0.91		0.90	
χ^2 for restrictions	0.96	0.33	1.89	0.60

After normalization, the coefficients for the prices in the "after normalization" columns of Table 2 are also long-run elasticities because the variables are log-transformed. The estimated long-run price elasticity of hardwood lumber demand is -0.328. Prices of plastic $P_{pla,t}$ and composite board $P_{boa,t}$ have positive coefficients. These coefficients imply that both wood and non-wood substitutes have significant substitution effects on hardwood lumber. The prices of electricity and interest rates have negative coefficients implying that power and capital are complements of hardwood lumber. The coefficient of manufacturing production is 0.879 and less than 1, meaning that the lumber demand will only grow 87.9 percent for every one percent increase in manufacturing production. This simply suggests that the demand for hardwood lumber grows slower than the manufacturing industry does. Although the sum of estimated coefficients of the current and lagged lumber prices in the supply equation is only 0.194, the cumulative effect in the long-run hardwood supply (after normalization) is 1.037, showing the significant impact from the lagged dependent variable. Consequently, the derived price elasticity of the long-run supply (1.037) is greater than unit, suggesting that the hardwood lumber supply is price elastic in the long-run. This long-run price elasticity is larger than those from the previous studies that overlooked the lag effects. The long-run log price elasticity of lumber supply is 0.278, implying that the lumber supply is inelastic to a log price change.

The short-run coefficients of the ECM in the form of model (2) can be obtained by transforming the estimated dynamic model (1) that includes equations (3) and (4). Let the equilibrium errors of the two equations be Z_d and Z_s, then:

$$Z_d = lnLum_t - (6.090 - 0.328 lnP_{lum,t} + 0.139 lnP_{pla,t} - 0.178 lnP_{ele,t} + 0.456 lnP_{boa,t} \\ - 0.087 lnP_{cap,t} + 0.879 \ln Mf - 0.012t)$$

$$Z_s = lnLum_t - (8.572 + 1.037 lnP_{lum,t} - 0.278 lnP_{tb,t} - 0.759 lnP_{ws,t} + 0.023t).$$

Table 2. Transformed long-run coefficients

	Demand equation		Supply equation	
Variables	Before normalization	After normalization	Before normalization	After normalization
$lnLum_t$	-0.735	-1	-0.187	-1
$lnP_{lum,t}$	-0.241	-0.328	0.194	1.037
$lnP_{lg,t}$			-0.052	-0.278
$lnP_{pla,t}$	0.102	0.139		
$lnP_{ele,t}$	-0.131	-0.178		
$lnP_{boa,t}$	0.335	0.456		
$lnP_{cap,t}$	-0.064	-0.087		
$lnP_{ws,t}$			-0.142	-0.759
$lnMf_t$	0.646	0.879		
constant	4.476	6.090	1.603	8.572
t	-0.0091	-0.012	0.0043	0.023

The two equations of the transformed ECM are

Demand:

$$\Delta lnLum_t = -0.0091 - 0.241 \Delta lnP_{lum,t} + 0.102 \Delta lnP_{pla,t} - 0.131 \Delta lnP_{ele,t} + 0.335 \Delta lnP_{boa,t} \\ - 0.064 \Delta lnP_{cap,t} + 0.646 \Delta lnMf_t - 0.735 Z_{d,t} + \varepsilon_{d,t}$$

Supply:

$$\Delta lnLum_t = -0.0043 + 0.740 \Delta lnP_{lum,t} - 0.052 \Delta lnP_{tb,t} - 0.142 \Delta lnP_{ws,t} - 0.187 Z_{s,t} + \varepsilon_{s,t}.$$

In the estimated ECM equations $\varepsilon_{d,t}$ and $\varepsilon_{s,t}$ are corresponding error terms. The first equation is for the hardwood lumber demand, and the second equation is for the hardwood lumber supply. The coefficient -0.735 of Z_d implies that the equilibrium error of demand of hardwood lumber is adjusted 73.5 percent in the next year; and the coefficient -0.187 of Z_s implies that the equilibrium error of the hardwood lumber supply is adjusted only 18.7 percent in the next year. The coefficients of the differenced variables are the corresponding short-run elasticities. The short-run price elasticities of lumber demand and supply are -0.241 and 0.740 respectively. All the other short-run coefficients of demand are the same as their corresponding coefficients in the estimated dynamic model. The short-run coefficient of log price in the lumber supply equation is close to zero (-0.052). The short-run coefficient for the sawmill wage rate in the supply equation is -0.142. These elasticities equal the current year coefficients and represent the current year responses of lumber demand and supply to changes in prices.

Discussion and Conclusions

With lag variables in the hardwood lumber demand and supply equations the estimated short-run and long-run elasticities are quite different. The estimated one year own-price elasticity of hardwood lumber supply is 0.740, in two years it is 0.194, but in the long-run it is 1.037. Empirically this result is easy to understand. It usually takes 9 to 12 months for green hardwood lumber to be dried before being shipped to consumers. Some drying methods dry lumber faster with a higher cost, and others like air drying take a longer time with a lower cost. When the lumber price is high, more wood will be dried by faster methods, and more lumber will be shipped in the current year. However, the lumber output will decrease in the second year because some of the lumber scheduled for that year had been shipped earlier. As a result, an increased price has a negative effect on the lumber supply in the second year. Therefore, hardwood lumber supply has a larger elasticity in one year but a smaller elasticity in two years.

When the lumber price stays at a high level in the long-run, sawmills are able to recover their inventory and invest more in hardwood production to enlarge capacity. The large coefficient (0.813) of lagged lumber supply suggests that it takes a long time for sawmills to increase hardwood lumber capacity. In the long-run, the effect of a high lumber price on the supply of hardwood lumber is significant, and the long-run hardwood lumber supply is price elastic with elasticity 1.037.

The estimated demand equation has a smaller coefficient of the lagged hardwood lumber consumption. Consequently, the long-run and short-run price elasticities of hardwood lumber demand are quite close (-0.328 and -0.241).

Based on the estimated results, hardwood lumber demand is driven by the manufacturing industry but the technological progress reduces consumption of hardwood lumber over time. The main substitutes for hardwood lumber are other wood products.

The meaning of short-run elasticity from an ECM is not the same as that defined in microeconomics textbooks. With ECM, the short-run elasticity implies the response of the dependent variable to a change in an independent variable in one year. On the other hand, the short-run elasticity in a microeconomics textbook represents the percentage change of the dependent variable as a result of a one percent change in the price of a factor when some other factors do not have time to respond to the change. Such a definition is theoretically clear but empirically not as useful as the short-run elasticity in an ECM, since the textbook definition could not tell how long a short-run response will take.

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STUMPAGE PRICE VOLATILITY IN THE U.S. SOUTH

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Abstract

Forest products have remained an important part of southern rural economies in the United States. As one of the major raw materials, stumpage has been a key component of production cost in the forest products industry, and therefore its price has been of great concern. Since the late 1970's stumpage prices in the U.S. South have been changing considerably over time. This study uses analysis of variance and regression analysis to examine the stumpage price volatility in the U.S. South between 1977 and 2007. The results reveal that there are some differences in stumpage price volatility among the four product classes, and the demand factor explains most of the variation in stumpage price volatility.

Keywords: ANOVA, fixed effects model, multiple comparison tests, pooled OLS

Introduction

The forest products industry has been playing an important role in the U.S. economy (Mei and Sun 2008). A majority of mill capacity in the United States is located in the South (Wear, et al. 2007). Stumpage, as one of the major raw materials in the forest products industry, is a key component of production cost. On the other hand, revenue from timber harvest is an important source of income for private forest landowners. Thus, price changes of stumpage are both concerns of the forest products industry and the private landowners.

Since the late 1970s, the stumpage prices in the U.S. South have been changing considerably over time. While all products have similar overall evolving patterns, some products seem to be more volatile than the others. The price index by product is shown in Figure 1. The sharp increase in the late 1980s is mostly attributed to the listing of the northern spotted owl as an endangered species, which had substantially reduced timber available for processing by the

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forest products industry on federal forests in the Pacific Northwest (Murray and Wear 1998).

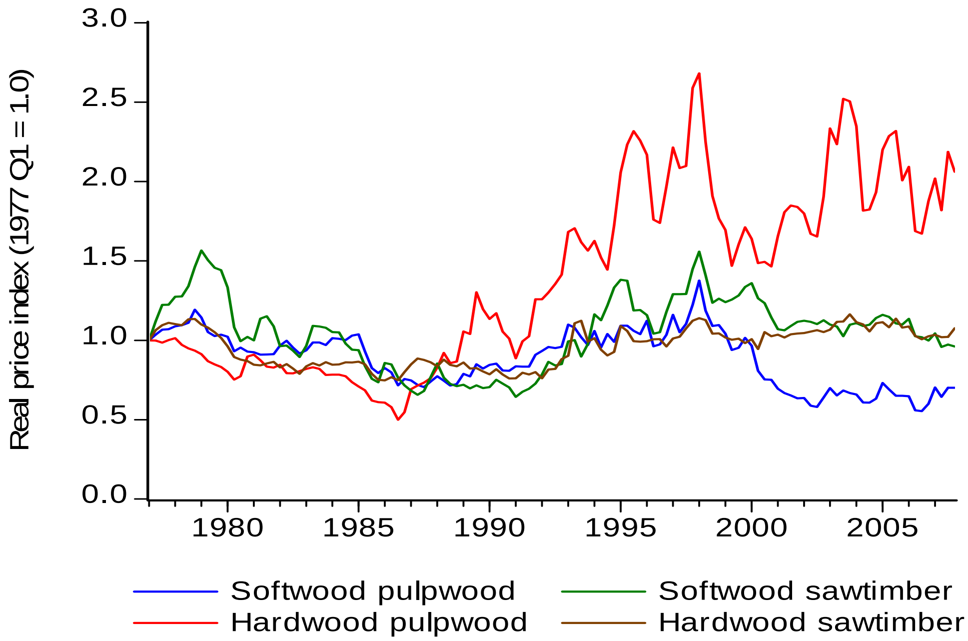

Figure 1. Real quarterly stumpage price index in the U.S. South by product (Real prices are derived by deflating the nominal prices using Consumer Price Index, (CPI for 1982-1984 = 100)

Source: Timber Mart-South.

While there have been several analyses on the evolution of stumpage price over time (*e.g.*, Saphores, et al. 2002; Baek 2006), research on stumpage price volatility has been quite limited. The only exception is the study of softwood lumber price volatility surrounding the U.S.-Canada softwood lumber trade disputes (Zhang and Sun 2001). Hence this study is intended to assess the stumpage price volatility in the U.S. South for the past three decades in order to identify factors that determine the stumpage price volatility by analysis of variance (ANOVA) and regression analysis, respectively. Results from this study will be helpful to private forest landowners, forest products companies, and policy makers.

Variable Specification and Data

Practically, price volatility can be defined in both absolute and relative measures. In absolute terms, price volatility is defined as the standard deviation of price in dollars per unit; in relative terms, price volatility is defined as percentage of the standard deviation over the mean. In this study, both measures are used. Given the frequency of Timber Mart-South data, absolute stumpage price volatility ($/ton) is derived by calculating the annualized standard deviation of quarterly price, and relative stumpage price volatility (%) is derived by the ratio of the standard deviation over the average annual price, also known as coefficient of variation. Stumpage price volatility is used as the dependent variable in the analysis. Consistent with Timber Mart-South's classification, stumpage is divided into four categories by product class. Namely they are softwood sawtimber, softwood pulpwood, hardwood sawtimber, and hardwood pulpwood. These four products are used as classification variables in ANOVA.

In regression analysis, three independent variables are proposed to be related to the variation of stumpage price volatility. They are weather condition (DI), industry capacity (CAP), and end product price volatility (EPV). Weather condition (DI), as approximated by Palmer Drought Severity Index, is related to harvest schedule. The drier the weather, the easier the harvest, the more the supply, and the less the stumpage price volatility. The index generally ranges from -6 to +6, with negative values denoting dry spells and positive values indicating wet spells. Thus it is expected to have a positive sign. Data for Palmer Drought Severity Index come from National Climatic Data Center, U.S. Department of Commerce. Industry capacity (CAP) is defined as real value of total industry shipments. It is used as a proxy of industry demand factor, and therefore is expected to have a positive sign. Data for total industry shipments value come from Annual Survey of Manufactures. End product price volatility is represented by composite price index. For the paper sector, the Producer Price Index (PPI) for pulp, paper, and allied products is used as a proxy for paper products price as reported by Bureau of Labor Statistics, U.S. Department of Labor; for the lumber sector, the Framing Lumber Composite Index is used for lumber products price as reported from Random Length, Inc.

Due to data unavailability for some variables, the balanced panel data set used in regression analysis ranges from 1978 to 2006 with 29 observations for each of the four products. At the 5% level or better, all these variables have passed the standard tests of stationarity.

Methods

Analysis of variance

Analysis of variance (ANOVA) is a commonly used statistical methodology in the investigation of factors that likely contribute to outcomes. The procedure involves dividing total observed variations in outcomes into individual components attributed to various factors and those due to random fluctuation. Then by performing tests, factors that influence the outcomes are identified. In this study, the single factor that is considered to affect the price volatility (outcome) is product class. The basic idea is that if all products have the same mean price volatility, then the variation of price volatility between products should be the same as that within products. Mathematically, the ANOVA model for this study is given as

$$PV_{it} = \mu + a_i + e_{it} \qquad (i = 1,..., p; t = 1,...,T)$$

where PV_{it} is the price volatility for the i^{th} product at time t; μ is the overall mean; a_i is the effect due to the i^{th} product; e_{it} is the random error; p is the number of different groups; and T is the number of observations within each group.

The variation in stumpage price volatility is separated into variation due to different product and variation due to random error.

$$SST = SS_B + SS_W$$

where SST (total sum of squares) is the sum of squared deviations of individual observations from the overall mean; SS_B (sum of squares between groups) is the sum of squared deviations of group means from the overall mean; and SS_W (sum of squares within group) is the sum of squared deviations from the group means. The null hypothesis of equal mean price volatility for all products can be tested by the *F*-statistic formed by the ratio of MS_B (mean squares between groups) and MS_W (mean squares within groups).

$$F_{p-1,T-p} = MS_B / MS_W$$

While ANOVA *F*-statistic can tell if there is a difference between groups, it cannot tell which one is different and by how much. Multiple comparison tests can solve this problem. This study uses the Scheffe's method, which ranks the group means by magnitude and then reports if the difference in means is significant.

Regression analysis

To investigate factors other than product classification variables that may contribute to the variation in stumpage price volatility, a linear regression model is formulated. Following Wooldridge's (2006) suggestion dealing with panel data with less cross-sectional units, we run pooled Ordinary Least Squares (OLS) with fixed-effects to get more precise estimates and test statistics with more power. The final regression model is

$$PV_{it} = \beta_0 + \beta_1 DI + \beta_2 CAP_{it} + \beta_3 EPV_{it} + a_i + \varepsilon_{it}$$

where a_i captures all unobserved, time-constant factors, referred to as fixed effects, or unobserved heterogeneity; ε_{it} is idiosyncratic error or time-varying error. Because of potential heteroscedasticity, White robust standard errors are calculated.

Results

Absolute and relative measures of stumpage price volatility are plotted in Figures 2 and 3, respectively. By standard deviation, sawtimber is more volatile than pulpwood, with softwood sawtimber being the most volatile. By coefficient of variance, all products show some similar patterns, with hardwood pulpwood being slightly more volatile. Although conclusions from these two measures do not coincide with each other, there is clear evidence that price volatility differs by product. Results from ANOVA model (Table 1) further confirm this proposition. The null hypothesis of equal price volatility is strongly rejected.

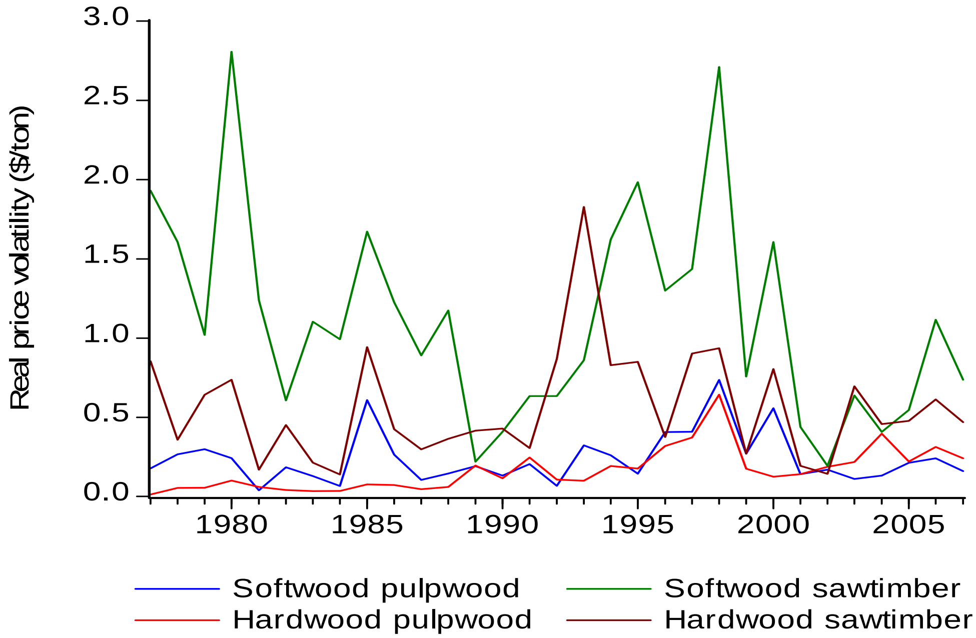

Figure 2. Standard deviation of real stumpage price by product

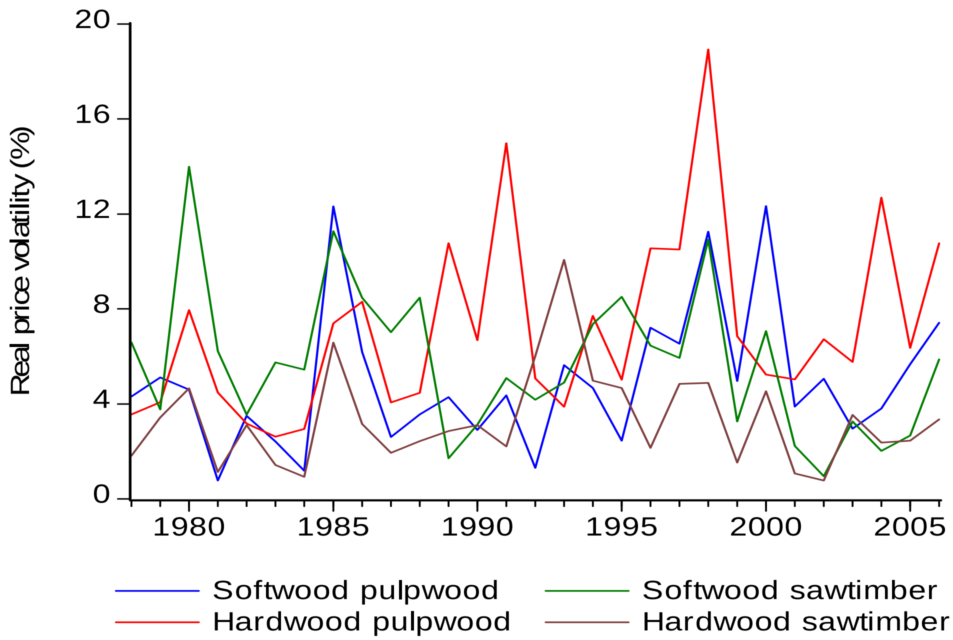

Figure 3. Coefficient of variance of real stumpage price by product

The results from multiple comparison tests are reported in Table 2. Means that are not significantly different at the 5% level are labeled with the same letters, while those that are significantly different are labeled with different letters. Consistent with results from Figures 2&3, in terms of standard deviation, softwood sawtimber is the most volatile, followed by hardwood sawtimber, then pulpwood. Whereas in terms of coefficient of variation, price volatility is similar, with hardwood sawtimber being least volatile.

Table 1. ANOVA table for stumpage price volatility by product

Source of variation	d.f.	Sum of squares	Mean square	*F*-Stat.	*P-value*
Nominal price standard deviation					
Between group	3	25.58	8.53	29.13	*0.000*
Within group	120	35.13	0.29		
Total	123	60.71			
Real price standard deviation.					
Between group	3	17.30	5.77	38.88	*0.000*
Within group	120	17.80	0.15		
Total	123	35.10			
Coefficient of variation					
Between group	3	215.73	71.91	7.89	*0.000*
Within group	120	1093.14	9.11		
Total	*123*	*1308.87*			

Table 2. Multiple comparison tests for stumpage price volatility

Product	No. of obs.		Nominal price s.d.			Real price s.d.			*Coefficient of variation*	
			Mean	Grouping		Mean	Grouping		Mean	*Grouping*
Softwood pulpwood	31		0.318	C		0.239	C		4.860	*AB*
Hardwood pulpwood	31		0.259	C		0.166	C		6.932	*A*
Softwood sawtimber	31		1.390	A		1.113	A		5.791	*A*
Hardwood sawtimber	*31*		*0.793*	*B*		*0.563*	*B*		*3.329*	*B*

Note: test at the 5% significance level. Means of standard deviation are in $US/ton; means in the same group are not significantly different; means in group A are larger than those in group B or C, and means in group B are larger than those in group C.

Results from regression analysis are reported in Table 3. All the coefficient estimates are of the correct sign, and industry capacity is significant at the 5% level, indicating that demand-side factors explain most of the variation in stumpage price volatility. The model fits well according to the adjusted R^2. Consistent with ANOVA results, the hypothesis of equal fixed-effects is soundly rejected by the Wald test.

Table 3. Pooled OLS estimation with White robust standard errors (using standard deviation of real stumpage price as dependent variable)

Variable	Coefficient		Std. error	*t-ratio*
Intercept	-0.180		0.282	*-0.638*
Drought index	0.004		0.017	*0.241*
Industry capacity	0.002*		0.001	*2.141*
End product	0.003		0.005	*0.557*
Cross sectional fixed effects			*Wald test of equal fixed effects*	
Softwood pulpwood	-0.510		*F*-Stat.	*8.64*
Hardwood pulpwood	-0.585		d.f.	*3.109*
Softwood sawtimber	0.818		*P*-value	*0.000*
Hardwood sawtimber	0.277			
Overall fitness				
R^2	0.506		*F*-Stat.	*18.61*
Adj. R^2	0.479		*P*-value	*0.000*
Total pool (balanced) obs:	*116*			

*significant at the 5% level

Discussion

The major conclusion of this study is that stumpage price volatility does differ across products. By ANOVA analysis and multiple comparison tests, stumpage price volatility is compared between the different products. In absolute measure, sawtimber prices are more volatile than pulpwood prices, with softwood sawtimber prices being the most volatile. In relative measure, stumpage price volatility also shows some difference, with hardwood sawtimber being the least volatile. One possible reason for the difference in price volatility is that the lumber industry is more economically sensitive than the paper industry to macroeconomic factors, such as business cycles, housing starts, and so on. Another reason is associated with substitution effects. While lumber products have several substitutes such as rubber, steel, etc., paper products have few.

Furthermore, by regression analysis, multiple factors are taken into account simultaneously to explain the variation in stumpage price volatility. Overall, industry capacity contributes most to the variation of stumpage price volatility. Intuitively, more industry capacity is expected to be related to expansion in timber consumption, and thus results in more stumpage price volatility. On the contrary, when industry capacity shrinks, timber demand also contracts; however, landowners also tend to postpone harvesting, which reduces price effects.

Stumpage price volatility reflects the uncertainty of the timber market; the more volatile the price, the more risky the market. Price volatility should be considered by both private landowners and timber managers when making decisions. In addition, stumpage price volatility, which affects production cost, may be related to the overall performance of the U.S. forest products industry.

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DISCOUNT RATES OF LIMITED RESOURCE WOODLAND OWNERS IN NORTH CAROLINA AND VIRGINIA

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Abstract

Discount rates were estimated for Limited Resource Woodland Owners (LRWOs) in North Carolina and Virginia, using a survey that asked landowners to choose between two harvesting scenarios with different payment amounts and rotation lengths. Our innovative sampling frame resulted in a more diverse set of respondents, with high proportions of minority and small woodland owners. The estimated annual discount rate was 2.6% (real rate, risk-free). Discount rates increased with age, income, and number of children (up to three). The marginal effect of age was lower among higher income landowners. Landowners preferred forestry income in shorter intervals. Those who lived on or near their property were less likely to make written wills. The discount rate was not a significant factor in determining the probability of contacting a professional forester or making woodland improvements.

Keywords: Written wills, time preference, NIPF

Introduction

The discount rate, which is a measure of time preference, is an ubiquitous parameter in forestry economics, yet its magnitude is not well understood. This study estimates the population discount rate, analyzes the determinants of the discount rate and, in turn, analyzes the discount rate's effects on future-oriented behavior. These behaviors are: making written wills, seeking advice from forestry professionals (consulting foresters and county forestry extension agents), and investing in woodland improvements.

We focused on Limited Resource Woodland Owners (LRWOs) in North Carolina and Virginia. LRWOs are family owners of woodland who operate under significant financial, social, natural and human capital constraints, and those who are traditionally underserved by public agencies. Some of these constraints are a result of historical discrimination and thus are correlated with race. Others are a result of poverty, low educational attainment, or woodland characteristics such as size, tenureship, and location.

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This work was motivated by the very thin literature and lack of understanding of this segment of woodland owners and of discount rates among woodland owners in general. One of the main barriers to quantitative research on LRWOs has been the lack of a sampling frame (Crim et al. 2003). Most commonly, researchers have used referrals from public agencies, environmental organizations, or fellow landowners (e.g., Gan et al. 2005, Crim et al. 2003). This results in good participation of minorities, women, and other target groups, but with a bias towards better-served landowners. Other studies have carefully selected their respondents based on woodland size but not the demographic characteristics of the landowner (e.g., Kendra 2003).

There were only a handful of studies that estimated the discount rates of woodland owners in general, and none applied specifically to LRWOs. Our objective is to fill this gap by using data from a survey of 299 woodland owners from six counties in eastern North Carolina (NC) and one county in eastern Virginia (VA). Our focus on small woodlands is also timely from a policy perspective, as there is growing concern about the generational turn-over of forest land and parcelization of forest (Riitters et al. 2002). In 2006, 95% of North Carolina's family forest owners owned less than 100 acres of woodland (Butler 2008). This is the fastest growing land size class and this trend will persist (Mehmood and Zhang 2001, Yi et al. 2007).

We address the challenge of sampling a population that has traditionally neither attracted nor sought attention from public agencies by narrowing our study area to counties with a high percentage of minority owned and operated farms, census blocks in those counties with high poverty and low income and education, and individuals who own at least 5 acres of woodland and no more than 100 acres total in the county. The resulting survey yielded a significantly higher proportion of minority and small woodland owners compared to the National Woodland Owner Survey, which targets family forest owners (Butler 2008).

Discount Rates of Woodland Owners

There were three studies that measured the discount rate of woodland owners, as summarized in Table 1.

Table 1. Summary of discount rate estimates for US NIPF owners

Study	State	Method	Acreage	Discount Rate
Kronrad & De Steiguer, 1983	NC	Stated Preference, open ended	Avg 183 ac	15.1% (Nominal, 25yr)
Bullard et al., 2002	MS	Stated Preference, open ended	Min 20 ac	13.1% (Nominal, 25yr)
Prestemon & Wear, 2000	NC	Observed Behavior, harvest timing	Avg 1247 ac	18% (Real)

Kronrad and de Steiguer (1983) surveyed 123 NIPF landowners in North Carolina about their present rate of return and the rate of return they desired from a 5 and 25-year investment. They found that landowners required higher hurdle rates for longer investment periods, and those with higher incomes demanded higher hurdle rates. A more recent study by Bullard et al. (2002) in Mississippi echoed these findings, using a larger dataset of NIPF landowners in Mississippi

(N=829). Prestemon and Wear's study deduced the discount rate from observing the decision to harvest between two survey periods that were six years apart and assuming that landowners only harvest when their expected returns from harvesting immediately are greater than the Net Present Value (NPV) of harvesting during the next period.

These studies focused on relatively well-informed, larger landowners. Respondents in the Kronrad and de Steiguer study were attendees of a series of informational meetings for NIPF landowners. Bullard et al. only included landowners with at least 20 acres of uncultivated land who had harvested timber in the last 5 years. In the Prestemon and Wear study, the average acreage ("area expansion factor") was 842 acres. Hence, these results may not be valid for small woodland owners who were not in this network of informed forest landowners.

Survey and Sampling Methods

Study Area

This study was a research component of a larger education and outreach project known as the Sustainable Woodlands Project (SWP), which was funded by the USDA Sustainable Agriculture Research and Education (SARE) program from 2003 to 2005. There were seven study counties in North Carolina and Virginia, divided into two clusters in the north (Brunswick (VA), Warren, Northampton, and Halifax (NC)) and south (Robeson, Sampson and Duplin)). All are in the coastal plain, except for Brunswick and Warren. These counties were chosen because they had high proportions of minority-owned or operated farms and woodland on farms (USDA-NASS 2002). They were underdeveloped relative to state and national averages (US Census Bureau 2004): higher percentage of adults without high school degrees, lower household median income, and lower income per capita. About 16-24% of the population lived under the poverty line, compared to 12% in the US. These counties were also among the most diverse counties in their states (US Census Bureau 2004), with up to 67% African American or Native American population.

Sampling Frame

Two datasets were used to identify and contact potential respondents: county tax rolls the and US Decennial Census. From the tax rolls, we identified parcels located in limited resource areas, which have high minority populations, low education attainment, and low median household income (or high percentage of households under the poverty line) relative to the county median (based on US census data).

A woodland owner was defined as the owner or co-owner of at least one land parcel with at least 5 acres of woodland. A small woodland owner owns at most 100 acres of land, which includes wooded and non-wooded land. The basis of the maximum acreage is the economies of scale in timber production. In tracts larger than 100 acres, landowners can take advantage of the economies of scale in most timber production activities (Cubbage and Harris 1986), and the probability of engaging in some types of forest management activities starts to decrease dramatically among landowners with less than 100 acres of forestland (Butler and Leatherberry, 2004).

Survey Implementation

Data were collected using mail surveys conducted in July-August 2004, following the standard Dilman procedure. Information about the survey was provided in local newsletters a month before the survey took place. Landowners selected for the survey were sent introductory postcards. A survey packet was sent in July; a month afterwards, landowners who had not replied were sent follow-up postcard reminders. The survey instrument was pretested by woodland owners, faculty at NCSU and NC A&T, as well as forestry extension agents. It consisted of 55 questions about forestland size and attributes, tenureship arrangement, forest management activities and objectives, heirs' participation in forest management, preference for information sources, future land use plans, socioeconomic characteristics, and time preference. The first question in the survey determined if the respondent was eligible to participate (*i.e.* they owned woodland in any of the study counties).

To improve response rates, we included a $1 bill in the survey package as a token of commitment and trust to the landowners that receive the package, and to pique their interest. The survey used large fonts (smallest font is size 14), wide spacing, simple question formats, and landowner-friendly language to accommodate landowners with limited formal education and forestry knowledge. A total of 1179 survey packets were mailed in July 2004, of which 84 were rejected due to address mistakes. Four of the 303 respondents no longer owned woodlands and were also rejected. The resulting overall response rate was 27%.

Respondent Characteristics

Table 2 summarizes the characteristics of respondents of this survey. Weighted results were based on the NWOS woodland acreage.

Methodology

Discount rate elicitation

Respondents were asked to choose between two timber harvest income scenarios, which had different rotation lengths and payoff (net returns) amounts. Landowners may find it difficult to exclude risk entirely from their decision even though payments in the scenario were certain and risk-free. To reduce the effect of risk aversion, the scenarios offered a certain upfront payment, and future payments that come at different intervals. Offering upfront payments ensured that respondents will consider both options regardless of their self-assessed life expectancy. The choice was between:

1) LS: Large (upfront) and Seldom payment: Clear cut with large payments received now and every 32 years.
2) SF: Small (upfront) and Frequent payment: Partial cut with small payments received now and every 8 years.
3) Neither

Table 2. Descriptive statistics

Characteristics	Sustainable Woodlands Survey (N=299)		NWOS 2006[a], NC (N=321)
	Unweighted	Weighted	Weighted
Woodland Acres: ≤30 acres	51.2%	88.4%	88.4%
30.1 – 50 acres	16.3%		
50.1-100 acres	16.1%	6.4%	6.4%
>100	14.3%	5.2%	5.2%
Race: Non-White[b]	28.8%	34.81%	0.94%
Gender: Female	35.8%	39.39%	26.53%
Annual HH Income: ≤$45,000 (2004)	29.8%	39.63%	33.92% [c]
Education Attainment: ≤ High School	27.8%	29.59%	46.33%
Median Age (yrs)	64	63	55-64 [d]
Median Woodland acres	30	22	1-9 ac [d]
Median Total Land Acres	48	40	
Made written will	56.2%	54.82%	
Contacted forester [a]	25.8%	21.63%	
Made stand improvements	40.8%	35.45%	

[a] National Woodland Owners Survey (Butler 2008).
[b] Non white = African American, Hispanic, Native American, Other.
[c] NWOS used a $50,000 benchmark, equivalent to $45669 in 2004 dollars.
[d] Range that included the median value.

There is an implied discount rate (ρ) that sets the net present value (NPV) of both choices equal to each other. Respondents who chose LS implied that their discount rate (r) was higher than the implied discount rate (r>ρ). Alternatively, they chose SF when their discount rate was lower than the implied rate (r<ρ). The implicit discount rate is determined by solving for ρ in the following equation:

$$\frac{P_{LS,q}}{P_{SF,q}} = \frac{1-e^{-\rho t_{LS}}}{1-e^{-\rho t_{SF}}}$$

Where t_{LS} and t_{SF} correspond to rotation length of option LS (32 years) and SF (8 years), ρ_q is the implicit discount rate for question q, and q is an index for question 1 or 2. The range of implied discount rates in the first and second question is from -3.1% to 20.0%, and 7.6% to 22.3% per year respectively. Most respondents chose the same option (LS or SF) in both questions, resulting in single-bounded estimates ($r>\rho_{High}$ or $r \leq \rho_{Low}$). 11.7% of respondents chose LS or SF in one question and either opt-out or no answer in the other question, which also results in a single-bounded estimate.

There were several promising signs that respondents understood this exercise: (i) Relatively high education level of respondents: only 11 respondents did not have at least a high school education;

(ii) Consistency: only 2.7% of respondents gave inconsistent answers to the two questions; (iii) This self-paced survey avoided respondent fatigue; (iv) Most respondents chose the SF (Smaller Frequent) payments; if they did not believe the intertemporal scenarios were plausible, they would have chosen the LS (Larger Seldom) option that offered a much larger upfront payment.

Estimating the Discount Rate and Its Determinants

Two parametric methods were chosen for this study because they provide a different insight into respondents' time preferences: (i) Binary Maximum Likelihood Estimation (MLE), and (ii) Grouped MLE. Table 3 compares the two methods.

Table 3. Comparison between binary and grouped MLE methods

	Binary MLE	**Grouped MLE**
Dependent variable	Probability of choosing LS for each question	Upper and lower bounds of the discount rate, based on implied rates from each question
Independent variable	Price of LS and SF (P_{LS} and P_{SF})	Respondent and woodland characteristics
Number of observations	Max. 2 per respondent	Max. 1 per respondent
Insights	Underlying preference for LS or SF, regardless of prices	Characteristics that are correlated with discount rates

Binary Maximum Likelihood Estimation (MLE)

This method involves two steps. The first is to estimate a function that explains the probability of choosing LS using the payment amounts (P_{LS} and P_{SF}), via Maximum Likelihood Estimation (MLE):

$$\Pr(LS_{q,j}) = \left\{1 + \exp\left[-\left(\alpha + \beta_{LS} \cdot P_{LS,q,j} - \beta_{SF} \cdot P_{SF,q,j} + \varepsilon_j\right)\right]\right\}^{-1}$$

Three variations of this model were estimated: (i) Basic Model: only intercept and prices; (ii) Intermediate Model: intercept, dummy variables for personal characteristics, and prices; and (iii) Complex Model: intercept, dummy variables, prices, and interaction terms between prices and personal characteristics. Following the time preference literature, the discount rate was modeled as a function of characteristics that includes age, income, age/income interaction term, number of children, household size, gender, race, age and education levels. Each question (q) is a single data point. Since each respondent could contribute up to two observations, the error term (ε) was clustered by respondent to take into account the panel nature of the data. A positive intercept means that respondents prefer the LS option regardless of the prices offered in either options (*i.e.* they have a stronger underlying preference for clear cutting every 32 years compared to partial cutting every 8 years). The resulting coefficients (β_{LS} and β_{SF}) were used to calculating the discount rate, by solving for r in the following equation:

$$\frac{\beta_{LS}}{-\beta_{SF}} = \frac{1-e^{-8r}}{1-e^{-32r}}$$

The data was bootstrapped 1000 times to estimate the discount rate variance.

Grouped Maximum Likelihood Estimation (MLE)

The Grouped MLE method is a parametric method that uses the observed discount rate ranges as dependent variables. The survey only provides the upper (ρ_{High}) and/or lower (ρ_{Low}) bounds of the discount rate. Hence, the dependent variable is left and/or right-censored. The relationship is modeled as:

$$\left(\rho_{Low,j}, \rho_{High,j}\right) = \sum_{k=1}^{K} \beta_k \cdot Z_{k,j}^{\rho} + \varepsilon_j$$

Where β is a vector of coefficients for a vector of explanatory variable Z, which is a set of personal characteristics used in the Binary MLE method; and ε is the error terms, which is assumed to follow a normal, log normal, or Weibull distribution. This model was estimated using the LIFEREG procedure in SAS, which was designed to work with censored data models. The predicted discount rates from the Grouped MLE method were used as explanatory variables for modeling forest management behavior as described in the next section.

Forest Management Decisions and the Discount Rate

Three activities related to forest management will be discussed in this study: (i) Having a written will, (ii) Contact with a professional forester, and (iii) Investing in forest-stand improvements. These behaviors will be analyzed as binary choice using logistic regression, and are functions of the variables listed in Table 4.

Two models were used for each forest management behavior: (i) Basic model: intercept and discount rate only, and (ii) Complete model: includes all other respondent characteristics listed in Table 4. The discount rate used in this model was estimated using the Grouped MLE method. To take into account that this was an estimated variable, this model was bootstrapped 1000 times.

Results

Discount Rate Estimates

The estimated discount rate from the Binary MLE method was 9.7% per year, derived from the Intermediate model, which proved to be the most parsimonious specification (Table 5). The 95% confidence interval was -1.3% to 21.33%. The estimated intercepts for all respondents were negative, ranging from -3.312 to -0.227, indicating that respondents preferred forest income in shorter intervals. Lower income households were especially more likely to prefer this type of income schedule.

Table 4. Hypothesized determinants of forest management behavior

Parameter	Variable Type	Expected signs		
		Written Wills	Contact Forester	Invest in Forest
Est. Discount rate from Grouped MLE	Continuous	(-)	(-)	(-)
Woodland acreage	Continuous	(+)	(+)	(+)
Gender: Female	Dummy	?	(-)	(-)
Race: African American	Dummy	?	(-)	(-)
Education: ≥ 4-year Bachelor's degree	Dummy	(+)	(+)	(+)
Occupational Status: Retired	Dummy	(+)	?	(-)
Tenure: Inheritance some woodland	Dummy	?	?	?
Tenure: Sole owner of woodland	Dummy	?	?	?
Tenure: Co-own woodland with spouse	Dummy	?	?	?
Distance: Within 5 miles to nearest woodland	Dummy	?	(+)	(+)

Table 5. Determinants of the discount rate

Parameter	Binary MLE		Grouped MLE	
	Estimate	Pr > ChiSq	Estimate	Pr > ChiSq
Intercept	-3.1321***	0.0014	-8.3105***	<.0001
Age	0.0255*	0.0556	0.0535**	0.0456
Age*Income>$45,000	-0.0388**	0.0291	-0.0797**	0.0263
Children	0.4515**	0.0313	0.7021*	0.0795
Children^2	-0.0864**	0.0345	-0.1271*	0.0891
Income>$45,000	2.806**	0.0157	5.6587	0.0169
P_{LS}	0.4213**	0.0363		
P_{SF}	-0.7438*	0.0077		
Observations	465		242	
Estimated discount rate[a]	9.7%		2.6%	
% Correctly predicted	26%		70%	

Dependent variable: Pr (Choose LS)
[a] Annual, risk-free real discount rate.
Significance level: ***(1%), **(5%), *(10%).
Note: Grey highlights indicate coefficients used in the discount rate estimation the Binary MLE.

The average discount rate from the Grouped MLE method was 2.63%, ranging from 0.01% to 7.2% per year, based on a log-normal distributional assumption. The Grouped MLE estimate was within the discount rate ranges for 70% of the respondents, which was much higher than the proportion correctly predicted by the Binary MLE estimate (26%).
The marginal effect of children on discount rates was positive for respondents with less than three children, zero for those with three children, and negative of those with more than three children. Since 87% of respondents had three children or less, the effect of the number of children on discount rates was generally positive. Discount rates increased with age, but this

effect was tempered by income. The discount rates of respondents with higher income increased at a slower rate as they aged, compared to those with lower income. Gender, race, household size and education were not significant variables in determining discount rates in either method.

The Role of Discount Rates in Forest Management Decisions

Results from the bootstrapped sample are displayed in Writing wills was the only behavior where the discount rate was a significant variable (Table 6). The significance of the estimated discount rate term was reduced in the Complete model. The direction of the effect was not as expected: respondents with higher discount rates were more likely to write wills. Recall that the number of children increased the discount rate, and could also increase the probability of written wills. Retirees were more likely to write wills. Woodland owners who lived on or near their woodlands were less likely to write wills. This result is troubling because it suggests woodland owners assumed their woods would be properly transferred upon their death because they were physically close to their woods. This result may be attributed to the notion that the woodland is special because it is their home instead of just a capital asset, or that their heir's ownership was secure because their own tenure was common knowledge to local residents.

Female respondents were less likely to contact professional foresters. This result was supported by anecdotal evidence from attendance profiles during woodland owner meetings that were held by the research team. Landowners who lived on or near their woodlands, or had larger acreages, were more likely to contact professional foresters. Respondents who co-owned woodlands with their spouses were less likely to contact foresters, compared to sole-owners and landowners who co-own with other family members. Spousal ownership may be related to woodland owners who lived on their woodland and saw it as part of their home. Sole owners and those who co-owned with their spouses may feel more responsible in making informed forestry decisions compared with owners with other types of tenureship arrangements (mainly co-ownership with family members).

Discussion

This study shows that discount rates of LRWOS were affected by factors such as age, household income, and number of children. These factors do not affect industrial landowners and indicate the underlying differences in the way small woodland owners make their intertemporal decisions. Unlike other behaviors considered in this study, writing wills was the only behavior influenced by the discount rate. It is also the only behavior that forced landowners to consider the welfare of their heirs in the context of their own mortality and family dynamics. This is where intertemporal decision-making mattered most.

Sole and spousal woodland owners were more likely to invest in their woods compared to owners with other tenureship arrangements. However, these types of ownership cannot be maintained in the long run without written wills. Our study finds that landowners who live on or near their woodlands were less likely to write wills, indicating a general lack of understanding of the role of wills in maintaining tenureship.

Table 6. Discount rates and forest management behaviors [a]

Parameter[b]	Pr(Written Wills)		Pr (Contact Forester)		Pr(Forestry Investment)	
	Basic	Complete	Basic	Complete	Basic	Complete
Intercept	-0.317	-0.809†	-1.212***	-1.547***	-0.571***	-1.215**
Est. Discount Rate	22.232***	14.694†	5.349	1.859	8.365	8.762
Female		-0.003		-0.680*		-0.248
Retiree		0.576**		-0.054		-0.590**
Inherited woodland		0.462		0.299		-0.499†
Sole owner		0.546		-0.090		0.856**
Co-Own with spouse		0.427		-0.601		0.801*
Live within 5 miles		-0.759***		0.522†		0.315
Woodland acreage		0.0013		0.007***		0.007***

[a] Coefficients in this table were the median of coefficients estimated from bootstrapping 1,000 times. Significance levels were also derived non-parametrically.
[b] Race and education attainment were included in the model but not displayed because they were not significant variables in any behavior.
Significance level: ***(1%), **(5%), *(10%), †(15%).

Our results reveal the need for outreach to female and retired woodland owners. From this paper, we have witnessed the importance of family dynamics in forest management decisions and its long-range implications (*e.g.* through will-making). Putting more resources on outreach targeted at female and retired woodland owners could be a fruitful long-term public investment. Landowners, especially those with lower incomes, showed a strong preference for smaller forest income that accrues in intervals shorter than the typical timber rotation lengths. However, what forest management options do they have? In a future where forests are becoming more fragmented, more effort is needed to increase the development and awareness of forest management alternatives that can provide these kinds of income streams.

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COMPARING MOTIVATIONS AND INTENTIONS OF INHERITORS TO NON-INHERITORS OF FAMILY FORESTS

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Abstract

This paper analyzes and compares the characteristics, motivations and future intentions of multi-generational family forest landowners (inheritors) to the single generational forest landowners (non-inheritors). Results suggest there are significant differences in their motivations and management behavior. Inheritors are more active forest managers and manage for both timber and non-timber forest products more aggressively than non-inheritors who typically value aesthetics, privacy, protection of biodiversity, and non-hunting recreation.

[Abstract Only]

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PLACES IN FAMILY FORESTRY: MACON AND ESCAMBIA COUNTIES, ALABAMA

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Abstract

Family forestry consists of various social dimensions such as marriage, inheritance, gender, race, social network and legacy. All of these social phenomena are strongly related with places. Family forestry is not only dynamic, but also of path dependence from the history of the places. Using family forest owners sampled from Macon and Escambia counties, Alabama, some characteristics of the landowners between the two places are compared and explained by history and natural environments of the places in this study. Even though the two counties have similar forest coverage currently, Macon County has a much larger presence of African-American forestland ownership than Escambia County, while Escambia has significant forest industry presence. There are some similarities, but the land holding, owners, and access to the land are found to be different between the two counties.

Keywords: Black belt, poverty, forest industry, non-industrial private forests, forest management objectives

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Introduction

There are an estimated 620 million acres of forestland in the conterminous United States (Smith et al. 2004). Almost 40% or 248 million acres is in family forest ownership or non-industrial private forests (NIPF) (Butler and Leatherberry 2004). Family forestry is characterized by heterogeneity and complexity in terms of ownership structure, owners' objectives and management practices. The majority of previous studies on family forests have tended to view them as individual decision makers using quantitative survey techniques to characterize landowners' objectives, management activities, and preferences (e.g. Binkley 1981, Dennis 1990, Vincent and Binkley 1993, Kuuluvainen 1996, Kendra and Hull 2005). For an excellent review of literature on family forests see Beach et al. (2005). However, family forestry has a great a great deal of social context (e.g. Schelhas and Zabawa 2004).

Considering land as the basic resource around which work and family life are organized (Lidstav and Nordfjell 2004), place could play a critical role in socio-economic evolution and family forestry. Place can be considered to have four dimensions: (1) biophysical elements, or the physical setting and environments (2) psychological aspects, or place attachment, (3) socio-cultural elements, referring to the social community and their culture, and (4) political economic elements and processes (Ardoin, Clark et al. 2000, Kruger and Jakes 2003, Stedman 2003). Together these elements of place shape the development of land use and other economic activities, as well as demography and other social patterns. Fraser et al. (2005) examined the spatial relationship between the African-American landowners and the well-being in Perry County, Alabama. Since agriculture and forestry are more land dependent than any other sectors, place has special meaning for family forestry.

We use Macon and Escambia counties as cases to explore the places in place of family forestry. In this paper, we will first introduce the basic facts of history, land, and forest resources in the two counties. Then the survey and some methods of the study will be described. Some results will be presented to illustrate the different forestland owners between the two counties.

Macon and Escambia Counties

Macon and Escambia counties are located southeastern Alabama, more specifically in the east-central portion and the southern part of Alabama. Macon County was created by the Alabama legislature in 1832 from territory acquired in the Creek cession. Escambia County was created by the Alabama legislature in 1868 from parts of Baldwin and Conecuh counties. The word "Escambia" is believed to come from the Choctaw Indian language, suggesting significant presence of Native Indians.

Two counties are endowed with rich forest resources where forest coverage is very high at 73% and 77%, respectively (USDA Forest Service 1999). However, the two counties are among the poorest in the state and nation, even though forestry is a viable option for economic development in the region (e.g. Bliss et al. 1993, Gan et al. 1995). Macon and Escambia counties have very different histories.

Macon County lies in the rich soils of the Black Belt. Macon was dominated by plantation agriculture and slavery in the mid-1800s and replaced by sharecropping as it replaced the plantation system in the late 1800s. Blacks continued in a subsidiary role in agriculture and found it very difficult to obtain land of their own (Yamaguchi 1981). Today, Macon County has been largely passed over by the development that has occurred along the I-85 corridor (Wear and Greis 2002). Farming has declined, with the only significant crop in 2006 being hay (Table 1), and many former farm lands are now in forest.

Table 1. Agricultural and forestry comparisons for Macon and Escambia County, Alabama (2006)

	Macon	**Escambia**
Cash receipts (1000 $)		
Crops	8,019	19,937
Livestock and Poultry	3,503	4,153
Forest products	7,113	23,696
Total Farm & Forestry	21,475	57,321
Crops (acres)		
Cotton	*	25,500
Corn	*	1,700
Peanuts	*	9.2
Wheat	*	1,100
Hay	4,600	2,70
Land area (Sq miles)	947.38	610.52

Data Sources: USDA, NASS, Alabama Field Office.

Escambia county, on the other hand, has a history of forestry—with forest products being the lifeline and chief exports—with sawmills, paper mills, and utility poles being the chief industries throughout the 20th Century (Waters 1983). There were few plantations using slave labor in Escambia County, and Blacks migrated to the county to work in the timber industry in the late 1800s. A number of Creek Indians hid in the swamps of southwest Alabama after most American Indians were moved to Oklahoma in the "Trail of Tears," and later Creeks returned and eventually the Poarch Creek Reservation was established, the only federally recognized Indian reservation in Alabama. Escambia County today is a major agricultural and forestry producer (Table 1).

Due to the difference in place and history, some differences between the two counties still can be found (Table 2). The most obvious one is the percentage of African-Americans: 85% in Macon County and 30% in Escambia County. Some difference in gender and age structure is also evident. It is more apparent that the difference in race structure came from historical causes. Macon was a very agricultural county that demanded a lot of slave labor, while Escambia had a lot of American Indians and less agriculture. But the causes of difference in gender and age structure might come from the current economic structure and life cycle. For example, Escambia has a stronger forest industry that hires mostly males and working age young people.

Table 2. Gender, age and race of the population in Macon and Escambia, Alabama

	Macon		Escambia	
	Number	**Percent**	**Number**	**Percent**
Gender				
Male	11075	45.9	19475	50.7
Female	13030	54.1	18965	49.3
Total	24105	100	38440	100
Age				
Under 20 years	7518	31.2	10414	27.1
20-64 years	13220	54.9	22788	59.3
65 Years and above	3367	14	5236	13.6
Race				
White	3365	14	24754	64.4
Black and African American	20403	84.6	11837	30.8
American Indian & Alaska Native	39	0.2	1157	3
Asian	91	0.4	94	0.2
Other	207	13.4	598	1.6
Poverty rate		28.3%		20.1%
Household medium income	$23,378		$29,330	

Data source: Census 2000

Methods and Data

To examine the difference in owners, their management objectives and other factors between the two counties, we use two sources of data. One is from USDA Forest Service; another one is from a mail survey study (random samples of forest landowners in Macon and Escambia). We can get information about numbers of forestland owners, their holding size distribution at the county level from Alabama fire tax data that has been assembled by the School of Forestry and Wildlife Sciences at Auburn University. A random sample of 500 names in each county was drawn from a list of forest owners with more than 10 acres of forest land based on county fire prevention tax records. Questionnaires and follow-ups were mailed to these people in accordance with Dillman's (2000) method for mail surveys. The delivered questionnaires are 418 for Macon and 392 for Escambia, respectively. The survey consists of 35 questions in landowner-friendly language, focusing on landowners' characteristics. The response rates are 30% for Macon and 28% for Escambia.

We examine the land and differences between of forestland owners in the two counties. In addition to basic data description, an analysis of variance (ANOVA) was used to investigate the characteristics of family forest landowners. The method is to compare the statistical difference between multiple categories based on sample means and variances (Moore and McCabe 2003).

Results and Discussion

Different historical occurrences in the two counties led to significant differences in forestland ownership. There is more forest industry in Escambia than in Macon (Table 3) and more small-scale family owners in Macon (Table 3). Forest industry owns 58% of forest land in Escambia County, but only 8% in Macon. Farmers, ranchers and other individuals own about 90% of the total forest land in Macon, but only 30% in Escambia County.

Table 3. Forestland and ownership in Macon and Escambia, Alabama

	Macon	**Escambia**
All land area (1000 acres)	392.8	608.6
forestland (1000 acres)/ land	288.8	472
(percent of total land)	(74%)	(78%)
Ownership structure		
National forest (1000 acres)	9.7	27.1
(% of total forestland)	(3.4%)	(5.7%)
State owned forest	0	11.4
(% of total forestland)	(0.0%)	(2.4%)
County and Municipal	0	5.7
(% of total forestland)	(0.0%)	(1.2%)
Forest Industry	23.8	273.8
(% of total forestland)	(8.2%)	(58.0%)
Farmers and ranchers	65.3	45.6
(% of total forestland)	(22.6%)	(9.7%)
Private individual	190.1	108.4
(% of total forestland)	(65.8%)	(23.0%)

Data sources: USDA Forest Service 1990

The characteristics of forest landowners in the two counties are summarized in Tables 4 and 5. Considering the similarities between these two counties (good representative of Black Belt counties in southern Alabama, rich forest resources where forest coverage, among the poorest in the state and nation), family forestry shows many similarities in terms of age, income, gender etc. For example, forestland owners have significantly higher income; proportionally whites are more likely the landowners.

Some differences can be found between the two counties largely because of their history. Macon has been changing from an agricultural country, while Escambia has been changing from forestry. Differences in forest landowners by race are evident in both counties. For example, more owners in Macon purchased their land than in Escambia. The holding size on average in Macon is much smaller than in Escambia.

Table 4. Family land owners' characteristics in Macon and Escambia, Alabama

		Macon # (%)	***Escambia*** ***# (%)***
Race	White	82 (73.21%)	*89 (89%)*
	African-American	28 (25%)	*4 (4%)*
	American Indian	1 (0.89%)	*5 (5%)*
	Total number of observations	112	*100*
Gender	Male (%)	81.98% (n=111)	*64.08% (n=103)*
Ages	Under 25 years	0 (0%)	*0 (0%)*
	25-44 years	11 (9.65%)	*6 5.77%*
	45-64 Years	60 (52.64%)	*47 (45.19%)*
	65 years and above	43 (37.71%)	*51 (49.04%)*
	Total number of observations	114	*104*
	Average (S.D.)	61 (11.75)	*64 (11.64)*
	F (P-value)	*4.75 (0.0303)*	
Income	Less than $25,000	6 (6.19%)	*14 (15.38%)*
	$25,000-$49,000	17 (17.53%)	*26 (28.57%)*
	$50,000-$99,000	42 (43.30%)	*29 (31.87%)*
	$100,000 and above	32 (32.98%)	*22 (24.18%)*
	Total number of observations	97	*91*
	Average (S.D.)	118118.56 (109054.31)	*90439.56 (93152.80)*
	F (P-value)	*3.48 (0.0637)*	
Education	Less than 12th grade	3 (3.63%)	*5 (4.85%)*
	High school graduate and GED	8 (7.02%)	*27 (26.21%)*
	Some college/associate or technical degree	29 (25.44%)	*34 (33.02%)*
	Bachelor's/Graduate degree	74 (64.91%)	*37 (35.92%)*
	Total number of observations	*114*	*103*

Table 5. Forestland Characteristics and forestland transaction in Macon and Escambia, Alabama

		Macon		*Escambia*	
Holding size (acres)	1-9	1	(0.84%)	3	*(2.83%*
	10-19	6	(5.04%)	11	*(10.38%)*
	20-49	20	(16.81%)	38	*(35.85%)*
	50-99	31	(26.05%)	26	*(24.53%)*
	100-199	22	(18.49%)	12	*(11.32%)*
	200-499	23	(19.33%)	9	*(8.49%)*
	500-999	9	(7.56%)	1	*(0.94%)*
	1000-4999	7	(5.88%)	4	*(3.77%)*
	5000 and above	0	0	2	*(1.89%)*
	Total number of observations	119		*106*	
	Average (S.D.)	353.95 (692.95)		*386.51 (1454.98)*	
	F (P-value)	*0.05 (0.8276)*			
How did you get your forestland?	Bought	65	(54.17%)	43	*(39.81%)*
	Inherited	40	(33.33%)	42	*(38.89)*
	Got it as gift	3	(2.5%)	4	*(3.75%)*
	Bought and Inherited	10	(8.33%)	16	*(14.81%)*
	Bought and Got it as gift	1	(0.83%)	1	*(0.93%)*
	Bought, inherited, and got it as gift	1	(0.83%)	2	*(1.85%)*
	Total number of observations	120		*108*	
Farm or ranch within 1 mile away?	Yes	71.19% (n=118)		*73.58% (n=106)*	
Home or cabin within 1 mile away?	Yes	74.56% (n=114)		*85.71% (n=105)*	
Was the land forested	*Yes*	*81.74% (n=115)*		*82.86% (n=105)*	

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INFLUENCE OF INSTITUTIONAL CHANGE ON LANDOWNER WILLINGNESS TO ALLOW FEE-BASED RECREATION IN THE LOUISIANA DELTA

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Abstract

The willingness of landowners to allow fee-based recreational use of their land was investigated using data obtained from a mailed questionnaire sent to landowners in the Delta region of Louisiana. Previous studies have identified that landowners often chose not to engage in recreational leasing due to liability concerns. An institutional change that reduces liability risk to landowners may increase the amount of private land available for public recreation. Also, owners of marginal agricultural land may be more willing to consider alternative land uses such as fee-based recreation. Probit models are used to examine the yes/no decision to allow fee-based recreation pre- and post-institutional change.

About 14% of landowners indicated that they would be willing to allow fee-based recreation under the current institutional environment. If the Louisiana recreational use statute was amended giving greater liability protection to landowners, the number of landowners willing to allow fee-based recreation on their lands would increase to nearly 24%. Clearly, an institutional change that reduces liability risk to landowners can increase the potential amount of private land that could be used for fee-based recreation. Owners of marginal land were particularly responsive to an institutional change providing greater liability protection. Risk-averse landowners were more unlikely to allow fee-based recreation under the current institutional environment. Following an institutional change it was observed that risk preference was no longer a significant predictor of the willingness to allow fee-based recreation indicating that the element of risk was diminished.

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Keywords: Fee-based recreation, recreational use statute, institutional change, binary probit

Introduction

Recreational hunting, fishing, and wildlife watching opportunities on private land for public use may be a possible way to provide income to landowners in the Louisiana Delta and restore marginal lands as a contributor to the local economy. However, generating additional income for landowners by allowing recreational activities brings with it the possibility of legal action as landowners may be sued if bodily injury results to a recreational user of the property (Copeland 1998). State legislatures have passed recreational use statutes designed to encourage landowners to allow recreational use of their land by offering immunity from lawsuits related to accidental injury (Copeland 1998). Most state recreational use statutes insulate landowners from liability if access is granted without a charge. However, there are an increasing number of states allowing landowners to charge a fee and retain liability protection (Wright 1989, Wright et al. 2002). Today all 50 states have adopted recreational use statutes that are intended to encourage landowners to make their lands available for public recreational use by providing greater liability protection to the landowner (Wright et al. 2002).

Even with the liability protection afforded to landowners by state recreational use statutes, there remains a significant gap between landowners' perceptions regarding liability and the reality of liability (Wright et al. 2002). In their survey of recreation use statutes, Wright et al. (2002) observed that researchers have clearly identified that landowners are concerned about liability but have only documented that it is perceived as a problem. Wright et al. (2002) indicated that a better understanding is needed of how liability and various other disincentives collectively influence landowners' access decisions. Mozumder et al. (2004) suggested that the necessary institutions for hunters and landowners may not be in place to promote recreational leasing, and that institutional changes that facilitate more exchanges would shift the supply curve outward. The effects of institutional change on landowner leasing behavior can be explored by asking if landowners would allow recreational access and/or leasing if liability was limited by state law. The Louisiana recreational use statute (La. R.S. § 9:2791) does not extend liability protection if a fee is charged for access. It would be interesting to see how landowner leasing policies may change by expanding the liability protection of recreational use statutes to allow the charging of a fee intended to generate a return to the landowner. Investigating the effect of such an institutional change can provided insights into landowner leasing behavior and possible effects on the supply of available recreational land.

The primary objectives of this study are to understand how landowners' attitudes and perceptions about recreation, liability, and other possible disincentives collectively influence landowner access decisions, and how institutional change might stimulate public recreational access to private land. Using survey data and econometric techniques, this study will seek to identify land and landowner characteristics that may have a positive or negative effect on a landowner's probability of choosing to offer fee-based recreation.

Methods and Data

This study utilizes primary data obtained from a mail survey questionnaire developed according to the tailored design method (Dillman 2000) and sent to agricultural landowners in the Delta region of Louisiana. Questions focused on current land uses, landowner access policies, and landowner attitudes and perceptions regarding the potential for allowing fee-based recreational access. Landowners were also asked to indicate their knowledge of the Louisiana recreational use statute and how possible changes in the use statute would impact their access policies. Additional questions addressed land tenure, usage, and landowner demographics.

One factor that may influence the behavior of landowners regarding fee based recreation is that of risk preference, given that there is an inherent element of risk associated with recreation and liability. A common method used to elicit risk preference is that of direct risk preference elicitation. A study by Fausti and Gillespie (2006) compared mail survey results for five commonly used methods to elicit risk preference and examined the consistency of the elicitation procedures. Fausti and Gillespie (2006) noted that a simpler elicitation method (such as the self-rank risk preference question) performs relatively well and may be a better choice for elicitation of risk when mail survey respondents are not offered rewards or incentives for spending time to correctly answer questions. The mail survey instrument used in this study attempted to assess landowner risk preference by using a self-rank risk preference elicitation method that asked respondents to indicate if they tend to avoid, take on, or neither seek nor avoid risk in their investment decisions. Possible landowner concerns over the risk of liability associated with allowing recreational access necessitates an assessment of landowner risk preference. Information on landowner risk preference may be a useful variable in understanding recreational access decisions.

Analysis of possible relationships between dependent and independent variables was investigated using qualitative choice models. When a dependent variable involves only two values, a Binary Probit model can be used to examine how various independent variables (X_i) influence the probability of observing a certain outcome (Y_i=1, 0 otherwise) in a binomial dependent variable (Franses and Paap 2001). The yes or no response to allow fee-based recreational access and the influence of independent variables on the probability of that decision was examined using a Binary Probit model. A second Binary Probit model was used to examine the access decision following a hypothetical institutional change. This was examined using responses to a second access question that included a hypothetical scenario involving a proposed amendment to the Louisiana recreational use statute that would allow landowners to charge a fee for recreational access while retaining liability protection.

Results

The survey response rate was 26.9%. More than half of respondents have allowed individuals outside of their immediate households to use their land for recreational purposes; however, such access was not commonly allowed for individuals that landowners do not know personally. Just over 10% of landowners have allowed recreational access to individuals they do not know personally, and only 11.2% have accepted money to allow recreational use of their land.

The vast majority of respondents indicated that they are very concerned about the liability issues associated with allowing people on their land. This concern may explain in part why so few landowners have allowed recreational access to individuals they do not know personally. However, when asked if their liability concerns were eased would they be more inclined to allow recreational access, 36% of landowners indicated that they either somewhat or strongly agreed. This indicates that an institutional change may increase recreational access to private lands. However, over 40% respondents either somewhat or strongly disagreed with allowing recreational access if their liability concerns were eased. This suggested that liability concern may not be a major factor in the decision not to allow recreational access for some landowners. The results indicated that there exists a clear need for more landowner education on land access and liability. When it came to having knowledge of liability and legal issues, the vast majority of respondents either do not know or are unsure about matters regarding written agreements between landowners and land entrants, posting of "no trespassing" signs, state recreational use statute, and the availability of liability insurance for fee-based recreation.

Another possible factor that may influence the decision to allow fee-based recreation is that of risk preference. Allowing recreational use of land introduces the risk associated with liability, and over 70% of respondents indicate that they are risk averse and that they tend to avoid risk in their financial decisions. The implications are that many landowners may choose not to allow fee-based recreation because of the liability risk, but it may also indicate that an institutional change reducing landowner liability may increase landowner willingness to allow fee-based recreation.

Fee-based recreation may be more attractive to respondents owning marginal agricultural land. Respondents considered 33.3% of their lands to be marginal for agricultural purposes. There seems to be potential for developing such opportunities as results indicate a high volume of marginal land. About 80% of respondents described their marginal land as forest or wooded areas, which would be ideal for certain types of wildlife associated fee-based recreation. When landowners were asked if they would be willing to allow fee-based recreation on their land, 14.1% of landowners said yes. When landowners were presented with a hypothetical scenario describing a change to the recreational use statute that would allow them to charge a fee for recreational access and keep the liability protection afforded to free access landowners, 24% of landowners indicated a willingness to allow access, a 70% increase. Clearly, an institutional change that reduces the liability risk to landowners can increase the potential amount of private land that could be used for fee-based recreation. The average amount of land that landowners would be willing to use for fee-based recreation was 256.6 acres. So under the current Louisiana recreational use statute or with a modification to the recreational use statute, the potential exists to make available a sizable amount land for public fee-based recreational use.

The level of participation in government conservation programs was high, as indicated by 60% of respondents. This suggests that Louisiana Delta landowners may be willing to adopt non-agricultural uses of their land, such as fee-based recreation. While most landowners are single owners, 37% of landowners indicated they owned land jointly. Such joint owners of land responding to the survey may not be comfortable with allowing fee-based recreation since they may lack autonomy in the decision process. In addition, there may be costs involved such as the cost of having to deal with their co-owners, such as the cost of bargaining and negotiating.

Alternative land uses may also not be as attractive to individuals that purchased land, which was indicated by over 55% of respondents, with the assumption that they purchased the land for some specific purpose or use in mind. However, 46% of respondents indicated that they acquired land through inheritance and may be more inclined to consider alternative uses. Also, agricultural production of row crops was indicated by 57.4% of respondents. This may suggest that landowners might be willing to consider alternative land uses, since over 40% are not using their land for agriculture.

Probit models were used to analyze the probability of the yes/no decision to allow fee-based recreation under both the current and modified recreational use statutes for Louisiana. The dependent and independent variables, based on survey responses, used in the Probit models are described and their mean and standard deviation values presented in Table 1. Probit parameter estimates and marginal effects for the decision to allow fee-based recreational access under the current Louisiana recreational use statute are presented in Table 2. Probit parameter estimates for the decision to allow fee-based recreational access under a modified Louisiana recreational use statute are presented in Table 3.

Discussion

The potential effect of easing liability concern of landowners was a very significant predictor for the probability to allow fee-based recreation whether pre- or post-institutional change. This is represented by the two variables that indicate if landowners disagree (CONCERNEASED2) or agree (CONCERNEASED3) with allowing recreational use of their land if their liability concerns were eased. This provided a very consistent theme for both Probit models where if landowners disagreed the effect was negative and if they agreed the effect was positive for the decision to allow recreational access. For many landowners the reason they chose not to allow fee-based recreational access is not related to liability concern.

As for the positive effect of CONCERNEASED3 (i.e., agree with allowing recreational use of their land if their liability concerns were eased) and its significance in both Probit models, one would expect the magnitude of the positive effect to be greater in the post institutional change model, since the liability risk would be lower for landowners under the post-institutional change environment relative to the pre-institutional change conditions. This appears to be true. In the pre- and post-institutional change models, the probabilities of allowing fee-based recreation increase from 6.9% to 11.9%. This reflects the responsiveness of landowners to an institutional change, meaning that landowners would be much more likely to allow fee-based recreation following an institutional change that reduces their liability concerns.

The element of risk is inherent in allowing fee-based recreation. This risk exists as liability with the ever looming potential of a lawsuit, which can be a potentially powerful disincentive to a landowner depending on how a landowner perceives risk. The influence of risk preference was represented in the Probit models by the two dummy variables of RISKPREFERENCE1, indicating risk seeking behavior, and RISKPREFERENCE2, indicating risk aversion. Given that the risk is far greater under the current institutional arrangements, it is not surprising that the

Table 1. Description of variables used in Probit models and mean and stand deviation of survey responses by variable

Variable	Description	Mean	Std. Dev.
ACCESSCUR	Access allow under current RUS (1=yes)	0.141	0.348
ACCESSAMEND	Access allow under amended RUS (1=yes)	0.237	0.426
PERSONALUSE	Land is used for personal recreational use (1=yes)	0.588	0.493
FRIENDSFAMILY	Land is used for recreation by family or friends (1=yes)	0.563	0.496
LEASEDREC	Land has been leased for recreational use (1=yes)	0.112	0.316
LIABILITYCONCERN2	Liability concern over recreational use, disagree (1=yes)	0.106	0.308
LIABILITYCONCERN1	Liability concern over recreational use, not sure (1=yes)	0.090	0.287
LIABILITYCONCERN3	Liability concern over recreational use, agree (1=yes)	0.799	0.401
WRITTENAGREE2	Written agreement protects from liability, disagree (1=yes)	0.250	0.433
WRITTENAGREE1	Written agreement protects from liability, not sure (1=yes)	0.400	0.490
WRITTENAGREE3	Written agreement protects from liability, agree (1=yes)	0.343	0.475
CONCERNEASED2	Liability concern eased, allow recreation, disagree (1=yes)	0.405	0.491
CONCERNEASED1	Liability concern eased, allow recreation, not sure (1=yes)	0.220	0.415
CONCERNEASED3	Liability concern eased, allow recreation, agree (1=yes)	0.369	0.483
NOTRESSPASS	Protection from liability requires me to post, unsure (1=yes)	0.464	0.499
RUSPROTECTS	Protected from recreational liability if free, unsure (1=yes)	0.661	0.474
INSURACEKNOW	Insurance exists for allowing recreation, unsure (1=yes)	0.618	0.486
RISKPREFERENCE1	substantial levels of risk in my financial decisions (1=yes)	0.073	0.260
RISKPREFERENCE2	I tend to avoid risk in my financial decisions (1=yes)	0.754	0.431
RISKPREFERENCE3	I neither seek nor avoid risk in financial decisions (1=yes)	0.158	0.365
MARGINALLAND	Any land "marginal" for agricultural purposes? (1=yes)	0.446	0.497
MARGINALACRES	Number of acres marginal for agricultural purposes	46.283	127.649
LANDOWNERCOOPER	Ever worked with your adjacent or local landowners (1=yes)	0.258	0.438
COOPERATIVE	Ever been involved with a cooperative (1=yes)	0.141	0.349
CONSERVATION	Enrolled land in a government conservation program (1=yes)	0.447	0.498
TRACTS	Number of separate tracts of non-residential land	2.066	2.077
ADJACENT	Non-residential land adjacent to primary residence (1=yes)	0.432	0.496
DISTANCE	Number of miles to nearest tract of land	70.319	238.110
TOTALACREAGE	Total acreage of all tracts of land	324.809	634.085
YEARSOWNERSHIP	Number of years you have been a land owner	28.010	22.637
OWNERSHIP1	Ownership of land organized as corporation (1=yes)	0.011	0.105
OWNERSHIP2	Ownership of land organized as LLC (1=yes)	0.034	0.181
OWNERSHIP3	Ownership of land organized as joint ownership (1=yes)	0.369	0.483
OWNERSHIP4	Ownership of land organized as single ownership (1=yes)	0.642	0.480
ACQUIRE1	Acquire non-residential land by inheritance (1=yes)	0.467	0.499
ACQUIRE2	Acquire non-residential land by marriage (1=yes)	0.027	0.163
ACQUIRE3	Acquire non-residential land by purchasing (1=yes)	0.552	0.498
ACQUIRE4	Acquire majority of non-residential land by other (1=yes)	0.008	0.089
ROWCROPS	land for agricultural production of row crops (1=yes)	0.574	0.495
COTTON	land for cotton production (1=yes)	0.457	0.499
LEASEDFORAG	leased any of your land for agricultural uses	0.674	0.469

Table 1. (Continued)

HAYLAND	Own land for hay production (1=yes)	0.222	0.416
LIVESTOCKLAND	Own land for raising livestock (1=yes)	0.204	0.403
GENDER	Gender (1=female)	0.349	0.477
AGE	Age in years	61.872	13.666
ETHNIC	Ethnic background: Caucasian (1=yes)	0.945	0.229
OCUPATION1	Primary occupation: farming (1=yes)	0.140	0.347
OCUPATION2	Primary occupation: business (1=yes)	0.102	0.303
OCUPATION3	Primary occupation: self-employed (1=yes)	0.109	0.312
EDUCATION1	Education: high school graduate or less (1=yes)	0.343	0.475
EDUCATION2	Education: some college to college graduate (1=yes)	0.435	0.496
EDUCATION3	Education: graduate or professional degree (1=yes)	0.171	0.377
INCOME1	Less than $25K (1=yes)	0.117	0.322
INCOME2	Income $25K to $75K (1=yes)	0.370	0.483
INCOME3	Income $75K or more (1=yes)	0.313	0.464

variable RISKPREFERENCE2 is significant only in the pre-institutional change Probit model and not in the post-institutional change model scenario where the riskiness of allowing fee-based recreational access is substantially lessened. However, in the pre-institutional change Probit model, these variables have the expected sign consistent with theory. An individual that is a risk seeker would be more likely to allow fee-based recreation under the current institutional environment. However, the probability of allowing fee-based recreation under the current institutional environment was 13.6% lower for risk-averse landowners.

The fact that the variable indicating if landowners are aware about the availability of commercial liability insurance (INSURACEKNOW) is significant and negative in sign only in the pre-institutional change Probit and not significant in the post-institutional change model is interesting. Being unsure about the availability of commercial liability insurance (INSURACEKNOW) has a negative effect on the decision to allow fee-based recreation and reduces the probability of allowing access by 4.6%. Having such insurance would reduce the risk of allowing fee-based recreation under the current institutional environment. The fact that this variable is not significant in the post-institutional change model is not surprising since the value of such insurance would be reduced following a change to the recreational use statute that extends liability protection to landowners charging a fee for recreational access.

It was hypothesized that marginal landowners might be more willing to use their land for fee-based recreation, since generating income through agricultural applications may not be practical or profitable. Therefore, it is not surprising that the variable indicating ownership of marginal land is significant and positive in sign. In addition, marginal landowners appear to be very responsive to institutional change. Under the current recreational use statute marginal landowners have a 6.5% higher probability of allowing fee-based recreation than non-marginal landowners, which increases to 11.4% post-institutional change.

Table 2. Probit estimates for the decision to allow fee-based recreational access under the current recreational use statute for Louisiana landowners

Variable	Coefficient	Std. Err.	dF/dx	Std. Err.	z	P>|z|
PERSONALUSE	-0.093507	0.221599	-0.012353	0.029679	-0.42	0.673
FRIENDSFAMILY	0.080768	0.213254	0.010409	0.027174	0.38	0.705
LEASEDREC	0.023169	0.274595	0.003055	0.036689	0.08	0.933
LIABILITYCONCERN2	-0.388816	0.476823	-0.040141	0.038075	-0.82	0.415
LIABILITYCONCERN3	0.078379	0.375110	0.009839	0.045367	0.21	0.834
WRITTENAGREE2	0.360093	0.237933	0.053686	0.040244	1.51	0.130
WRITTENAGREE3	0.311215	0.203367	0.043767	0.031002	1.53	0.126
CONCERNEASED2	-0.679240‡	0.284530	-0.081479	0.030880	-2.39	0.017
CONCERNEASED3	0.486406‡	0.226416	0.068780	0.035831	2.15	0.032
NOTRESSPASS	0.283615	0.190248	0.037708	0.026279	1.49	0.136
RUSPROTECTS	0.032826	0.201386	0.004242	0.025799	0.16	0.871
INSURACEKNOW	-0.334240*	0.197762	-0.045890	0.028806	-1.69	0.091
RISKPREFERENCE1	0.301500	0.333392	0.047304	0.062010	0.90	0.366
RISKPREFERENCE2	-0.777010†	0.225991	-0.135883	0.049129	-3.44	0.001
MARGINALLAND	0.477448‡	0.195757	0.064758	0.027421	2.44	0.015
MARGINALACRES	-0.000241	0.000665	-0.000031	0.000086	-0.36	0.717
LANDOWNERCOOPER	0.226347	0.198820	0.031968	0.030538	1.14	0.255
COOPERATIVE	-0.146936	0.247039	-0.017667	0.027417	-0.59	0.552
CONSERVATION	0.416684‡	0.190247	0.055903	0.026633	2.19	0.029
TRACTS	-0.025994	0.047352	-0.003384	0.006149	-0.55	0.583
ADJACENT	-0.428650‡	0.191252	-0.053972	0.023972	-2.24	0.025
DISTANCE	-0.000423	0.000377	-0.000055	0.000049	-1.12	0.262
TOTALACREAGE	0.000294*	0.000155	0.000038	0.000020	1.89	0.058
YEARSOWNERSHIP	0.000929	0.004335	0.000121	0.000564	0.21	0.830
OWNERSHIP1	-0.226444	0.851523	-0.024909	0.077808	-0.27	0.790
OWNERSHIP2	0.189810	0.389312	0.028124	0.065314	0.49	0.626
OWNERSHIP3	0.007583	0.185743	0.000989	0.024264	0.04	0.967
ACQUIRE1	0.252032	0.303739	0.033418	0.041007	0.83	0.407
ACQUIRE2	0.160295	0.554645	0.023336	0.089610	0.29	0.773
ACQUIRE3	0.192070	0.310752	0.024613	0.039156	0.62	0.537
ROWCROPS	-0.415796	0.325248	-0.057451	0.047964	-1.28	0.201
COTTON	0.470485	0.313448	0.063031	0.043931	1.50	0.133
LEASEDFORAG	-0.021367	0.207201	-0.002797	0.027263	-0.10	0.918
HAYLAND	-0.258995	0.251751	-0.030387	0.026630	-1.03	0.304
LIVESTOCKLAND	0.018172	0.254865	0.002384	0.033685	0.07	0.943
GENDER	-0.167212	0.207152	-0.020912	0.024983	-0.81	0.420
AGE	-0.000861	0.007308	-0.000112	0.000951	-0.12	0.906
ETHNIC	-0.148494	0.372592	-0.021332	0.058824	-0.40	0.690
OCUPATION1	0.100250	0.289564	0.013777	0.041891	0.35	0.729
OCUPATION2	0.269369	0.288588	0.040879	0.050373	0.93	0.351
OCUPATION3	0.466254*	0.264091	0.079097	0.056177	1.77	0.077
EDUCATION1	0.175392	0.205421	0.023843	0.029140	0.85	0.393
EDUCATION3	0.464431‡	0.242182	0.075453	0.047225	1.92	0.055
INCOME1	-0.653350*	0.366203	-0.058458	0.021959	-1.78	0.074
INCOME3	-0.356240*	0.199143	-0.042628	0.022113	-1.79	0.074
CONSTANT	-1.253742	0.787720			-1.59	0.111

†, ‡, *, indicates significance at the 1, 5, and 10 percent level, respectively. N = 531; Chi-square = 145.80; Log-L= -153.88486; Prob>Chi^2 = 0.0000; Pseudo R-squared: 0.3215.

Table 3. Probit estimates for the decision to allow fee-based recreational access under the amended recreational use statute for Louisiana landowners

Variable	Coefficient	Std. Err.	dF/dx	Std. Err.	z	P>|z|
ACCESSCUR	3.241970†	0.440187	0.868092	0.029223	7.36	0.000
PERSONALUSE	-0.171585	0.212467	-0.052391	0.065481	-0.81	0.419
FRIENDSFAMILY	0.113663	0.214483	0.034035	0.063682	0.53	0.596
LEASEDREC	0.063558	0.276840	0.019506	0.086443	0.23	0.818
LIABILITYCONCERN2	0.072253	0.416813	0.022254	0.131015	0.17	0.862
LIABILITYCONCERN3	0.215002	0.322644	0.061538	0.087324	0.67	0.505
WRITTENAGREE2	-0.079261	0.231540	-0.023553	0.067709	-0.34	0.732
WRITTENAGREE3	-0.074148	0.197148	-0.022164	0.058381	-0.38	0.707
CONCERNEASED2	-0.62856†	0.236170	-0.179312	0.062294	-2.66	0.008
CONCERNEASED3	0.383300*	0.214742	0.118667	0.068202	1.78	0.074
NOTRESSPASS	0.099882	0.187082	0.030217	0.056817	0.53	0.593
RUSPROTECTS	-0.204836	0.198734	-0.063136	0.062643	-1.03	0.303
INSURACEKNOW	-0.142831	0.190677	-0.043518	0.058645	-0.75	0.454
RISKPREFERENCE1	-0.106906	0.410501	-0.031135	0.115163	-0.26	0.795
RISKPREFERENCE2	-0.311508	0.236488	-0.099270	0.078865	-1.32	0.188
MARGINALLAND	0.37550‡	0.193584	0.114330	0.059255	1.94	0.052
MARGINALACRES	-0.001052	0.000956	-0.000317	0.000289	-1.10	0.271
LANDOWNERCOOPER	-0.123564	0.206976	-0.036441	0.059584	-0.60	0.551
COOPERATIVE	0.052979	0.256622	0.016207	0.079605	0.21	0.836
CONSERVATION	0.280984	0.181879	0.085268	0.055544	1.54	0.122
TRACTS	-0.006128	0.049607	-0.001849	0.014966	-0.12	0.902
ADJACENT	-0.062809	0.176587	-0.018887	0.052923	-0.36	0.722
DISTANCE	-0.000473	0.000454	-0.000143	0.000136	-1.04	0.297
TOTALACREAGE	0.000310*	0.000190	0.000093	0.000057	1.62	0.104
YEARSOWNERSHIP	-0.001733	0.004221	-0.000523	0.001273	-0.41	0.681
OWNERSHIP1	-2.073588	1.599861	-0.231901	0.032751	-1.30	0.195
OWNERSHIP2	-0.509130	0.504167	-0.125114	0.096016	-1.01	0.313
OWNERSHIP3	-0.303876	0.191556	-0.088220	0.053316	-1.59	0.113
ACQUIRE1	0.187048	0.332507	0.056712	0.101092	0.56	0.574
ACQUIRE2	-0.453394	0.635552	-0.113751	0.126814	-0.71	0.476
ACQUIRE3	0.194002	0.338737	0.057949	0.099993	0.57	0.567
ROWCROPS	0.074300	0.279447	0.022308	0.083531	0.27	0.790
COTTON	-0.032246	0.266303	-0.009720	0.080205	-0.12	0.904
LEASEDFORAG	-0.127525	0.198968	-0.039076	0.061865	-0.64	0.522
HAYLAND	-0.434770*	0.265936	-0.119024	0.065237	-1.63	0.102
LIVESTOCKLAND	0.369618	0.264460	0.119484	0.090432	1.40	0.162
GENDER	0.175312	0.190302	0.053994	0.059580	0.92	0.357
AGE	0.014640*	0.007739	0.004414	0.002323	1.89	0.059
ETHNIC	0.845540*	0.512817	0.179991	0.067466	1.65	0.099
OCUPATION1	0.205958	0.264847	0.065457	0.087957	0.78	0.437
OCUPATION2	-0.049416	0.297296	-0.014692	0.087080	-0.17	0.868
OCUPATION3	0.114996	0.298603	0.035836	0.095990	0.39	0.700
EDUCATION1	-0.162749	0.197495	-0.048113	0.057225	-0.82	0.410
EDUCATION3	-0.179449	0.243937	-0.051702	0.067054	-0.74	0.462
INCOME1	-0.266425	0.296012	-0.073958	0.074683	-0.90	0.368
INCOME3	0.046025	0.202344	0.013964	0.061708	0.23	0.820
CONSTANT	-2.68543†	0.920132			-2.92	0.004

†, ‡, *, indicates significance at the 1, 5, and 10 percent level, respectively. N = 528; Chi-square = 300.32; Log-L= -155.225; Prob>Chi^2 = 0.0000; Pseudo R-squared: 0.4917.

Having land in government conservation programs, such as the Conservation Reserve Program and Wetland Reserve Program, had a positive effect on the probability of allowing fee based recreation under both the pre- and post-institutional change environments. It was hypothesized that such a relationship may exist since such landowners have a demonstrated willingness to use their land for non-traditional agricultural uses. Therefore, it is not surprising to find that these landowners had a higher probability of adopting fee-based recreation and to find that these landowners were also responsive to institutional change, which resulted in an increased probability of 5.6% pre-institutional change. Therefore individuals that use their land for alternative land applications such as conservation programs may be more likely to allow fee-based recreation.

The organization of land ownership seems to influence the decision to allow fee-based recreation. Joint ownership, as compared with single ownership, appears to have a negative effect on the probability of allowing fee based recreation under both the pre- and post-institutional change environments, whereas limited liability ownership has a positive effect as compared with single ownership on the probability of allowing fee based recreation under the current institutional environment. The negative effect of joint ownership may, as noted previously, be a result of joint owners having a lack of autonomy in the decision process and thus are not comfortable or able to make a decision regarding fee-based recreation. The result that LLC land ownership has a positive effect on allowing fee-based recreation may be related to the legal structure of LLCs, in that the personal wealth of the individual is better protected from liability as compared with either single or joint ownership. Therefore, the higher probability of choosing to allow fee-based recreation under the current institutional setting by LLC landowners may likely result from that recognition on the part of the landowner. Also, for that same reason it is not surprising that the same variable is not significant in the post-institutional change model where liability issues and associated risk are greatly reduced and the comparative benefit to LLC landowners over joint or single landowners is also greatly reduced.

Conclusions

Amending the Louisiana recreational use statute can increase the number of private landowners willing to use their land for fee-based recreational use. About 14% of landowners indicated that they would be willing to allow fee-based recreation under the current institutional environment. If the Louisiana recreational use statute were amended giving greater liability protection landowners, the number of landowners willing to allow fee-based recreation would increase by 70% to nearly 24% of respondents. Clearly, an institutional change that reduces the liability risk to landowners can increase the potential amount of private land that could be used for fee-based recreation. Owners of marginal land were particularly responsive to an institutional change providing greater liability protection. Amending the recreational use statute would increase the amount of land available for recreation by providing a needed incentive as landowners on average would be willing to allocate a little more than 250 acres for fee-based recreation.

A fee-based recreational enterprise under the current legal environment caries with it the risk of liability; thus, as expected, risk preference was a significant predictor of the decision to allow fee-based recreation. Risk-averse landowners were more unlikely to allow fee-based recreation under the current institutional environment. Following an institutional change it was observed that risk preference was no longer a significant predictor of the willingness to allow fee-based recreation indicating that the element of risk was diminished.

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RECREATIONAL LIABILITY AND LITIGATION DELAY RAISED BY PRIVATE LANDOWNERS IN THE US

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Abstract

This study investigated the determinants of the landowners' liability from a legal standpoint and examined these factors that influenced litigation length of US recreational incidents within recreational use statute from 1958 to 2007 using Lexis/Nexis and Westlaw databases. Reviewing the 103 cases from a legal standpoint revealed that the landowners had no liability in general, but under some situations the landowners had liability (*e.g.* defective materials). Results were not affected by appellant type, recreational activity type, users or landowners' characteristics, users' injury severity levels, case location, or case entry time. Further parametric duration analysis concluded that strategic variables, such as severity levels, existing genuine issue, and a profit-motivated fee charge, lengthened litigation time. The user appealing the case took longer for the court to close the case than the landowner appealing the case. The difference among recreational activities was significant. Cases in the South had a shorter litigation time.

Keywords: Duration analysis, recreational use statute, landowners' liability, litigation delay

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Introduction

Private landowners' liability to recreational users has long been recognized as one of major disincentives for landowners to open their lands to the public (Benson 2001; Jones et al. 2001; Wright et al. 2002). Most landowners are concerned about the threat of liability and are therefore justified their restriction on public access based on liability. The National Private Landownership Study in 1997 provided that only 12% of private landowners allowed recreational access, mainly because of liability concern (Teasley et al. 1999). In Mississippi, landowners' liability expenditures were one of the largest in fee hunting (Jones et al. 2001). State wildlife administrators also rated liability as the second-most-significant access problem faced by landowners (Wright et al. 2002).

In order to encourage private landowners to open their land to recreational use, governments have made efforts to enact recreational use statutes (RUS) to reduce landowners' liability in the past four decades (Barrett 1977; Wright et al. 2002). Recreational users frequently employed traditional common-law theory against landowners (Eshee et al. 2005). These rules categorized recreational users as invitees, licensees, or trespassers. Among the three categories, invitees receive the greatest legal protection, licensees moderate protection, and trespassers little protection. If the entrant is a trespasser, the owner owes only a duty to refrain from willfully or wantonly inflicting injury, whereas if the entrant is an invitee, the owner owes a higher duty of ordinary care (Becker 1991; Noble 1991). Under RUS, landowners' duty owed to recreational users is limited, thus, landowners' liability to recreational users has been reduced significantly (Wright et al. 2002).

Unfortunately, private landowners have been vexed by increasing litigation by recreational users, even under the protection of RUS (Kaiser 1986). According to Wright et al. (2002), 330 cases were collected and involved lawsuits against private landowners since 1965. In reality, the perception of landowners' liability appears to be greater than the actual liability risks (Wright et al. 2002). This gap between the perception and actual liability risks further increases the liability concern for landowners.

The liability concern naturally leads to issues related to the delay in case litigation once recreational incidents happen. Traditional legal disputes often take considerable time to settle or to go to trial, ranging from 18 to 40 months (Fenn and Rickman 1999). But court cases related to recreational use might be longer. Delay in litigation has several significantly negative social costs (Fenn and Rickman 1999). It is costly both to the individuals involved and to society. It can also take an emotional toll on the individuals and can be burdensome to health providers (Hughes and Savoca 1997). Moreover, the delay may cause evidence to deteriorate.

This study was motivated by these unaddressed issues associated with liability concern and delay in case litigation raised by private landowners. The objective of this study was to investigate the determinants of landowners' liability from a legal standpoint and, using duration analysis, examine the factors that influence litigation time of US recreational incidents within RUS. The case data were collected from Lexis/Nexis and Westlaw databases from 1958 to 2007. The final case list (103 cases) was produced and 15 variables were identified and coded. A qualitative analysis was used to investigate the determinants of landowners' liability and a quantitative duration analysis was employed to examine these factors that have influence on case litigation time. The results will improve our understanding of the determinants of the landowners' liability and case litigation time of US recreational incidents and factors that influence variations in length. In the rest of this paper, we first present literature review related to liability and litigation delay. Then we introduce the methodology of duration analysis. Next, we describe cases' sources and variables. Furthermore, we investigate the determinants of the landowners' liability from a legal standpoint case by case and present the results of the duration analysis, followed by conclusions and discussions.

Concern related to the liability of providing outdoor recreational use by private landowners has been an active research topic in law (Barrett 1977; Lee 1995; Noble 1991). One reason is that the liability has acted as one of the major disincentives for landowners to open their lands to the public. Reduction or immunity from the liability will result in promotion of outdoor recreation on private lands, especially fee-based recreation, which has several benefits to landowners and society (Jones et al. 2001; Sun et al. 2007). Despite widespread concern for the benefits and costs of the liability, few studies have documented actual bodily injuries and property damages resulting from recreational activities in the US. For example, Wright et al. (2002) examined rural landowners liability risks through an analysis of the 50 state RUS and compiled a database of 637 court cases from 1965 to 2000. They reported the number of cases by state and recreation type. Unfortunately, they did not reveal more details, such as verdict of injuries liability, and no such work has been done to investigate the determinants of the landowners' liability and case litigation delay once incidents happened on private premises.

The further concern with case litigation time and the social costs resulting from the litigation delay has motivated extensive literature investigating the causes of delay in the resolution of legal disputes using a duration method from political science, policy, medical science, law and economics (Fenn and Rickman 2001; Fournier and Zuehlke 1996; Hughes and Savoca 1997; Kessler 1996; Spier 1992; Spurr 2000, 2002). Nevertheless, applications in forestry or natural resources were limited. Among the limited studies, Malmsheimer and Floyd (2004) used four competing judicial decision models to test if federal judges substitute their own preferences for federal natural resource agencies' management decisions. However, no such work has been conducted to investigate causation of the delay in case litigation within RUS in the US.

Overall, the review revealed that there is a great need to understand liability determinants from a legal standpoint and to examine the causes of litigation delay within RUS, given the importance of recreational use for both recreational users and private landowners at present.

Methods

Qualitative Analysis

Qualitative analysis is a common approach in law to review litigation data and to investigate determinants of landowners' liability (Goebel and Goebel 1999; Wright et al. 2002). Initially, descriptive outcomes of these cases within recreational use statute were analyzed using descriptive statistics. These major characteristics included number of cases by state, party position, court type, numbers of NIPF owners and forest business owners, a fee charge, and liability of owners. The determinants of the landowners' liability were further investigated from a legal perspective case by case. These factors included appellant type, recreational activity type, users or landowners' characteristics, users' injury severity levels, existing genuine issue of material fact, a fee charge, case location, and case entry time. All these cases were classified into two categories: the landowners had no liability and the landowners had liability.

Under each category, these factors (*e.g.* a fee charge) were examined based on liability theory in recreational litigation. Generally, plaintiff (recreational user) filed lawsuits against defendant (landowner) based on negligence rules when recreational incidents happened on private premises. In order to prevail on a cause of action for negligence, the plaintiff must prove that a) the defendant owed the plaintiff a duty to exercise reasonable care; b) the defendant breached that duty; c) that breach caused harm to the plaintiff; and d) the plaintiff suffered actual loss (Aronovsky 2000). Duty is the obligation that each person in society owes others to act in a manner that is not negligent toward them. However, RUS provided landowners a defense because under RUS, landowners did not owe recreational users a duty to keep the property safe or to give warning of a dangerous condition except for willful or malicious conduct (see 47 ALR4th 271-272). Correspondingly, it is impossible for the landowners to breach their duty and cause the users' losses. Note that RUS did not change negligence rules, but limited landowners' duty. The judgment summary at the higher court for each case also provided a way to identify factors which determined the landowners' liability.

This qualitative analysis painted a whole picture of investigating the determinants of the landowners' liability from a legal standpoint, the further duration analysis was conducted to examine case litigation delay. Duration analysis is a class of statistical methods that investigates survival times (*i.e.*, the occurrence and timing of events) (Allison 1995; Greene 2003). In this study, duration (*T)* is measured by the time between the beginning of an observation period and the occurrence of an event that is the decision of case in a court. Cases that are remanded and are not decided are censored in the sense that their duration is at least the observed litigation time.

<u>Parametric Duration Analysis</u>

Parametric duration analysis provides a complete characterization of the relationship between case duration and various factors influencing the duration. There are four equivalent ways to describe the relation in duration analysis. Treating duration *(T)* as a random variable, its probability density function (PDF) can be denoted as *f*(t) and its cumulative distribution function (CDF) can be denoted as *F*(t). Mathematically, they can be expressed as:

$$f(t) = \frac{dF(t)}{dt} = \lim_{\Delta t \to 0} \frac{\Pr(t \le T < t + \Delta t)}{\Delta t} \tag{1}$$

$$F(t) = \Pr(T \le t) = \int_0^t f(x)\,dx \tag{2}$$

Another is survivor function *S (t)*, defined as the probability that an event time will be greater than *t*. The other is hazard function *h (t)*, representing the instantaneous rate of closing at time *t*, given that the case has survived up to t. Hazard function provides a notion of duration dependence. Positive duration dependence implies that the hazard rate increases with time (*i.e., dh (t)/dt* > 0 and vice versa). Thus, they can be expressed as:

$$S(t) = \Pr(T \geq t) = \int_t^{\infty} f(x)dx = 1 - F(t) \tag{3}$$

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T < t + \Delta t / T \geq t)}{\Delta t} = \frac{f(t)}{S(t)} \tag{4}$$

Equations (1)-(4) show that they are equivalent. Given any one of them, the others can be recovered. The functions of *f(t)* and *F(t)* are foundations of parameter estimation and *S(t)* and *h(t)* are more related to research questions (*e.g.* how long does it take for a case to be decided if it is remanded?). As a whole, these four functions provide the theoretic framework for empirical analysis.

The accelerated failure time (AFT) model (Allison 1995) describes a relationship between survival functions of any two individuals. If $S_i(t)$ is the survival function for individual *i*, $S_j(t)$ for another individual *j*, the AFT model holds:

$$S_i(t) = S_j(\phi_{ij} t) \text{ for all } t \tag{5}$$

where ϕ_{ij} is a constant that is specific to the pair (*i*, *j*). Actually, the AFT estimation is similar to an ordinary linear regression. Because litigation time delay is generally explained by bargaining game or nonstrategic models (Fenn and Rickman 2001; Fournier and Zuehlke 1996; Malmsheimer and Floyd 2004; Spier 1992), we assumed that the value of case length (T_i) is a function of a vector of variables, $x_{i1}, \ldots, x_{ij}$, indicating type of appellant, type of recreational activity, parties' bargaining power, and legal environment. Then, the model is expressed as:

$$\log T_i = \beta_0 + \beta_1 x_{i1} + \ldots + \beta_k x_{ik} + \sigma\varepsilon_i \tag{6}$$

where $\beta_0, \ldots, \beta_k$, and σ are parameters to be estimated; ε_i is a random disturbance term with variance σ. If there are no censored data, we can estimate the model by ordinary least squares (OLS).

But it is difficult to handle censored data with OLS because duration data usually have some censored observations. In this study, all remanded cases were interval censored. These interval-censored data must be incorporated into likelihood function first. Interval censoring occurs when the time of event occurrence is known to be somewhere between times *a* and *b*, but the exact time is not known. We assumed all remanded cases in this study would be decided within one year after the judgment date by the higher court. The contribution to the likelihood for an observation censored between times *a* and *b* is just $S_i(a) - S_i(b)$, where $S_i(.)$ is the survival function for observation *i*. Suppose there is *r* uncensored observations and (*n-r*) censored observations. Arranging the data such as uncensored cases first, then censored cases, the likelihood can be written as follows:

$$
\begin{aligned}
L &= \prod_{i=1}^{r} f_i(t_i) \prod_{i=r+1}^{n} [S_i(a_i) - S_i(b_i)] \\
&= \prod_{i=1}^{n} f_i(t_i)^{\delta_i} [S_i(a_i) - S_i(b_i)]^{1-\delta_i}
\end{aligned}
\qquad (7)
$$

The censoring indicator δ_i acts as a switch, turning the appropriate function on or off, depending on whether the observation is censored. The equation shows how censored and uncensored cases are combined in maximum likelihood estimation (MLE). Taking the logarithm of both sides of equation (7), the likelihood function is expressed as:

$$
\log L = \sum_{i=1}^{n} \delta_i \log[f_i(t_i)] + \sum_{i=1}^{n} (1-\delta_i) \log[S_i(a_i) - S_i(b_i)] \qquad (8)
$$

Once a particular distribution is chosen, the effect of covariates is incorporated by specifying a scale parameter $\lambda = \exp(-\beta' X)$ where $\boldsymbol{X}$ is a vector of covariates and $\boldsymbol{\beta}$ is the vector of parameters. To estimate the parameters in this model, MLE method was applied. Empirically, a combined category including all cases was estimated using MLE first. Then these cases were classified into three events: confirmed without liability, reversed, and remanded. A multinomial logit analysis was conducted to examine the difference among the three events. If there was no significant difference among the three events, we focused on the category in which all cases were confirmed and the landowners had no liability, while treating other cases as interval-censored data because they were related to the study objective.

For each category, five widely-used distributions, such as exponential, Weibull, log-normal, log-logistic, and gamma, were considered and only one distribution was selected. Since gamma distribution is the most unrestricted, likelihood ratio statistics can be used to compare nested models and make a selection: that is, taking the differences of the log-likelihood between nested models and multiplying by two yields the likelihood ratio χ^2 statistics. If the statistic is not significantly different from zero, then the two models are statistically the same.

Because the actual regression format was a semi-logarithmic one in parametric duration analysis, a simple transformation provided interpretive values. For quantitative variables, a transformation of $100(e^{\beta} - 1)$ is needed to give the percentage changes in the expected case length for each 1-unit change in the variable. For dummy variables, the value gave the estimated ratio of the expected duration time between the group in consideration and the base (Allison 1995).

Case sources and variables

Case data were obtained using fact patterns from two legal databases, Lexis/Nexis and Westlaw. Lexis/Nexis and Westlaw are computerized legal databases containing case law decisions, legal statutes, and law review articles, as well as synopses of lawsuit verdicts and settlements gleaned from legal periodicals. Three methods were used to thoroughly search the databases (Mersky and Dunn 2002). First, it was searched by the keyword combination of “recreational use statute”, “private land” and “activities such as hunting.” This search resulted in 754 cases from

Lexis/Nexis and 708 cases from Westlaw. Many were unrelated to recreational use on private land, but were for other types of land (*e.g.* an injury sustained by diving into swimming pool in residential backyard). In this study, private land includes all private forestland, farmland, and undeveloped/unimproved land. After identifying case by case, we kept only 62 cases from Lexis/Nexis and 75 cases from Westlaw because they were related to the study objective. The two databases overlapped on 42 cases. Second, a search by West KeyCite was conducted for each of the cases from the keyword search. As a citatory service provided by Westlaw, the KeyCite revealed all subsequent cases that have cited the case of interest and, furthermore, reported whether there has been any negative treatment for the instant case. With the help of the KeyCite search, the case list was further modified and expanded through cited cases and citing reference. Finally, a search by West Key Number was conducted. The West Key Number digest has more than 400 topics and 10,000 keys. The cases from the previous two search steps revealed that more than 100 West Key Numbers were related to recreational use on private land. Typical Key Numbers were 272XVII (F) recreational use doctrine and statutes. The West Key Numbers that appeared frequently were used to search the database again. This search produced the final case list (104 cases) for this study. Note that only cases that proceeded through trial and reached the appeals court were included in this analysis. Then we coded all variables as specified below case by case. The definition and means of dependent and independent variables were presented in Table 1.

The dependent variable in the analysis was defined as the length of time in months that a case lasts before being decided in the court from the date of accident. Generally, a case length is calculated from the date of entry in the court to its closure in the court. But in this analysis, many cases do not have filing date to the court. Instead, the case length was calculated from the date of the accident to its closure in the court. The minimal duration time in the data set is 13 months, while the maximum duration time for a case during the span of this data is 103 months. Note that average case length of 50 was taken for the cases that do not have happening data.

Since no such work has been done to investigate causation variables for recreational use cases, we identified 15 independent variables serving as the causation of litigation delay before the courts. The first variable, recreational user appealing to the higher court, provided a case-specific measure of appellant type. A second set of variables captured the influence of the type of activity on the court decision according to legal model suggested by Malmsheimer and Floyd (2004). In this study, five dummy variables were employed to capture their impacts in the litigation. There were hunting, boating, off-road vehicle, snowmobiling, and other (other than hunting, boating, off-road vehicle, or snowmobiling).

A third set of variables indicated strategic behavior and deliberate actions of the plaintiff and defendant (Spurr 2000). Severity levels of injury were used to capture the behavior and actions of the plaintiff. Three dummy variables were employed for different levels of severity of injury of the claimant: light injury, severe injury, and death. Likewise, existing genuine issue of material fact and fee charge were used to secure the landowner’s behavior and actions. In this study, two dummy variables were used to see if existing genuine issue of material fact and fee charge have influence on the case time in the litigation before the courts.

Table 1. Definitions and means of variables

Variable	Definition	Mean
Case length	The length of the case from the happening date of the accident to its closure in the court (in months)	49.961
Type of appellant		
User	Equal to 1 for the users appealing the case, otherwise 0	0.854
Type of activity		
Hunting	Equal to 1 for hunting, otherwise 0	0.194
Boating	Equal to 1 for boating, otherwise 0	0.049
Off-road vehicle	Equal to 1 for off-road vehicle, otherwise 0	0.262
Snowmobiling	Equal to 1 for snowmobiling, otherwise 0	0.078
Others	Equal to 1 for other than hunting, boating, off-road vehicle, snowmobiling; otherwise 0	0.417
Plaintiff		
Light injury	Equal to 1 for light injury, otherwise 0	0.039
Severe injury	Equal to 1 for severe injury, otherwise 0	0.777
Death	Equal to 1 for death, otherwise 0	0.194
Defendant		
Genuine issue	Equal to 1 for genuine issue existing, otherwise 0	0.184
Fee charged	Equal to 1 for fee charged, otherwise 0	0.136
Case location		
RegSouth	Equal to 1 for 13 states in the south, otherwise 0	0.214
RegNorth	Equal to 1 for 20 states in the north, otherwise 0	0.485
RegWest	Equal to 1 for 5 states in the west, otherwise 0	0.155
RegMid	Equal to 1 for 12 states in the mid-west, otherwise 0	0.155
Time of case born		
Entry70	Equal to 1 for cases born from 1960 to 1979, otherwise 0	0.117
Entry80	Equal to 1 for cases born in 1980's, otherwise 0	0.408
Entry90	Equal to 1 for cases born in 1990's, otherwise 0	0.417
Entry2000	Equal to 1 for cases born from 2000 to 2007, otherwise 0	0.058

Furthermore, a fourth set of geographic region and time-point indicator variables was used to pick up spatial and contemporary variations in the political culture that affects court decision (Malmsheimer and Floyd 2004; Wenner and Dutter 1988). In this paper, dummy variables were included for the location of the case hypothesized to have an influence on its time duration. For simplicity, four regions were identified in this study. RegSouth is a dummy variable that is equal to one for cases that are decided in 13 states in the south; RegNorth is a dummy variable for 20 states in the north; RegWest is a dummy variable for five states in the West; and RegMid is a dummy variable for 12 states in the Midwest. Also four dummy variables were created for the year the case was born to represent the possible divergence due to the time of decision in the court. Entry70, Entry80, Entry90, and Entry2000 were used to represent the cases from 1958-1979, 1980's, 1990's, and 2000's.

Results

<u>Qualitative Analysis</u>

The results of descriptive statistics on recreational use cases within recreational use statute were presented. By state, the cases covered 27 states; more specifically, they covered 15 cases in Louisiana and 16 cases in New York. By party position, 68 cases were involved between recreational users and private landowners. 16 cases were between recreational users and lessees where users did not file lawsuit against landowners. 19 cases involved three parties: the user, the lessee, and the landowner. By court, 70 cases were from the court of appeals, while 33 cases were from the Supreme Court in a state. No case from different states was identified in federal courts. By ownership type, only 16 cases held some forestland or woodland and were classified as non-industrial private forest (NIPF); 37 cases involved forest business; and 50 cases were from farmland and undeveloped land. By charged fees, 14 cases involved a business relationship. By verdict of injurers' liability, liability for private landowners was not found at both the lower court and the higher court in 64 cases and liability was found at the lower court and reversed at the higher court in six cases. Thus, appellate courts or supreme courts confirmed that landowners had no liability in 68% of cases (*i.e.*, 64/103+6/103), plus four cases remanded for further proceedings with a direction in favor of the landowners. Among the other 25 cases where landowners had liability, the appellate courts or supreme courts confirmed the lower court decision in five cases, reversed the lower court decision in three cases, and reversed the lower court decision for further proceedings with a direction in favor of the recreational users in 17 cases. This summary revealed that the actual liability of landowners was lower than the landowners' previous perceptions.

The results of investigating the determinants of the landowners' liability case by case within RUS from a legal standpoint delivered some insights. In this study, 74 cases alleged that the conduct of the landowners was negligent or willful and malicious in the lower court, but all claims were dismissed. Four other cases were reversed and remanded for further proceedings with a direction in favor of the landowners. For example, in Castille v. Chaisson (LA 1989), parents of a minor who drowned in a pond while hunting filed action against the landowner, alleging causes of action in negligence. The court of appeals in Louisiana held that the property owner had RUS immunity against tort liability and owed no duty to warn hunters of the existence of the man-made pond. This investigation revealed that the landowners had no liability in general, as long as there was no profit-motivated fee charge and genuine issue of material fact did not exist. These factors, such as appellant type, recreational activity type, users or

landowners' characteristics, users' injury severity levels, case location, and case entry time, had no influence on determining the landowners' liability.
In contrast, under some circumstances where genuine issue of material fact did exist and there was a profit-motivated fee charge, the landowners had liability to the recreational users. Other factors had no influence on the determination of the landowners' liability. In this study, eight cases were found that the landowners were liable for the users' injuries, plus 17 cases remanded for further proceedings with the direction in favor of the users. Among the 25 cases, nine cases involved a profit-motivated fee charge, four cases involved improper conduct of the landowners, five cases involved defective material or injury-causing condition, and six cases involved failure to have safety rules, warn user of danger, or mark hazards. For instance, in Sauberan v. Ohl (NY 1997), the appellate court held that the landowner's allegedly improper conduct in telling a hunter to shoot at a target that the landowner could not see removed him from protection under RUS. Only one case was found to have vicarious liability, which is a substituted liability that the landowner bears for the actionable conduct of the lessee according to the relationship. In Scott v. Wright (IA 1992), the user filed a lawsuit against the driver's negligence and the landowners on the theory of vicarious liability for the driver's negligence. The Supreme Court of Louisiana held that the statute making the owner of the tractor liable for damages when the vehicle was driven by another with the owner's consent applied to the vehicle driven on private property.

Parametric Duration Analysis

One thing to bear in mind is that the nonparametric analysis was univariate with regard to time *t* only, parametric duration analysis provided a relationship between case duration and its causation. Since multinomial logit analysis revealed that there was no difference among the three events, the empirical results had two categories: combined data including all cases and confirmed data where the landowners had no liability. The results of maximum likelihood estimation for each of the two categories showed that the log-likelihood was -141.5 and -191.8 for the exponential distribution, -55.7 and -105.4 for Weibull, -55.6 and -104.6 for lognormal, -52.8 and -102.5 for log-logistic, and -54.2 and -103.7 for gamma, respectively. The likelihood tests revealed that log-normal distribution was the best for each of the two categories. The results of log-normal distributions for each of them are presented in Table 2.

The first category for combined data in the first column in Table 2 indicated that all coefficients had the expected signs and 8 out of 15 variables were significant at the 5% and 10% levels. These were recreational user appealing the court as well as hunting, snowmobiling, other activities, severe injury, genuine issue, fee charge, and RegSouth. For a recreational user appealing to the higher court, the coefficient's value was 16%. Thus, for the recreational user appealing the case, the litigation time was increased by 16%, compared with the landowner appealing the case.

Among recreational activities, hunting, snowmobiling, and others have negative and significant impacts on survival time and the corresponding values were -34, -30, and -27, respectively. This implied that hunting had a 34% shorter case length, snowmobiling had a 30% shorter litigation time, and others had a 27% shorter time than boating when the base activity used was boating. An intuitive explanation is that it takes more time for the fact finder (*i.e.,* jury or judge alone) to uncover information for boating incidents.

Table 2. Results of log-normal distributions for each of two specifications for US cases within RUS over 1958-2007

Variable	Combined all data		Confirmed data without liability	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	4.120	0.194**	4.148	0.192**
User	0.163	0.097*	0.128	0.095
Hunting	-0.409	0.165**	-0.406	0.162**
Off-road vehicle	-0.226	0.167	-0.226	0.165
Snowmobiling	-0.364	0.198*	-0.367	0.195*
Others	-0.312	0.163*	-0.311	0.161*
Light injury	-0.104	0.172	-0.102	0.169
Severe injury	-0.200	0.081**	-0.195	0.080**
Genuine issue	0.246	0.085**	0.246	0.084**
Fee charged	0.182	0.103*	0.176	0.102*
RegSouth	-0.210	0.101**	-0.211	0.100**
RegWest	-0.002	0.095	0.002	0.094
RegMid	-0.062	0.097	-0.061	0.096
Entry80	0.128	0.106	0.133	0.104
Entry90	0.031	0.105	0.036	0.103
Entry2000	-0.140	0.161	-0.129	0.159
Number of cases	103		103	
Scale	0.297		0.293	
Log-L	-55.594		-104.634	

*Significant at 10% level. **Significant at 5% level.

Among these strategic variables, severe injury as an approximation of the bargaining power of the plaintiff (recreational user) had a negative and significant effect with a coefficient value of -0.20. Its transformed value was -18%. This suggested that severe injury had 18% shorter case duration than death used as the base. Similarly, existing genuine issue of material fact had a significantly positive effect with a coefficient value of 0.25. Its transformed value was 28%. This indicated that existing genuine issue of material fact increased case duration by 28% than that without the genuine issue. Fee charge variable also had a significantly positive effect with a coefficient value of 0.18. Its transformed value was 19%. This indicated that a fee charge increased litigation time by 20%. Turning to spatial and temporary variables, only the RegSouth variable had a negative and significant effect on litigation time, indicating that the case litigation time was 19% shorter in the south than in the north. The time of case entry had no effect on the litigation time.

One limitation of the first category is that it combined all data together without considering variation among confirmed, reversed and remanded cases. The benefit of the second category was to emphasize confirmed cases where all cases were decided and private landowners had no liability. The results of the second category were close to the first one. The only exception is that appellant type had no significant effect on the case litigation time. This further implied that landowners' concern on case litigation delay can be reduced to some extent as the appellant type chosen by users had no effect.

Discussion

This study focused on the issues associated with liability and delay in case litigation raised by private landowners. Review of the recreational cases revealed that the landowners generally had no liability, but under some situations the landowners could have liability if genuine issues of material fact did exist (*e.g.* defective materials) and there was a profit-motivated fee charged. These findings were independent of appellant type, recreational activity type, users or landowners' characteristics, users' injury severity levels, case location, and case entry time.

Parametric duration analysis also was used to examine the influence of several case-specific characteristics. The estimated coefficients and the corresponding transformed values for some of the eight significant variables have important policy implications for decreasing litigation delays.

Among the eight significant variables, strategic variables potentially have the greatest impact on timely litigation. On the plaintiff's (recreational user) side, litigation time for these severe injury cases can be shortened by 18% in death cases. An intuitive explanation is that one would expect the stakes to be higher for more severe injuries, leading to longer negotiations. This result is consistent with the results in literature for other law cases (Fenn and Rickman 2001; Spurr 2000). Coupled with the results of the summary on the landowners' liability, the implication is that the recreational users could take a risk while engaging in recreational activities. Injury severity levels just postpone litigation time, but cannot eliminate the landowners' liability under RUS. Likewise, on the defendant's (landowner) side, existing genuine issues of material fact can increase litigation time by 28% more than cases without the genuine issues. The implication is that existing genuine issue of material fact cannot waiver the landowners' liability but can prolong litigation time. The landowners also should be aware that a profit-motivated fee charge cannot remove liability but can increase litigation time. From a policy perspective, reducing genuine issues, such as improper conduct, defective material, and failure to have safety rules, is critical because it can remove the landowners' liability and reduce litigation delay. A further investigation of these fee-charged cases implied that leasing private lands to lessees for maintenance of the lands cannot naturally lead to vicarious liability of the landowners. The key implication is that the lessees should be non-profit motivated. Of course, the landowners themselves should be non-profit motivated as well.

Appellant type is another key variable. Generally, the party who has lost at the lower court level is appealing to an appellate court. Combined with the results of the summary on the landowners' liability, the implication is that users cannot be keen on the higher court reversing the judgment of the lower court if they cannot provide proof of negligence, in which the landowners' duty owed to the users is much lower than required by common-law. Results of duration analysis of the second category (confirmed cases where landowners had no liability) further implied that users appealing to the higher court cannot affect the landowners' liability nor litigation time. From policy standpoint, reducing confusion on understanding of the intention of RUS is important.

Recreational activities, such as hunting, snowmobiling, and others, have significantly negative impacts on litigation time. Despite their relatively large marginal impacts, they have limited policy value because recreational activities rely on land availability and features. Similarly, regional variable, *RegSouth*, despite its significantly negative effect on extending litigation time by 19%, has limited policy implication as well.

Overall, these results from the duration analysis of litigation delay are consistent with results in literature for other law cases. They help us understand the liability concerns and litigation delays faced by the private landowners, and thus promote the supply of outdoor recreation by the landowners. Nevertheless, caution should be taken in reaching any definite conclusions from our findings due to low levels of data availability and technical constraints. Further research is needed to extend the databases and to investigate the liability for other parties related to recreational use statute such as public ownership.

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VALUING DIVERSITY AND SPATIAL PATTERN OF OPEN SPACE PLOTS IN URBAN NEIGHBORHOODS

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Abstract

This study evaluates the diversity, spatial configuration, and pattern of open spaces in urban neighborhoods. Empirical evidence from hedonic modeling reveals that urban residents positively value the varieties of open space but negatively value the diversity within developed land uses. Square shaped plots of open spaces with smooth, as well straight edge are preferred to those of complex and convoluted shapes with irregular edges.

Keywords: Open space, Spatial configuration, Hedonic model, Roanoke, Virginia

Introduction

With increasing population density and congestion in U.S. cities, there is a rising demand for ecosystem services and overwhelming citizen support for open space protection. While federal, state, and local governments are currently planning to preserve more open space to ensure a sustainable supply of ecosystem services and environmental benefits (Kline 2006), our understanding of the economics of open space is inadequate to properly justify investments in open space. With some notable exceptions, most of the previous open space studies have focused on the amenity benefits from the quantity of open space only, while the amenity value of their spatial configuration and pattern effect has remained understudied (Cho et al. 2008).

Previous studies applied the hedonic method to estimate the dollar value of open space in the neighborhood as reflected by housing prices (Acharya and Bennett 2001; Irwin and Bockstael 2001; Irwin 2002; Anderson and West 2003; White and Leefers 2007). Other studies have focused on specific types of open spaces, such as wetlands (Mahan et al. 2000), farmland

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(Bowker and Didychuk 1994), and forest land (Tyrvainen and Miettinen 2000; Thorsnes 2002). McConnell and Walls (2005) reviewed an extensive list of recent open space research on various types such as forests, wetlands, parks, and farmland. One of the limitations of previous studies is that they focused only on the quantity of open space while failing to evaluate the quality, which can partly determine ecosystem services and aesthetic values. Nevertheless, research on valuing the quality of open spaces as measured by the spatial pattern and diversity of land use has been developed only recently. Bockstael (1996); Geoghegan et al. (1997); and Acharya and Bennett (2001) reported that the spatial pattern of land use affects nearby residential house prices. Geoghegan et al. (1997) found that value of landuse diversity depends on the location and level at which the landuse attribute is measured. Cho et al. (2008) analyzed the spatial variation in amenity value of some of the green open space amenities and concluded that composition and spatial pattern of open space greatly varies according the level of urbanization within the city.

The compositional variety in open space has not been the focus of previous studies, however. A recent study by Acharya and Bennett (2001) in an urban watershed revealed that both land use diversity and richness are not desirable factors in the neighborhood, regardless of location in the watershed. However, they measured land use diversity combining all types of land uses such as developed and undeveloped, making it difficult to interpret the diversity value of open space. Their findings do not answer questions such as whether the residents value a neighborhood with a mixture of low-density residential use and industrial use, a mixture of forests and high-density development, or a mosaic of grassland, hardwood forest, and pastureland. To better understand the benefits arising from the quality of open space, separate indices should be used to measure the diversity within the undeveloped land or open space (McConnell and Walls 2005).

This study measured the quality of open space with a more complete set of variables to capture the diversity, spatial configuration, and pattern of open space and to assess their effect on property price. The objectives were achieved by using separate indices of diversity within the natural or undeveloped open spaces as well as developed spaces. In addition, the spatial pattern and configuration of open space were measured using shape and plot density indices that were borrowed from landscape ecology literature.

Methods

We used a typical hedonic model, in which the equilibrium sales price of a house is explained as a function of structural attributes of the house, characteristics of the neighborhood where the house is located, and the landuse amenities in the neighborhood. Following Irwin and Bockstael (2001), endogeneity of open space variables were checked using a Durbin-Wu-Hausman test of endogeneity (Wooldridge 2003, pp. 483) and accordingly instrumented.

The structural variables included the size of living area, number of stories, age of house, number of bedrooms, and size of parcel on which the house was located. Dummy variables were used to capture the presence of exterior brick walls, central air conditioning (AC), masonry fireplace, and a garage. A seasonal dummy variable was included to control for seasonal difference in sales price. The neighborhood variables included the percentage of African-American population, percentage of residents with college degrees, and percentage of neighborhood residents below the poverty level. Distances from the house to public bus routes, nearby parks, regional airport, and railroad were also included. Size of the nearest park was also included to capture the size of publicly available open space in the neighborhood.

A set of open space and land use variables, the primary variables of interest in this study, were included in the model. Following Geoghegan et al. (1997), and Acharya and Bennett (2001), the diversity index originally proposed by Turner (1990) was used to two create separate indices of diversity for open space, or undeveloped land uses, and developed land use. The magnitude of this index represents the degree of dominance by few or many land use types in the neighborhood and depends not only on the diversity but also on the evenness of the land use type distribution. The interpretation of the index is that the larger the index value, greater the diversity (Geoghegan et al. 1997; Acharya and Bennett 2001). Eight land use types were identified within the open space or undeveloped category in the study area, and three within the developed land category.

Similarly, the concept of habitat mean patch fractal dimension (MPFD) was borrowed from landscape ecology (McGarigal and Marks 1995) to compute the open space mean plot fractal dimension. A MPFD value of 1 indicates plots of square shapes with simple, smooth, and straight boundaries, whereas a value of 2 indicates more complex plot shapes with convoluted, rougher edges. In addition, a plot density measure was included to capture spatial pattern of open space distribution within neighborhood. Unlike the diversity index, open space plot density was measured by aggregating open space acres of all types in a single category. The plot or patch density represents the number of distinct open space patches per hectare of open space area (McGarigal and Marks 1995). This captures the extent to which a given amount of open space is scattered in numerous plots within a neighborhood.

This model was applied to a dataset of 11,125 houses that were sold between 1997 and 2006 within the city limits of Roanoke, Virginia. Data on structural attributes and sales price of house were obtained from the Geographic Information System (GIS) database of the city's real estate valuation department. The annual housing price index for Roanoke was used to convert the house sale prices to 2000-dollar values. Data on neighborhood variables were obtained from the U.S. Census Bureau's 2000 census block group database. Further, the distance variables were computed in ArcGIS 9.2 using the GIS shape file of park locations, regional airport, railways, and bus routes obtained from the city's real estate department. Data on landuse diversity and open space were obtained from the citywide Satellite Imagery of Landsat 7 classified and developed by National Land Cover Database 2001. The open space amenities were measured within the neighborhood, which are delineated by the local tax assessors. Bourossa et al. (2003) argued that small neighborhoods defined by the local tax assessor and real estate developers based on their experiences are appropriate measures of neighborhood, and are useful in hedonic modeling and prediction purpose.

Results and Discussion

The null hypothesis of the exogeneity for open space and landuse variables was rejected by Durbin Wu Hausman test at the 1% level, justifying the treatment of open space variables as endogenous regressors. Most of the structural and neighborhood variables were significant and had signs consistent with the literature. Importantly, all of the open space and landuse variables in the model were significant at the 5 % level or better (Table 1), suggesting that open space and landuse features are important predictors of housing price. The diversity index for open space type was positively and significantly related to housing price at the 1% level, suggesting urban residents prefer a neighborhood with more diverse and heterogeneously composed open spaces to a neighborhood with less diverse and homogenously composed open spaces.

Table 1. Regression estimates of open space variables from the hedonic model (dependent variable: natural log of real house sales price)

Variables	Definition	Coefficient	Standard error
Open space diversity	Diversity index of open space category in the neighborhood	0.537**	(0.180)
Developed land diversity	Diversity index of developed land category in the neighborhood	-0.508*	(0.249)
Open space MPFD	Mean Plot Fractal Dimension of Open spaces in the neighborhood	-31.705**	(6.813)
Opens space Plot Density	Number of plots in which per hectare of open space is distributed in the neighborhood	-0.033*	(0.014)
R2	0.50		
No. of observations	11,125		

Note: **, and * indicate the significance of parameters at 1%, and 5% respectively. Numbers in parenthesis are White's robust standard error.

Conversely, the diversity index for developed land was negatively and significantly related to housing price, suggesting that people do not prefer a neighborhood where residential landuse is mixed with industrial or commercial land uses. This result is also consistent with Stull (1975). Similarly, mean plot fractal dimension (MPFD) of open space was negatively and significantly related to housing price at the 1% level, suggesting that people prefer open spaces in more even and square/rectangular shape than those in crooked or convoluted shapes. This result agrees with findings of a similar study by Nelson et al. (2004) that the managed edges of forest landscape increase house price. The coefficient on spatial distribution of open space plots as measured by plot density was negative and significant at the 5% level, suggesting that an open space of a given amount increases house price in the neighborhood if it is aggregated into few larger assemblages and decreases house price if it is fragmented and spatially distributed in numerous plots throughout the neighborhood.

Conclusion

Findings from this study confirmed that urban residents value variety and spatial pattern of open space in their neighborhood. Preserving various types of open spaces might not only increase biodiversity and productivity of local ecosystems, but also raise the local tax base through increased house prices. In contrast, any growth policy that mixes different types of developed landuse in a residential neighborhood would be undesirable. Our analysis reveals that square shaped open space plots, with smooth and more managed boundaries are preferred to those with complex and convoluted shaped plots with unmanaged boundaries. Likewise, people prefer few larger plots of open space to numerous tiny plots those are spatially disaggregated around the neighborhood. This is consistent with the “bigger the better” principle, and reveals that smart open space protection polices should favor protecting fewer but sizable amounts of plots, rather than protecting numerous tiny plots randomly located around the neighborhood. Increasing urban population in U.S. cities will result in tremendous pressure on the remaining open spaces. Findings from this study would provide useful guidance for effective design and management of those spaces which will be crucial to derive the best human value from these amenities.

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