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Forests and Rural Economic Development in the Northeastern United States

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Abstract: Forests provide a broad economic basis for rural communities throughout the Northeastern United States. Contemporary resource management and rural development planning increasingly emphasize the integration of raw material production with forward-linked processing activities. Furthermore, the tacit acceptance of joint production of both wood and amenity-based recreation often pits the forward linked sectors of wood processing and tourism against one another as development strategies. Empirical studies suggest that both wood processors and tourism businesses locate proximate to forest resources. Assessing the regional firm location decisions of wood processors has raised important and complex issues of sectoral heterogeneity and regional economic performance. This study addresses the question of the relative importance of alternative forest uses in supporting rural economic vitality. Specifically, we initiate analysis of firm location in three wood processing sub-sectors through descriptive location quotients of primary, secondary, and reconstituted wood products manufacturing sectors and compare the presence of tourism sector activity to that of the timber sector. Explanatory variables that support these sectoral specific location quotients include proxies for raw material inputs and output markets. Our work on rural resource dependency expands this into metrics associated with income, unemployment, poverty, and regional economic diversity. Results suggest that important differences exist in locational dependency attributes between wood products sub-sectors and that dependence on joint forest resource outputs is clearly associated with unique attributes of regional socioeconomic structure.

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FORESTS & RURAL ECONOMIC DEVELOPMENT IN THE NORTHEASTERN UNITED STATES

1. INTRODUCTION

1.1 Brief literature review

Regional science has a strong literary component that addresses regional resource endowments, primary industry location, resource dependency, and export base attributes of regions. The early work of North (1955) and the overview of economic base multipliers by Richardson (1985) identified the importance of raw material endowments and their processing as principle explanatory factors involved in an export-base concept of regional growth. Porter's work in regional competitive advantage (Porter 1990, 1996) clearly identified factor resource conditions as critical in location decisions of the firm.

Forest resources have provided location-specific advantages for many regions at various stages in their economic development. In early stages of development, timber production and wood processing industries created plentiful and relatively high-paying job opportunities. The wood products sector continues to be a strong economic presence throughout rural forested regions of North America (Webster & Chappelle 1989).

Since the 1960s, several forces have come together to fundamentally alter the manner in which forest resources act as engines of economic growth. International competition has led wood products industries of the U.S. to lose their price competitiveness in world commodity markets (Freudenburg 1992; Weber 1995; Pulver 1995; Galston & Baehler 1995). Also, the economic restructuring of the American economy toward a service base has significantly tempered the importance of raw material commodity production as inputs for regional economic production (Bluestone & Harrison 1982; Chevan & Stokes 2000). Finally, environmental and political activism of urban audiences have provided strong criticism of extractive productive practices by emphasizing adverse environmental impacts, threats to bio-diversity and sustainability, and global environmental change (Castle 1993; Buttel 1995).

These regional resource development issues have forced a reexamination of the uses and management of forest resources; particularly publicly owned land-based resources such as forests and water resources in the American West and the Northeastern Lake States. Since the late 1960s, forest management has broadened its focus to incorporate non-extractive environmentally sensitive land management practices that reflect broader non-market values (Power 1996; Hays 1998). Natural amenity-rich communities have become aware that forest resources provide not only a source of physical raw material commodities but can also serve as a source of recreational use that provides a backdrop for tourism development (Galston & Baehler 1995; Isserman 2000; Green 2001).

The natural amenity component of forests is clearly thought to provide an integral component of recreation, tourism, and retirement development (Fredrick 1993; Keith & Fawson 1995; Jakus et al. 1995; Keith et al. 1996; Marcouiller 1997; McDonough et al. 1999). Natural amenities such as lakes, forests, and wildlife provide the substantive but latent primary factor input into tourism industry output (Marcouiller 1998). As a quality-of-life factor, forests also are believed to play a critical role in human migration and firm location decisions (Graves 1979, 1980, 1983; Gottlieb 1994). The regional economic reliance on tourism and wood products production given joint production of raw material inputs, increasingly global linkages for both output demand and production inputs, and the trend toward service sector domination provide the issue set of this applied empirical work. How do tourism and timber interact to contribute to rural economic characteristics? Within forested regions, how can we characterize variation in regional economic and demographic change with respect to alternative reliance on these two sectors? How can we improve the development policy discussion with respect to these two sectors? These are the primary questions being addressed in this manuscript.

While the extraction and processing of natural resources have the potential to provide a regional comparative advantage relative to other economic sectors by virtue of their ability to generate surplus resource rents above normal returns to other factors of production, large-scale dependency on resource extraction also can contribute to regional instability over time (Gunton 2003).[1] In practice, it is generally accepted that diverse economic structures provide significant benefits to economic stability and growth. This said, the diversity literature also identifies a rather interesting and dichotomous applied policy dilemma. Whereas diversity is often viewed as beneficial from a stability perspective, it runs somewhat counter to the notion of comparative advantage (Wagner & Deller 1998; Siegel et al. 1995; Wagner 2000). Regardless, the location of resource endowments and related firm activity represents an increasingly important component associated with the new economic geography (Fujita, Krugman, & Venables 1999; Audretsch 2003) and in the analysis of spatial economic issues (Anselin 2003; Fingleton 2003).

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[1] Regional economic investigations of the wood products sector are limited. Important work has been done on the impact of timber production and the wood products sector on local economies; however, literature dealing with the regional economic effects associated with timber production and wood products sector activity either do not address or gloss over important issues of firm location (Cox & Munn 2001; Aruna *et al.* 1997) and interaction with tourism. Others have examined the environmental impacts of timber production and the wood products industry through regional comparisons without mention of firm location (McNulty *et al.* 2000; Lewis *et al.* 1996). Lohmander (1994) addresses cost minimization and firm location in the forest products industry from a transportation cost perspective; however, transportation is only one of many factors in the firm location decision process. It is important to note that minimizing transportation costs does not necessarily maximize profitability. It is the goal of transportation planning to optimize the expected present value of the firm where transportation is only one in a number of cost variables.

To more accurately model regional firm location, models should address additional factors such as demand market size, raw material availability, and labor markets. Abt (1987) examined the regional impacts of labor and raw materials in the United States lumber industry, while Smith and Munn (1996) examined labor and capital regional impacts of the logging industry. Both studies present interesting information but fail to address the spatial aspects of firm location. Leigh (2000) examined issues of foreign competition and competitiveness in the U.S. woodworking industry and suggests that the timber industry and construction activity may impact the location of woodworking producers. However, a detailed analysis of these two factors was not pursued.

1.2 Problem statement and objectives

This study addresses the question of the relative importance of alternative forest uses in supporting rural economic vitality. The goal of this project is to develop county-level estimates of forest use value and assess the relative importance of forest use alternatives in rural economies for the 20 northeastern states. In particular, the primary objective is to quantify the economic impacts of forest use on rural county-level economic structures.

In related work, regional location models that investigate the wood products and tourism sectors have been constructed and analyzed. For example, Bowe et al. (2004) looked at firm location for three wood products sub-sectors. Although lacking specific firm-level profit components, these empirical models contained significant explanatory variables that served as gross proxies to the generic location decision framework. Results suggested that the location of two of the three wood-products sub-sectors were significantly related to timber removals with intra sector location important as both intermediate demand and input suppliers. The role of recreation sites and tourism on remote rural economic change was examined in recent work by Dissart (2003) and Kim (2002). In this work, explanatory models of regional economic change focused on growth and distribution but firm location and interaction with other primary economic sectors was not addressed.

The problem we address in this report extends previous work focused on firm location in the wood products sector and the linkage between recreation sites and rural tourism in remote rural regions. Namely, within resource dependent regions, how do primary economic sectors such as forestry and tourism interact with respect to socioeconomic characteristics such as poverty and unemployment? Furthermore, how do these sectors provide for local income opportunities for rural households?

Specifically, we are drawn to a more focused regional geography that highlights both remote rural conditions and significant resource dependency. Namely, our geography is now limited to regions that are heavily forested. For this research, we have defined forested counties as having 50 percent or greater forestland cover with non-forested counties have less than 50 percent forestland cover (Figure 1). Forest cover data was interactively accessed using the USDA Forest Service Forest Inventory and Analysis database (USDA Forest Service 2004a). Focusing on forested counties allows us to focus on a distinct type of resource dependency and provides a sub-categorization with unique and statistically significant different social and economic characteristics. Within this set of rural counties, there remains significant heterogeneity in socio-economic characteristics.

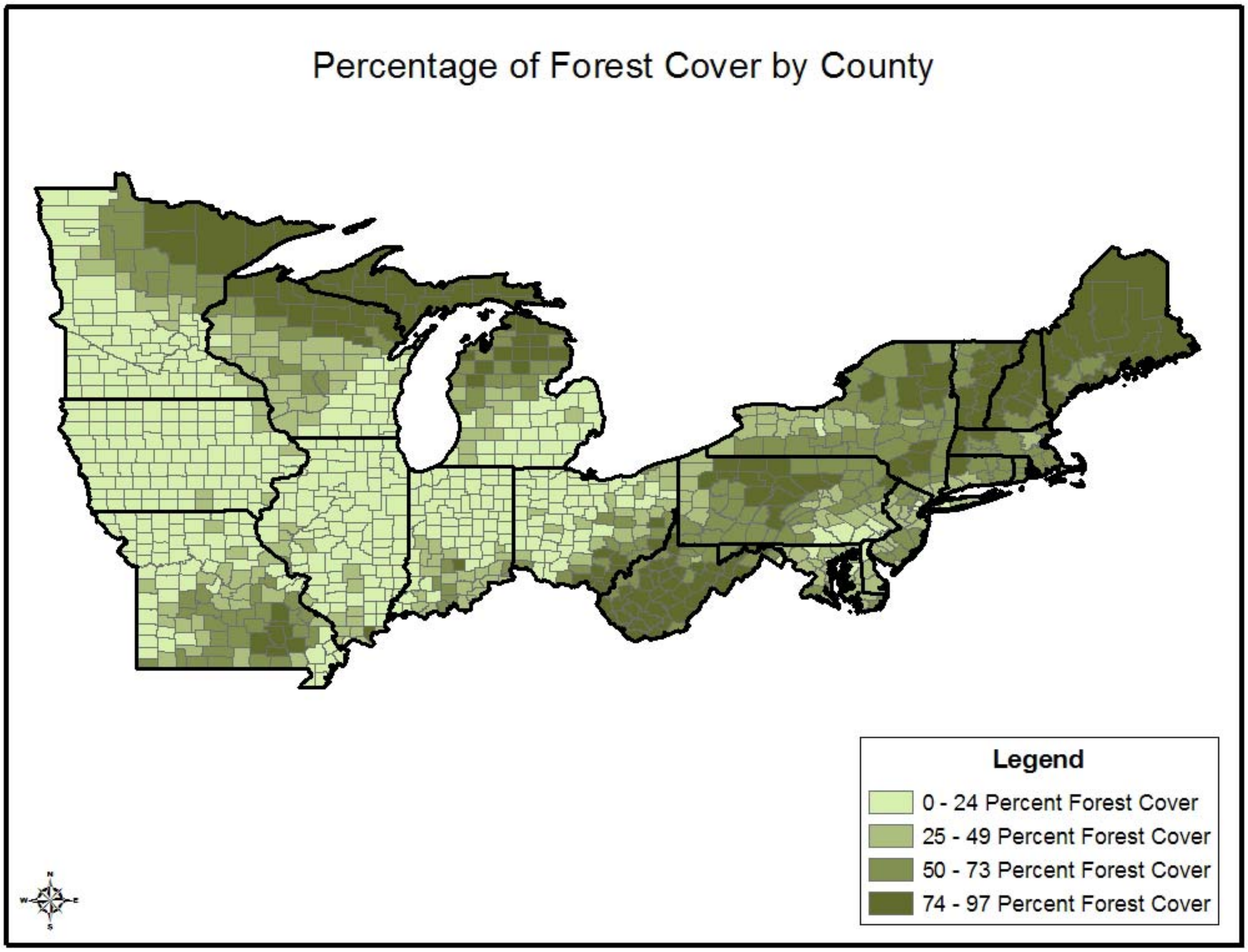

Figure 1: Percent forest cover by county for the 20 Northeastern United States.

Our problem set focuses on resource dependency and issues of economic characteristics including diversity. Building on early work of Webster and Chappelle (1989) that argues for a combination of forest products and tourism, the following questions become apparent. First, what spatial patterns exist in the location of both wood products and tourism firms in the Northeastern United States? How can we logically characterize these regions into homogeneous groupings that allow issues of resource use to be distinguished? Once distinguished, how do economic characteristics such diversity, income source, poverty, and unemployment differ among groupings? These are the questions addressed in this manuscript.

1.3 Outline of this report

These assessments will provide a comparative view of alternative forest uses with respect to the broader regional economies of the rural Northeastern United States. Inferences are drawn from descriptive and statistical analysis with interest in the relative importance of forest use alternatives. Ties to relevant literature, policy implications, and further research are outlined. This publication is intended to be a comprehensive summary of the information gathered.

This report is organized into three additional sections. First, we outline the methods used to organize, compile, and present relevant data. The next section provides a comprehensive outline of both descriptive and analytical results. Finally, we conclude with a discussion of relevant policy implications that result from our analysis.

2. METHODS USED

Firm location decisions offer the basis for understanding regional economic vitality. In many respects, regions grow or decline based on their ability to attract and retain firms. The relative ability of regions to retain and attract firms is dependent, at least in part, on their unique comparative advantages. These unique comparative advantages relate to how firms perceive a location's conduciveness to allowing them to maximize profits. Important components associated with a firm's ability to maximize profits relate to location as it affects cost minimization and/or demand maximization. Furthermore, the location and characteristics of industry clusters relative to the breadth of sectoral diversity determines the extent of regional dependency on any given industrial sector. This is particularly important for rural resource-dependent regions across the United States.

2.1 The location of firms

The general problem facing the firm is a situation where their consumers and suppliers are scattered across a heterogeneous economic plane. The firm is faced with the locational choice that places the firm somewhere on the economic plane in a manner that maximizes profits. The firm does this by minimizing the transportation costs of shipping input supplies to the firm and maximizing the potential market demand for their good or service. In other words, the profit maximization approach to location decisions declares that businesses select the site from which the number of buyers whose purchases are required for maximum sales can be served at the least possible total cost (Greenhut, 1956; McCann, 2002). This site need not be the lowest total cost site possible, but rather a site from which monopolistic control over buyers makes this site more profitable than a lower cost site. In other words, an individual business can offer a delivered price to buyers at lower than competitors' prices. This approach recognizes the interaction between demand (locational interdependence) and the cost of production in site selection.

The profit maximization approach examines both the total revenues and the total costs portion of the profit equation:

$$\textbf{Profit = Total Revenues - Total Costs} \qquad \textbf{(1)}$$

The firm is faced with balancing two factors, the location of customers which drives the revenue side of the profit maximizing equation and the location of suppliers with drives the costs side of the equation. Typically, the firm believes one of these factors is more important than the others, and they focus on either maximized revenue or minimized costs first. Other factors enter the decision only after that initial choice is made.

Formally we can state our problem outlined in equation (1) as:

$$\textbf{Profit =} \sum_{i=1}^{m} P_i D_i(P_i) - f - vq(x_i) - \sum_{i=1}^{m} t(s,s^i) D_i(P_i) - \sum_{i=1}^{n} d(s,s^i) x_i \qquad \textbf{(2)}$$

Where P_i is the price charged at market i (i = 1…m), $D_i(P_i)$ is the demand for the firm's product at market i, s^i is the spatial location of market i, $t(s,s^i)$ is the cost of transporting one unit of the good from firm location s to market location s^i, f is the fixed costs facing the firm to produce the good, v is the constant marginal cost of producing one unit of the good, x_i is the production inputs from market i (i = 1 … n), $d(s,s^i)$ is the cost of transporting one unit of input x_i from market location s^i to firm locations, and $q(x_i)$ is the output level of the firm.

The firm selects location given a set of prices (P_i) that maximize demand at each market and a location (s) that minimizes transportation costs. Clearly, the number of output markets (m) need not be equal to the number of input markets (n) and the cost of transporting output ($t(s,s^i)$) need not be the same as the cost of shipping inputs ($d(s,s^i)$). We could make our problem even more general by allowing for multiple outputs (q_i) and multiple firm locations (e.g., multiple plants) (s^j).

2.2 Firm location and the wood products sector

The wood products sector has a long history of activity throughout rural North America. This is particularly true in rural regions endowed with significant forest resources (Webster & Chappelle 1989). The reliance of this sector on raw material inputs and its increasingly global linkages for both output demand and production inputs provides an interesting focus for applied empirical work.

Regional economic investigations of the wood products sector are limited. Important work has been done on the impact of timber production and the wood products sector on local economies; however, literature dealing with the regional economic effects associated with timber production and wood products sector activity either do not address or gloss over important issues of firm location (Cox & Munn 2001; Aruna *et al.* 1997). Others have examined the environmental impacts of timber production and the wood products industry through regional comparisons without mention of firm location (McNulty *et al.* 2000; Lewis *et al.* 1996). Lohmander (1994) addresses cost minimization and firm location in the forest products industry from a transportation cost perspective; however, transportation is only one of many factors in the firm location decision process. It is important to note that minimizing transportation costs does not necessarily maximize profitability. It is the goal of transportation planning to optimize the expected present value of the firm where transportation is only one in a number of cost variables.

To more accurately model regional firm location, models should address additional factors such as demand market size, raw material availability, and labor markets. Abt (1987) examined the regional impacts of labor and raw materials in the United States lumber industry, while Smith and Munn (1996) examined labor and capital regional impacts of the logging industry. Both studies present interesting information but fail to address the spatial aspects of firm location. Leigh (2000) examined issues of foreign competition and competitiveness in the U.S. woodworking industry and suggests that the timber industry and construction activity may impact the location of woodworking producers. However, a detailed analysis of these two factors was not pursued.

The problem we address in this paper more clearly specifies attributes of firm location in the wood products sector. Specifically, the empirical questions we set out to answer are rather straightforward and fall into three basic categories. First do the locations of sub-sectors within the wood products sector relate to one another? Second, to what extent does this correlation among alternative sub-sectors differ by sub-sector? Finally, what elements help explain why some regions have concentrations of the three forest products sub-sectors while others do not? This latter question moves us toward answering important issues related to firm location.

2.3 A proxy spatial location metric

In an effort to address the questions outlined above, we begin with a simple proxy that allows for identification of location choice as a regional phenomenon. Our work then moves into developing models that explain this location choice proxy. It is important to point out that our theoretical model identified above relates generically to the spatial profit maximization problem consistent with firm-level economic theory. Operationally, we step back and rely on an empirical model tempered by the realities of readily available secondary data.

Location quotients are used as a proxy for spatial location. The location quotient represent an index that places the percent of local employment in a given sector as a ratio to the percent of national employment in same sector as follows:

$$\mathbf{LQ}^{\mathbf{i}}_{\mathbf{s}} = \left(\frac{e_s^i}{e_s^t}\right) \Big/ \left(\frac{e_n^i}{e_n^t}\right) \qquad \mathbf{(3)}$$

Where LQ^i_s is the location quotient for industry i in place s, e^i_s is employment in industry i place s, e^t_s is total employment place s, e^i_n is a national reference for employment in industry i while e^t_n is total national employment.

These indices represent the level of sectoral dominance in regional economies and are sensitive to issues of economic diversity, size and economic scale. As such they are well-suited to the development questions raised here. They are limited, however, in measurements requiring an absolute incidence of sectoral activity. For instance, regions with large diverse economies may have a significant absolute level of activity in the industry under question. But, given the large extent of "other" sectors present in the economy, may not show large location quotients because the relative importance of the sector is muted with respect to overall economic activity. Thus, our use of the location quotient as a proxy for firm location neglects to incorporate agglomerating influences and the pecuniary externalities of firm interaction. It does, however, capture the relative importance of firm location particularly evident in smaller rural counties. Also, it represents a useful proxy for identifying the extent to which export-base activity exists within these regions.

2.4 The empirical firm location models

The operational models seek to explain these location quotient indices using a set of independent variables that mimic our generic model of firm location as outlined in equation 1. Namely, we construct models based on reasonable industry characteristics for inputs and outputs that reflect the sectoral cost structure (or supply) and its output markets (or demands). The latter represent proxies for revenue while the former represent costs. Operationally, this initial work is based on very gross measures of demand and supply driven by the available regional data.

Perhaps the most straightforward forest products sub-sector is what we identify as primary wood processors. This sub-sector is representative of firms that turn roundwood into dimensional material. Specific examples include sawmills and plywood mills. Output demand for primary processors includes both intermediate demands of the forward-linked processing sectors (e.g. furniture manufacturers) and final demands within the construction trades and general public consumption. Thus a more specific empirical model for the primary processing sub-sector includes the following:

$$\mathbf{LQ}^{\mathbf{primary}} = f\,(\mathbf{D_{INT2}, D_{INT3}, D_{FIN}, RM_{RW}, RM_{INT}, control}) \qquad \mathbf{(4)}$$

Where D_{INT2} is the demand from the secondary wood processing sub-sector (measured as regional sub-sector output), D_{INT3} is the demand from the reconstitituted wood processing sub-sector (again measured as regional sub-sector output), and D_{FIN} is the set of final demands. In these models, final demand is proxied by the county-specific USDA Rural-Urban Continuum classification. This represents a gross indicator of market proximity. Input costs on a regional basis are related to the availability and relative transport costs associated with raw materials used in the primary wood processing sub-sector. Namely, these include timber harvested from surrounding forests. For our purposes in these initial models, we have two alternative forms of timber removals that represent removals from growing stock (RM_{RW}) that include all volumes (sawtimber and pulpwood) and what we term intermediate inputs representing timber removals that are merchandised as sawtimber alone (RM_{INT}).

The secondary wood products sub-sector represents those firms who use dimensional and reconstituted wood products to produce some final finished good. Specific examples include furniture manufacturers and cabinet makers. For purposes of explaining firm location in the secondary wood products sub-sector, our logic rests on the notion that the primary sectoral output will be for final demands (D_{FIN}) with raw material inputs including output of primary processors (RM_{INT1}) such as dimensional wood members and the reconstituted sector (RM_{INT3}) such as fiberboard and wood-based laminates. In future models, we will also seek to include non-wood based inputs such as chemicals and textiles. Also important in these future models will be skilled labor supplies. Thus, our initial model for secondary wood products sub-sector location is as follows:

$$\mathbf{LQ}^{\mathbf{secondary}} = f\,(\mathbf{D_{FIN}, RM_{INT1}, RM_{INT3}, control}) \qquad \mathbf{(5)}$$

The reconstituted wood products sub-sector represents those firms involved in using wood chips or wood pulp to produce some good that has both intermediate and final demands. Specific examples of firms included in this sub-sector are oriented-strandboard manufactures and paper mills. Our model of firm location for the reconstituted sector rests on the logic that these types of firms are both closely tied to timber output (wood chips and pulpwood) and are inextricably linked to other downstream processors (secondary wood processors, publishers, etc.). Our model for reconstituted sector location quotients is represented as:

$$\mathbf{LQ}^{\text{reconstituted}} = f\,(\mathbf{D_{INT1}, D_{INT2}, D_{FIN}, RM_{RW}, RM_{INT}, control}) \qquad (6)$$

Where outputs are consumed by intermediate (D_{INT1}, D_{INT2}) and final (D_{FIN}) demands and raw material inputs include timber; both roundwood (RM_{RW}) and sawtimber (RM_{INT}).

2.5 Models of resource dependency

Our approach in this applied research focused on resource dependent counties in the 20 Northeastern United States as defined by presence of forest cover. As a justification for our focus on the forested region of the 20 Northeastern States, Table 1 presents empirical evidence that highlights the distinct differences between the forested and non-forested counties with particular reference to the wood products and tourism sectors. Since our focus remains embedded within the interaction between tourism and wood products, we address only those differences reflected by the wood products sector dependencies, which in all instances are significantly higher in the forested sub-region of these 20 states. From this table, note that 341 counties of the 1,037 counties in the 20 Northeastern States have at least 50 percent forest cover.

In these resource dependent counties, the first empirical issue that needed to be addressed dealt with developing a logical approach to disaggregating the forested region based upon variation in relative dependency given 3 types of wood processing sectors and five types of retail and service sectors that were combined to represent tourism. This disaggregation into distinct sub-regions was based on sectoral dependence accomplished using location quotients for forest products and tourism sub-sectors.

If we split the forested regions into four quadrants (high forestry/high tourism; high forestry/low tourism; low forestry/low tourism; low forestry/high tourism), we view distinct sub-regions based on characteristic differences of resource dependency. Quadrant 2 is most desirable representing a diverse regional economy and demonstrating the co-existence of the wood products and tourism sectors. In contrast, quadrant 3 represents a regional economy with limited activity in both the wood products and tourism sectors. Quadrants 1 and 4 represent economies with less economic diversity, and a greater dependency on either the wood products or tourism sectors independently.

Location quotients represent the level of sectoral dominance in regional economies and are sensitive to issues of economic diversity, size and economic scale. As such they are well suited to the development questions raised here. They are limited, however, in measurements requiring an absolute incidence of sectoral activity. For instance, regions with large diverse economies may have a significant absolute level

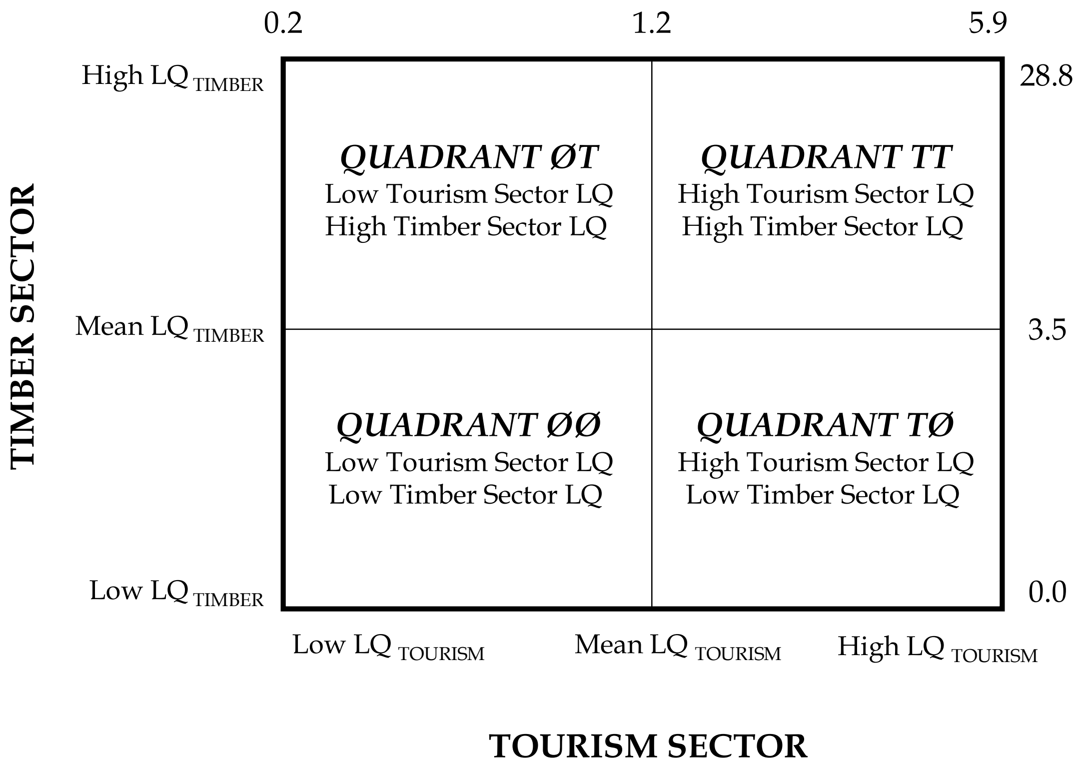

Figure 2. A tourism-timber dependency modeling structure that allows differentiation of alternative diversity types.

of activity in the industry under question. But, given the large extent of "other" sectors present in the economy, may not show large location quotients because the relative importance of the sector is muted with respect to overall economic activity. Thus, our use of the location quotient captures the relative importance of firm location particularly evident in smaller rural counties. Also, it represents a useful proxy for identifying the extent to which export-base activity exists within these regions.

Table 1. Descriptive statistics that distinguish forested from non-forested counties by quadrant in the 20 Northeastern United States[1].

Forested (>50% FOREST COVER)	**Range**[2]	**Mean**[2]	*Metric*[2] **Quadrant ØT**	**Quadrant TT**	**Quadrant ØØ**	**Quadrant TØ**	**Total**[2]
# Counties			66	40	145	90	341
Output Timber	$0 - $1,468	$114	$13,479	$6,520	$13,841	$5,073	$38,913
Output Tourism	$4 - $6,656	$290	$4,880	$5,523	$52,672	$35,747	$98,822
LQ Timber	0.0 - 28.8	3.5*	9.1**	7.2**	1.3**	1.2**	na
LQ Tourism	0.2 - 5.9	1.2*	0.8	1.7	0.9	1.8	na
Non-Forested (< 50% FOREST COVER)							
# Counties			50	5	571	70	696
Output Timber	$0 - $4,486	$129	$24,840	$3,214	$58,277	$3,643	$89,974
Output Tourism	$3 - $24,037	$550	$10,694	$2,047	$339,867	$29,844	$382,452
LQ Timber	0.0 - 17.5	1.2	7.0**	5.9**	0.7	0.8**	na
LQ Tourism	0.2 - 3.4	0.9	0.8	1.4	0.8	1.6	na

Notes:
1. Total of 1037 total counties in the 20 Northeastern States
2. Monetary values are in millions of 1997 US dollars; monetary values under the four quadrant headings represent the output sum for each quadrant. Location quotients (LQ) are based on output as a ratio of ratios following equation 1 and are reported as means under the four quadrant headings.
* indicates significant difference (from non-forested mean) at the $p < 0.05$ level.
** indicates significant difference (between tourism and timber) at the $p<0.05$ level.

We had distinct interest in comparing levels of economic diversity among the four quadrant sub-regions to answer the specific question of what explains low diversity among alternative resource dependency types. For this work, we chose a specific log share entropy measure known as the Wiener Index (others refer to the Shannon-Wiener Index). The Wiener Index has been used extensively in both ecological and economic settings (Magurran 1988; Wagner 2000). In an economic context, equal levels of economic activity in all industry sectors represent ideal diversity. A region heavily weighted to a specific industry would represent a specialized and less economically diverse region. Specifically, the Wiener is calculated as shown in equation (7).

$$W_i = -\sum_{s=1}^{S_i} \left(\frac{o_{si}}{o_i} \right) \ln \left(\frac{o_{si}}{o_i} \right) \tag{7}$$

where S_i is the total number of industries in the ith region, o_{si} is the output of industry s in the ith region, and o_i is the total output in the ith region. The Wiener Index captures diversity by displaying larger values for regions with a greater level of diversity. For this work, the Wiener Index was derived at 4 digit SIC and obtained from the USDA Forest Service (2004b).

2.5 Data used in the empirical models

The research question is addressed through the analysis of secondary data. All data relates to county-level characteristics of the 20 Northeastern states of the U.S. (as identified in Table 2). These counties can be found along the spectrum from highly urbanized centers to very rural and remote areas as referenced by the Urban-Rural continuum codes shown in Figure 3. In particular, the first objective of the study (to identify characteristics relevant to forest use in nonmetropolitan counties of the 20 northeast states) is met through the analysis of a county-level dataset of (1) relevant forest use characteristics developed from USDA inventories of timber, land, water, and recreational attributes, and (2) socioeconomic variables (e.g. population, economic structure, etc.) and spatial identifiers (e.g. metro-adjacency remoteness, etc.) obtained from Census files, BEA-REIS, and MicroIMPLAN. These main variables and sources used in the analysis are found in Table 3.

Table 2. Regions and states included in the study (USDA-FS U.S. Northeast region)

Region	States	Number of counties
North Central	Illinois	102
	Indiana	92
	Iowa	99
	Michigan	83
	Minnesota	87
	Missouri	115
	Wisconsin	72
North East	Connecticut	8
	Delaware	3
	Maine	16
	Maryland	24
	Massachusetts	14
	New Jersey	21
	New Hampshire	10
	New York	62
	Ohio	88
	Pennsylvania	67
	Rhode Island	5
	Vermont	14
	West Virginia	55
Total	20	1037

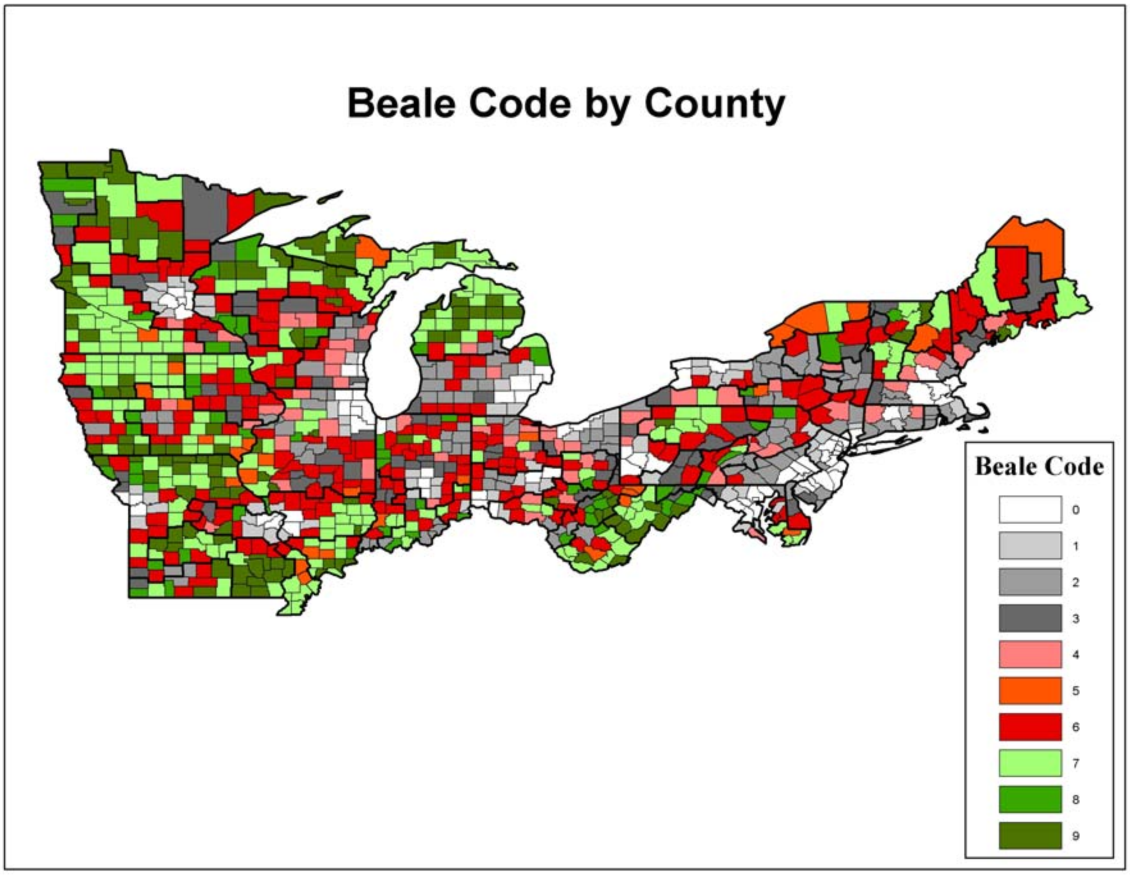

Figure 3. Urban-rural continuum classifications of the counties found in the 20 Northeastern United States.

Data on sectoral characteristics for calculating location quotients were generated using IMPLAN developed by the Minnesota IMPLAN Group (MIG, 2001). Specifically, we used IMPLAN data to construct county-level estimates of sector output (in dollars) and other components of value added such as employee compensation, other property type income, proprietor's income and indirect business taxes. For our purposes, Table 4 outlines the aggregation template used for the various sub-sectors of the forest products industry including the primary, secondary, and reconstituted forest products sectors. In addition to forest sector data, IMPLAN also provided data for the tourism sectors. In our case, we have combined five tourism sectors into one measure

Table 3. Description and source of selected variables

Variable description	Source [physical source]
% of county land classified as timberlands (1990-1998)	FIA-DBRS, NORSIS [**www.srsfia.usfs.msstate.edu/scripts/ew.htm**]
Population density per square mile (1990)	U.S. Census [fisher.lib.Virginia.EDU/ccdb/]
% of public timber lands in total timber lands % of private timber lands in total timber lands gross indes of management intensity (removals per acre)	FIA-DBRS www.srsfia.usfs.msstate.edu/scripts/ew.htm]
% of urban population in total population (1990) % of rural population in total population (1990) Median household income (1990) Median family income (1990) Per capita income (1990) % of seasonal housing units per total housing units (1990)	U.S. Census CensusCD+Map (Geolytic, INC)
% change of proportion of persons below poverty (1989-93)	U.S. Census [govinfo.kerr.orst.edu/usaco-stateis.html]
% change of unemployment rate of civilian labor force (1990-96)	U.S. Census [govinfo.kerr.orst.edu/stateis.html]
% change of population (1990-98) % change of proprietors income (1990-98) % change of per capita income (1990-98) % change of tourism industries earnings (1990-98)	REIS [fisher.lib.virginia.edu/reis/county.html]
Economic structure: - sectoral output, employment, and income by industry group - entropy measure of industrial diversity - interindustry relationships and county-level indexing - Type II and SAM multipliers	Descriptive and indexed Micro-IMPLAN data and regional input-output models based on peer-groupings
% of urban related recreation facilities (1997)	NORSIS [USDA-FS]

called aggregate tourism. Aggregate tourism consists of the travel, retail, dining, hotel, and service tourism sectors.

Our intent was to develop a sufficient list of variables that would allow us to draw conclusions about the relationship between wood products and aggregate tourism sectors. For this work we chose several metrics that allowed interpretation of resource dependent effects. Namely, we chose to focus on poverty incidence, unemployment, and population as general and standardized socio-demographic indicators. These data were developed from available REIS datasets. Economic characteristics focused on proprietor's income, sectoral earnings, and per capita income levels. Again, these data were obtained from REIS. Due to an interest in capturing a broader definition of tourism, we chose to look at recreational housing (seasonal and occasional use residential units) using data obtained from the US Census (USDC Census Bureau 2002).

Table 4. Sectoral aggregation used in the forest industry sub-sector specification.

IMPLAN Sector	Sectoral Description	Aggregated Sector
24	Forestry Products	Primary wood processing
133	Logging Camps and Logging Contractors	Primary wood processing
134	Sawmills and Planing Mills, General	Primary wood processing
135	Hardwood Dimension and Flooring Mills	Primary wood processing
136	Special Product Sawmills, N.E.C	Primary wood processing
137	Millwork	Primary wood processing
138	Wood Kitchen Cabinets	Secondary wood processing
139	Veneer and Plywood	Secondary wood processing
140	Structural Wood Members, N.E.C	Secondary wood processing
141	Wood Containers	Secondary wood processing
142	Wood Pallets and Skids	Secondary wood processing
143	Mobile Homes	Secondary wood processing
144	Prefabricated Wood Buildings	Secondary wood processing
145	Wood Preserving	Secondary wood processing
147	Wood Products, N.E.C	Secondary wood processing
148	Wood Household Furniture	Secondary wood processing
149	Upholstered Household Furniture	Secondary wood processing
152	Wood Tv and Radio Cabinets	Secondary wood processing
153	Household Furniture, N.E.C	Secondary wood processing
154	Wood Office Furniture	Secondary wood processing
156	Public Building Furniture	Secondary wood processing
157	Wood Partitions and Fixtures	Secondary wood processing
160	Furniture and Fixtures, N.E.C	Secondary wood processing
146	Reconstituted Wood Products	Reconstituted wood product
161	Pulp Mills	Reconstituted wood product
162	Paper Mills, Except Building Paper	Reconstituted wood product
163	Paperboard Mills	Reconstituted wood product
164	Paperboard Containers and Boxes	Reconstituted wood product
165	Paper Coated & Laminated Packaging	Reconstituted wood product
166	Paper Coated & Laminated N.E.C.	Reconstituted wood product
168	Bags, Paper	Reconstituted wood product
169	Die-cut Paper and Board	Reconstituted wood product
170	Sanitary Paper Products	Reconstituted wood product
171	Envelopes	Reconstituted wood product
172	Stationery Products	Reconstituted wood product
173	Converted Paper Products, N.E.C	Reconstituted wood product

Data on timber volumes was taken from the USDA Forest Service (FIA 2004). Specific data from this source included volumes for four measures of raw material availability including *growing stock removal*, *sawtimber removal*, *growing stock volume*, and *sawtimber volume*. *Growing Stock Removal* is defined as the volume of harvested live timberland trees of commercial species that contain at least one 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and meet specified standards of size, quality, and merchantability. *Sawtimber Removal* is defined as the volume of harvested growing-stock trees that contain at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer and meets regional specifications for freedom from defect. Softwoods must be at least 9.0 inches diameter and hardwoods must be at least 11.0 inches diameter. *Growing Stock Volume* is defined as the net volume in cubic feet of growing-stock trees at least 5.0 inches in diameter from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs. *Sawtimber Volume* refers to the net volume in board feet (International 1/4-inch rule) of the sawlog portion of sawtimber trees.

The second data source from which sectoral characteristics were identified was from the Minnesota IMPLAN Group (MIG, 2001). Specifically, we used IMPLAN data to construct county-level estimates of sector output (in dollars), employment (in # of jobs) and other components of value added such as employee compensation, other property type income, proprietors income and indirect business taxes. For our purposes, **Error! Reference source not found.** presents the aggregation template used for the various sub-sectors of the forest products industry.

Finally, county-level data on population and demographics was obtained from the United States 2000 Census (USDC 2002). At this point, the only Census data used in these forest products industry empirical models has been population. Other related work (Kim 2002; Dissart 2003) has incorporated data on socio-demographic conditions such as distributional income data, poverty rates, and unemployment. As future models are developed, these richer regional condition data elements will be incorporated.

As a conclusion to this section, we address issues of firm location in the forest products industry using regional explanatory models of locational attributes. Our proxy for spatial location is the sub-sector location quotient. Input costs are proxied by timber availability and, depending on the sub-sector, intermediate purchased inputs from other sub-sectors of the forest products industry. Output demands include both intermediate and final demands. Data sources capture forest inventory characteristics, industry sectoral characteristics, and socio-demographic elements of counties in the 20 Northeastern United States.

3. Results

3.1 Locational determinants of the wood products industry

Results suggest that location issues for each wood products sub-sector are unique in-and-of-themselves but are also distinctly related to one another. In this section, we outline the descriptive and inferential results of our analysis. First, the location quotients for each sub-sector are spatially arrayed and briefly described. We then proceed into a discussion of the statistical correlations that exist in the dataset used for the empirical models. This is followed by a brief discussion of the empirical OLS models used to develop an understanding of firm location in the forest products industry.

3.11 Descriptive results of spatial location. Location quotients were calculated for each forest products industry sub-sector. Calculations were generated by county, state, and forest survey unit levels. Twelve of the 20 northeastern states had location quotients greater than one for at least one sector on a statewide level. Three states had location quotients greater than 3. The analysis by forest survey unit proved useful. This level of analysis showed regional trends not visible with the state level analysis. Fifty-nine of the 74 forest survey units in the 20 northeastern states had location quotients greater than one for at least one sector. Thirty-three forest survey units had location quotients greater than 3 in at least one sector. For purposes of detail, we present the spatial array of each sub-sector on a county basis.

To simplify this discussion, our presentation of the spatial distribution of forest products sub-sectors is provided graphically in Figures 4, 5, and 6. Our first forest products sub-sector is termed "primary" and includes those firms involved in processing round-wood into dimensional products for use in construction or other forward-linked sectors. The county-level location quotient for this sub-sector is presented in Figure 4. As shown in the Figure, primary forest products firms dominate county economies in Northern Minnesota, Wisconsin, and Michigan as well as in Northern New England, the mid-Appalachian region, and the Ozark Mountains of Southeastern Missouri.

The secondary forest products sub-sector includes those firms involved in transforming dimensional wood into final products. A good example of these types of firms includes furniture and cabinet manufacturers. The county-level location quotients for this sub-sector are graphically presented in Figure 5. Notice from the Figure that there is much less concentration of these firms in the forested regions of the 20 Northeastern United States as compared to primary forest products firms. Notice also that the location quotients were generally smaller when compared to the previous grouping of firms. This perhaps represents the wider spatial distribution of secondary processors into more diverse and larger economies.

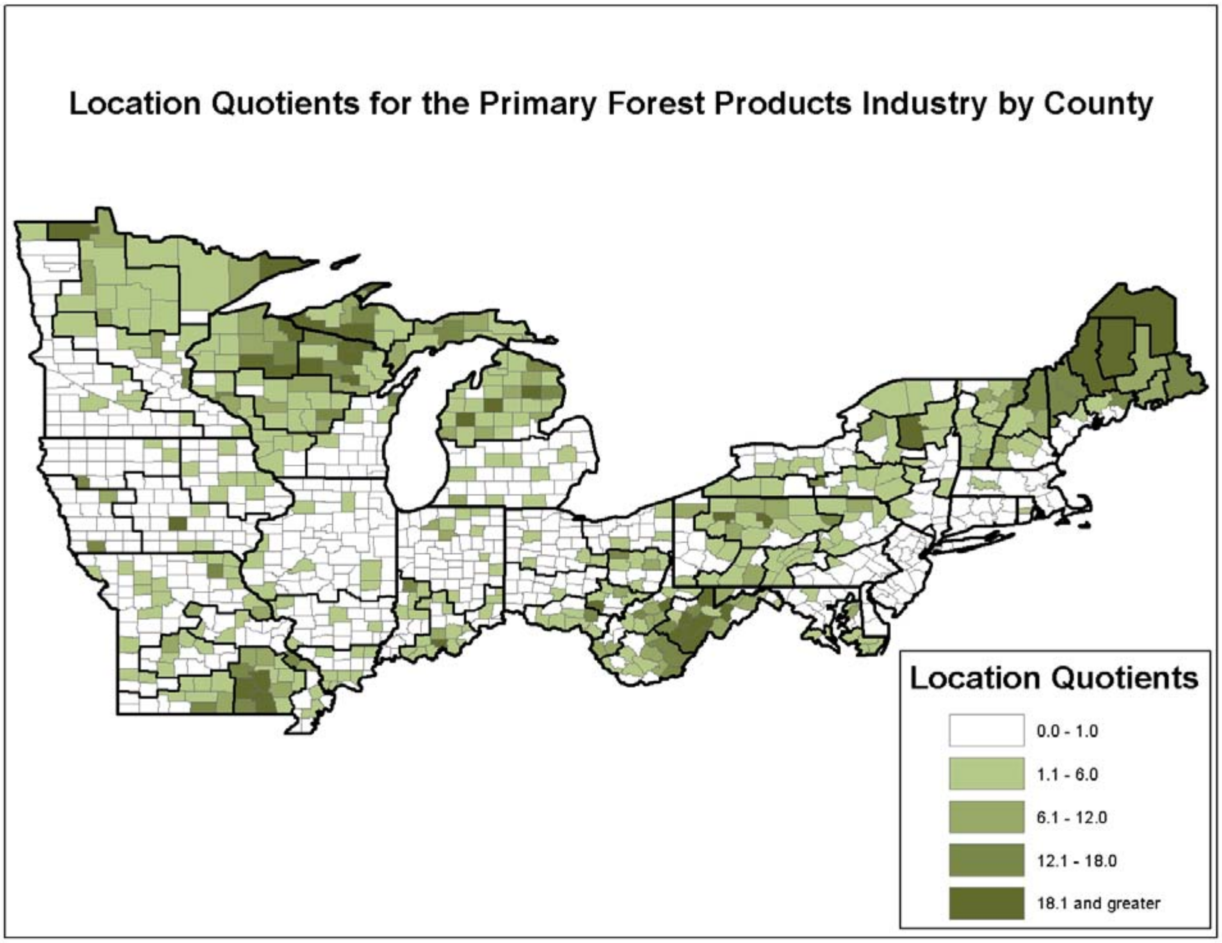

Figure 4: Location quotients for the primary forest products sub-sector by county calculated using 1997 MicroIMPLAN data on industry output.

The reconstituted wood products sector includes those firms engaged in processing goods that are comprised of wood that has been either chipped or pulped. Two good specific examples include oriented strandboard manufacturers and pulp and paper plants. The county-level location quotients for this sub-sector are presented in Figure 6. Note from the Figure that the spatial pattern appears similar to the primary forest products sub-sector. This was expected since both the primary and reconstituted industries extract their raw materials from largely forested areas. Both sawlogs and pulpwood are often harvested in the same areas with sawlogs being sold to sawmills and pulpwood being sold to pulpmills.

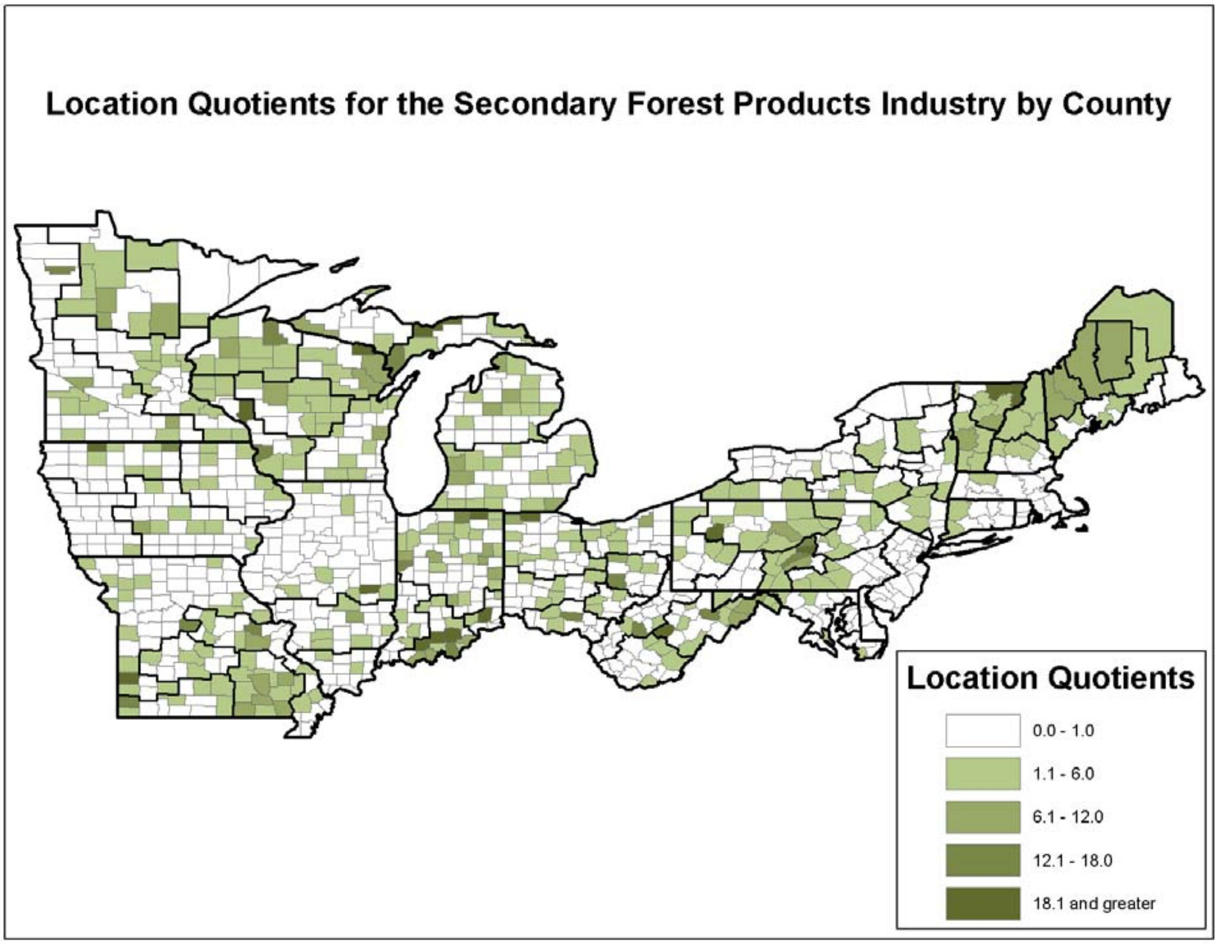

Figure 5: Location quotients for the secondary forest products sub-sector by county calculated using 1997 MicroIMPLAN data on industry output.

3.12 Relationships among dependent and independent variables. Our initial empirical work focused on developing a better understanding of the relationships among the location indices for the three forest industry sub-sectors and the alternatively identified explanatory variables for each subsector. As an entry into this work, we analyzed the correlation among primary dependent variables (LQs of primary, secondary, reconstituted sectors) and the array of independent variables (outputs of each sub-sector, the county-level Urban-Rural Continuum code, and county population). Pearson's sample correlation coefficients were used to identify correlation between the location quotients for the three forest products industry sectors and the four measures of raw material availability.

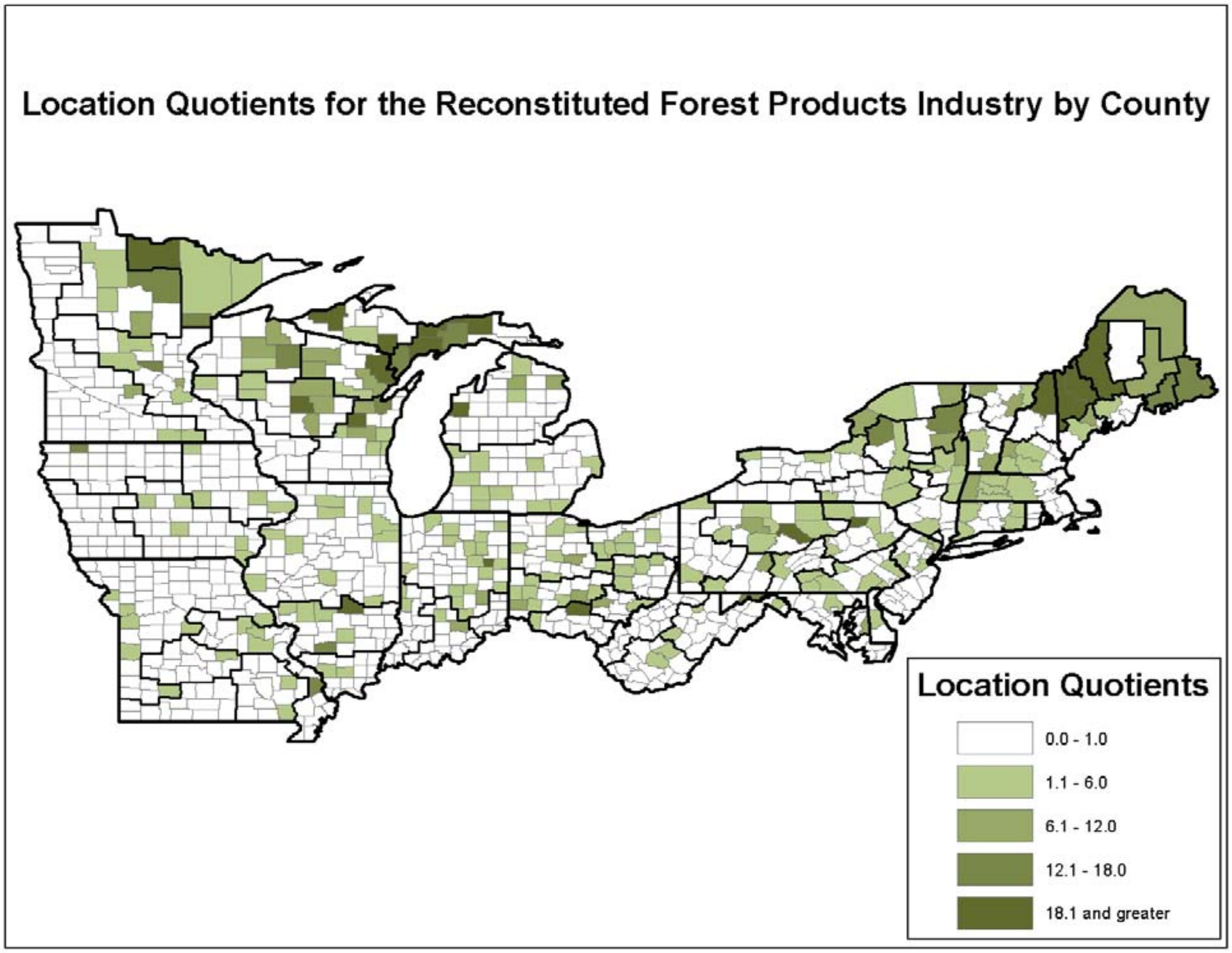

Figure 6: Location quotients for the reconstituted forest products sub-sector by county calculated using 1997 MicroIMPLAN data on industry output.

For county-level data, correlation coefficients of 0.6 were identified as significant. All measures from the FIA data including growing stock removal, sawtimber removal, growing stock volume, and sawtimber volume were significant and positively correlated. This was not surprising since they all account for the location and availability of the raw material. Both the primary and reconstituted sectors use timber in roundwood and sawtimber as their raw material and are both typically located in forested regions. In addition, the primary, secondary, and reconstituted forest products industry sectors were positively correlated to one another and positively correlated to the FIA variables, however, none were significant at 0.6. The control variable, population, was negatively correlated to all other variables in the model. A rural industry dependent upon natural resource extraction would not be positively correlated with large population concentrations.

3.13 Regression model results. In this paper, we present an initial look at empirical models of firm location in the forest products industry. These simple OLS models are presented in Table 5 by alternative dependent variable (location quotients by industry sub-sector). Prior to discussing the details of relationships within the models, we note that although all models are significant, the general lack of any explanatory power of the secondary wood products sub-sector model provides significant limitations to developing a story around its specific components. Future work will develop a broader re-specified model to hopefully improve our results with respect to the secondary wood products sub-sector. Furthermore, there are several extensions to these models that we will continue to develop that should improve their ability to explain locational aspects of each sub-sector. These include respecification of the independent variables through a broader inclusion of components of regional economic structure, economic diversity, and socio-demographic characteristics.

The results of these models suggest that timber availability is a key input to the primary and reconstituted wood products sub-sectors. Raw material input variables were significant in both models with interesting and predictable signs. Sawtimber removals were positively related to location of the primary wood products sub-sector location quotient while the pulpwood component of removals emphasized in the roundwood raw material variable played a positive role in explaining location of the reconstituted wood products sub-sector. The primary sector output variable was significant for the secondary sector model. This result was expected given the dependence of the secondary sector on the primary sector for its raw material inputs. The secondary sector also depends upon the reconstituted sector for raw materials such as particleboard, yet the reconstituted sector output variable was not significant. Since the reconstituted sector is heavily weighted to the paper industry, the impact of the particle board type producers may have been masked.

The Beale code (also known as the Rural-Urban Continuum Code), which represented our gross proxy for final demand, was significant and positive in explaining the location quotients for primary and secondary wood products sub-sectors. Other locational factors such as proximity to a water source may have a larger impact on the reconstituted sector than distance to the final market.

Important locational relationships exist between these sub-sectors. Of particular note is the importance of a primary wood products sub-sector in the location of secondary and reconstituted wood products sub-sectors. Interestingly, there was no significant relationship between the primary wood products sub-sector and the locational index for the reconstituted wood products sub-sector. One might explain this one-sided relationship by noting that the reconstituted sector depends upon the primary mills for sawdust and shavings for a portion of their raw material input, but sawmills don't need to sell their sawdust and shavings to the reconstituted sector since they can sell their sawdust and shavings in the fuel and animal bedding markets.

Table 5. OLS regression analysis for location quotient by industry sub-sector.

	Dependent Variables					
	LQ primary		LQ secondary		LQ reconstituted	
	b	t-ratio	b	t-ratio	b	t-ratio
DFIN (Beale Code, 0 to 9)	0.814	10.136***	0.218	3.746***	0.07205	1.372
	(0.328)		(0.132)		(-0.047)	
DINT2 (Sec. sector output)	-6.024E-4	-0.215			0.001616	0.870
	(-0.007)				(0.029)	
DINT3 (Recon. sector output)	-0.000131	0.150				
RMRW (Growing stock removals)	-0.371	-2.699**			0.386	4.282***
	(-0.338)				(0.569)	
RMINT (Sawtimber removals)	0.271	4.926***			-0.08846	-2.453*
	(0.617)				(-0.325)	
RMINT1 (Primary sector output)			0.01001	2.420*	0.01057	2.577*
			(0.076)		(0.086)	
RMINT3 (Recon. sector output)			2.666E-5	0.042		
			(0.002)			
Population 2000	1.042E-6	1.092	-6.688E-7	-1.024	-1.158E-6	-1.993*
	(0.041)		(-0.04)		(-0.074)	
Constant	-2.277	-4.477***	0.783	2.148*	1.509	4.520***
R^2	0.193		0.028		0.097	
Adjusted R^2	0.188		0.024		0.092	
Model F	40.986***		7.354***		18.511***	

*p = 0.05, **p < 0.01, ***p = 0.001; Standardized beta coefficients in parenthesis

Although lacking specific firm-level profit components, our empirical models contained significant explanatory variables that served as gross proxies to the generic location decision framework. Results suggested that the location of two of the three wood-products sub-sectors were significantly related to timber removals with intra sector location important as both intermediate demand and input suppliers.

The theoretical linkages between the primary, secondary, and reconstituted wood products sub-sectors are straightforward. The primary and reconstituted sectors depend upon an abundant forest resource to supply their raw material needs. The secondary sector depends upon the primary (lumber) and reconstituted (panel products) sectors for its raw material needs. The models developed here address these raw material demands. The final demand for the primary sector can be explained by the secondary and reconstituted sectors. The final demands for the secondary and reconstituted sectors are more difficult to measure; however, the Beale Code performed well as a general indicator of final demand.

Our models do a fair job of providing empirical evidence in support of raw material dependency and intra-sectoral linkages among the three sub-sectors. The broader determinants of firm location in these three sectors involve raw material availability, transportation costs (dependent on infrastructure), demand market conditions, and more qualitative aspects of locational decisions. Indeed, this latter component includes issues such as behavioral, historic, cultural, social, and quality-of-life factors that could be particularly important and are not captured in our initial modeling efforts.

Institutional aspects are another locational attribute that could potentially be important and are not included in these initial models. Locational incentives available to a particular firm in a particular county or municipality were not considered in the models discussed in this paper. Although very much a part of the decision process utilized by firms in establishing their location, the inclusion of incentives such as tax incremental financing, discounted property values, community-based economic development grants, and industrial revenue bonds are issues to be considered by a much more defined and specific model.

Future efforts will focus on improving the fit of the models. Other variables such as a more accurate measure of final demand or the availability of trained workforce may have a positive impact, especially in the secondary sector model. Separating the paper product producers from the panel product producers in the reconstituted sector should improve the model. Both have similar raw material demands; however, final product demand for each sub-sector differs greatly.

In addition to satisfying theoretical curiosities, research addressing firm location and regional dependency has several practical applications. A basic understanding of where and why forest products firms locate is of interest to rural economic development specialists and natural resource managers. States with significant forest resources have a unique comparative advantage in attracting and retaining forest products firms. This manufacturing base can be the economic foundation for many rural communities. In recent years, economic pressures and public perceptions have brought change upon the forest products industry. Competition from foreign manufacturers has impacted many firms. Differing values on the use of our forest resources has caused disputes between various interest groups. A clear understanding of location factors can help address the array of issues facing the forest products industry today.

3.2 Results of resource dependency in heavily forested counties

For the 341 forested counties, means were calculated for the aggregate tourism sector location quotient and the primary, secondary, and reconstituted sector location quotients. These location quotient means were 1.21, 6.55, 2.46, and 2.67 respectively. Subsequently, these means were used to define the quadrant boundaries for the model shown in Figure 2. For example, when comparing the aggregate tourism sector to the primary forest sector, 1.21 (mean aggregate tourism sector location quotient) was the quadrant boundary on the x-axis and 6.55 (mean primary for sector location quotient) was the quadrant boundary for the y-axis. The quadrant model data of interest is outlined in Table 1. Note that the location quotients for the three forest sectors and the aggregated tourism sector are significantly higher for the forested vs. the non-forested counties. This result is intuitive for the forest sectors and demonstrates the importance of the forest amenity to the tourism sector.

3.21 Spatial distribution of dependency. Spatial descriptions of regional dependency on the timber sectors in relation to the aggregated tourism sector are summarized in Figure 7. In this figure, counties that contain less than 50 percent forest cover are shown in white.

In consideration of Figure 7, counties representative of Quadrant 1, high forestry-low tourism, are shown in green. Counties representative of Quadrant 2, high forestry-high tourism, are shown in dark red. Counties representative of Quadrant 3, low forestry-low tourism, are shown in tan, and counties representative of Quadrant 4, low forestry-high tourism, are shown in yellow. States such as West Virginia, Pennsylvania, and New York have a high occurrence of counties in Quadrant 3. From an economic diversity perspective, this is the least favorable scenario with neither the primary forest sector nor the tourism sector capitalizing on the forest resource. Quadrant 3 counties make the largest percentage representing 46 percent of the forested counties. Quadrant 1 and Quadrant 4 are weighed more heavily toward the primary sector and the tourism sectors respectively, with Quadrant 4 representing 91 counties (27 percent), the second largest quadrant in number. Quadrant 2 represents both economic diversity as well as economic strength for the forestry and tourism sectors and comprises 11 percent of the forested counties.

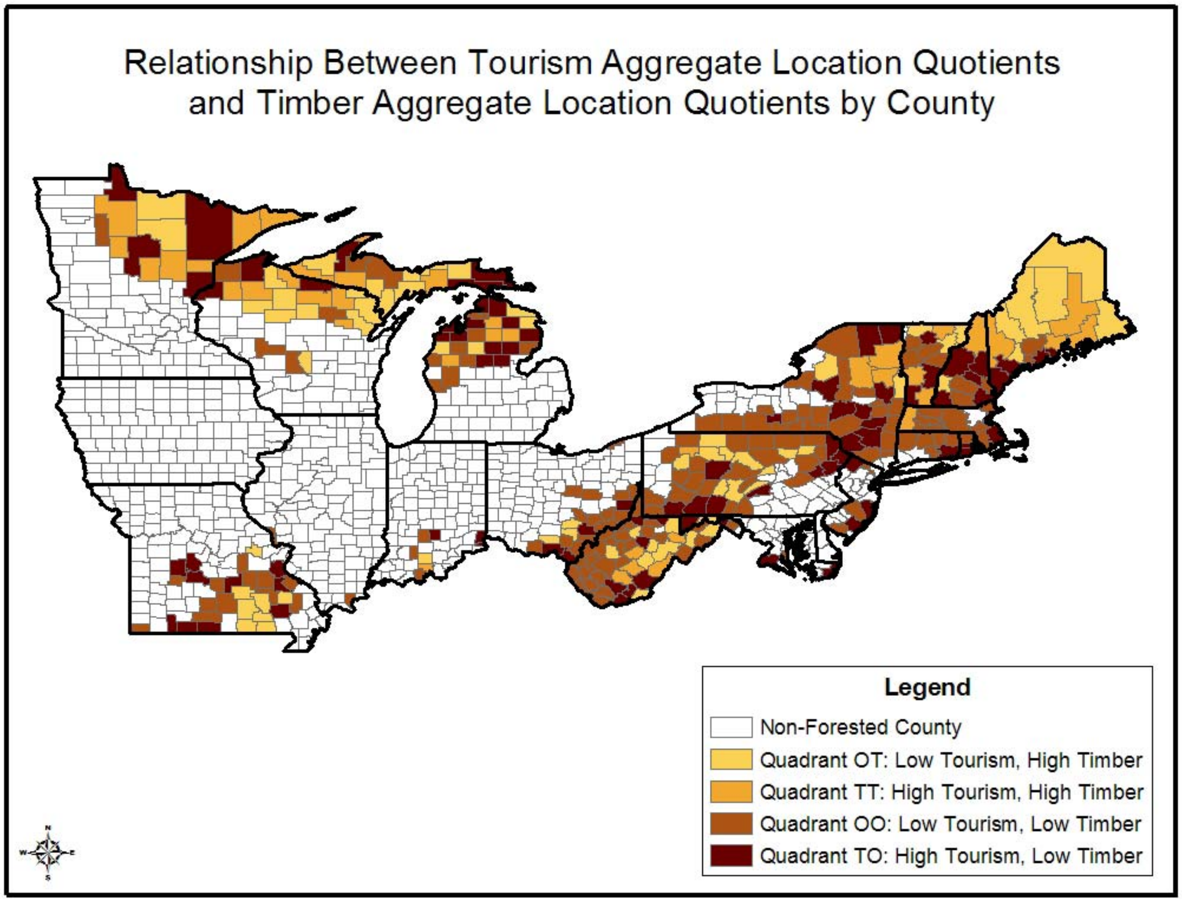

Figure 7. Spatial distribution of tourism and timber dependencies

3.21 Statistical difference among alternative dependency types. Quantitatively, gross comparisons between tourism and wood products sectors can be found in Tables 6, 7, and 8 for primary, secondary, and reconstituted forest sectors respectively. The primary forest sector shows significant differences by quadrant for six of the regional descriptors used. The secondary and reconstituted forest sectors show significant differences by quadrant for only three and one regional descriptor respectively. From this, the primary story to be told results from the primary wood products sector only.

When we focus on the primary wood products sectors and its comparison with the aggregated tourism sector, we see a host of interesting differences that allow us to initiate a set of relevant policy conclusions. This comparison is summarized in Table 9.

Table 6: Analysis of Variance by Model Quadrants for the Tourism, and Primary Wood Products Sectors.

PRIMARY FOREST PRODUCTS SECTOR COMPARISONS					
	ANOVA	Multiple Comparisons*			
Regional Descriptor	**Sig.**	**Quad 1 ↑Forest ↓Tour**	**Quad 2 ↑Forest ↑Tour**	**Quad 3 ↓Forest ↓Tour**	**Quad 4 ↓Forest ↑Tour**
Poverty Change 1989 to 1993	0.000	3, 4	3, 4	1, 2	1, 2
Proprietor Income Change 1990 to 1998	0.012	2, 3, 4	1	1	1
Unemployment Rate Change 1990 to 1996	0.440	-	-	-	-
Amusement & Rec. Earnings Change 90 to 98	0.129	-	-	-	-
Eat and Drink Earnings Change 1990 to 1998	0.401	-	-	-	-
Hotel Earnings Change 1990 to 1998	0.029	-	3, 4	2	2
Tourism Earnings Change 1990 to 1998	0.009	3	3	1, 2, 4	3
Personal Per Capita Income Change 90 to 98	0.170	-	-	-	-
Ag., For., Fish., & other Emp. Change 90 to 98	0.345	-	-	-	-
Population Change 1990 to 1998	0.000	4	3	2, 4	1, 3
Forestry Earnings Change 1990 to 1998	0.473	-	-	-	-
Recreational Housing Total Units	0.000	3, 4	3, 4	1, 2	1, 2
Wiener Index Change 1977 to 1993	0.736	-	-	-	-

- Calculations based on 341 Forested Counties in the 20 Northeastern States.
- Model Quadrant Definitions: Quadrant 1 = High Forestry, Low Tourism; Quadrant 2 = High Forestry, High Tourism; Quadrant 3 = Low Forestry, Low Tourism; Quadrant 4 = Low Forestry, High Tourism.

* Multiple comparisons based on the Least Significant Difference Post Hoc Test. Significant differences between quadrants are indicated by quadrant in column heading and listed quadrants the column below (alpha = 0.05).

Table 7: Analysis of Variance by Model Quadrants for the Tourism, and Secondary Wood Products Sectors.

SECONDARY FOREST PRODUCTS SECTOR COMPARISONS					
	ANOVA	**Multiple Comparisons***			
Regional Descriptor	**Sig.**	**Quad 1 ↑Forest ↓Tour**	**Quad 2 ↑Forest ↑Tour**	**Quad 3 ↓Forest ↓Tour**	**Quad 4 ↓Forest ↑Tour**
Poverty Change 1989 to 1993	0.122	-	-	-	-
Proprietor Income Change 1990 to 1998	0.167	-	-	-	-
Unemployment Rate Change 1990 to 1996	0.477	-	-	-	-
Amuse. And Rec. Earnings Change 1990 to 1998	0.101	-	-	-	-
Eat and Drink Earnings Change 1990 to 1998	0.940	-	-	-	-
Hotel Earnings Change 1990 to 1998	0.367	-	-	-	-
Tourism Earnings Change 1990 to 1998	0.114	-	-	-	-
Personal Per Capita Income Change 90 to 98	0.102	-	-	-	-
Ag., For., Fish., &other Emp. Change 90 to 98	0.015	2, 3	1, 4	1, 4	2, 3
Population Change 1990 to 1998	0.000	4	3	2, 4	1, 3
Forestry Earnings Change 1990 to 1998	0.885	-	-	-	-
Recreational Housing Total Units	0.001	3, 4	3	1, 2	1
Wiener Index Change 1977 to 1993	0.579	-	-	-	-

- Calculations based on 341 Forested Counties in the 20 Northeastern States.
- Model Quadrant Definitions: Quadrant 1 = High Forestry, Low Tourism; Quadrant 2 = High Forestry, High Tourism; Quadrant 3 = Low Forestry, Low Tourism; Quadrant 4 = Low Forestry, High Tourism.

* Multiple comparisons based on the Least Significant Difference Post Hoc Test. Significant differences between quadrants are indicated by quadrant in column heading and listed quadrants the column below (alpha = 0.05).

Table 8: Analysis of Variance by Model Quadrants for the Tourism, and Reconstituted Wood Products Sectors.

RECONSTITUTED FOREST PRODUCTS SECTOR COMPARISONS					
	ANOVA	Multiple Comparisons*			
Regional Descriptor	Sig.	Quad. 1 ↑Forest ↓Tour	Quad. 2 ↑Forest ↑Tour	Quad. 3 ↓Forest ↓Tour	Quad. 4 ↓Forest ↑Tour
Poverty Change 1989 to 1993	0.556	-	-	-	-
Proprietor Income Change 1990 to 1998	0.134	-	-	-	-
Unemployment Rate Change 1990 to 1996	0.269	-	-	-	-
Amuse. And Rec. Earnings Change 1990 to 1998	0.122	-	-	-	-
Eat and Drink Earnings Change 1990 to 1998	0.185	-	-	-	-
Hotel Earnings Change 1990 to 1998	0.397	-	-	-	-
Tourism Earnings Change 1990 to 1998	0.098	-	-	-	-
Personal Per Capita Income Change 90 to 98	0.266	-	-	-	-
Ag., For., Fish., & other Emp. Change 90 to 98	0.880	-	-	-	-
Population Change 1990 to 1998	0.000	4	4	4	1, 2, 3
Forestry Earnings Change 1990 to 1998	0.152	-	-	-	-
Recreational Housing Total Units	0.529	-	-	-	-
Wiener Index Change 1977 to 1993	0.220	-	-	-	-

- Calculations based on 341 Forested Counties in the 20 Northeastern States.
- Model Quadrant Definitions: Quadrant 1 = High Forestry, Low Tourism; Quadrant 2 = High Forestry, High Tourism; Quadrant 3 = Low Forestry, Low Tourism; Quadrant 4 = Low Forestry, High Tourism.

* Multiple comparisons based on the Least Significant Difference Post Hoc Test. Significant differences between quadrants are indicated by quadrant in column heading and listed quadrants the column below (alpha = 0.05).

Table 9 Model Quadrant Differences for Primary Wood Products Sector.

Regional Descriptor	ANOVA	Multiple Comparisons*			
	ANOVA Significance	Quadrant (A)	Comparison Quadrant (B)	Mean Difference (A-B)	Comparison Significance
Poverty Change 1989 to 1993	0.000	Quad. 1	Quad. 2 Quad. 3 Quad. 4	-0.0073 -0.0861* -0.1154*	0.836 0.001 0.000
		Quad. 2	Quad. 1 Quad. 3 Quad. 4	0.0073 -0.0788* -0.1081*	0.836 0.011 0.001
		Quad. 3	Quad. 1 Quad. 2 Quad. 4	0.0861* 0.0788* -0.0293	0.001 0.011 0.188
		Quad. 4	Quad. 1 Quad. 2 Quad. 3	0.1154* 0.1081* 0.0293	0.000 0.001 0.188
Proprietor Income Change 1990 to 1998	0.012	Quad. 1	Quad. 2 Quad. 3 Quad. 4	-0.1460* -0.1107* -0.1564*	0.018 0.014 0.001
		Quad. 2	Quad. 1 Quad. 3 Quad. 4	0.1460* 0.0354 -0.0104	0.018 0.506 0.855
		Quad. 3	Quad. 1 Quad. 2 Quad. 4	0.1107* -0.0354 -0.0457	0.014 0.506 0.234
		Quad. 4	Quad. 1 Quad. 2 Quad. 3	0.1564* 0.0104 0.0457	0.001 0.855 0.234
Unemployment Rate Change 1990 to 1996	0.440	-	-	-	-
Amuse. and Rec. Earnings Change 1990 to 1998	0.129	-	-	-	-
Eat and Drink Earnings Change 1990 to 1998	0.401	-	-	-	-
Hotel Earnings Change 1990 to 1998	0.029	Quad. 1	Quad. 2 Quad. 3 Quad. 4	-0.6211 0.1319 0.1672	0.067 0.623 0.557
		Quad. 2	Quad. 1 Quad. 3 Quad. 4	0.6211 0.7530* 0.7883*	0.067 0.005 0.005
		Quad. 3	Quad. 1 Quad. 2 Quad. 4	-0.1319 -0.7530* 0.0353	0.623 0.005 0.853
		Quad. 4	Quad. 1 Quad. 2 Quad. 3	-0.1672 -0.7883* -0.0353	0.557 0.005 0.853
Tourism Earnings Change 1990 to 1998	0.009	Quad. 1	Quad. 2 Quad. 3 Quad. 4	-0.0581 0.4331* 0.0408	0.810 0.015 0.833
		Quad. 2	Quad. 1 Quad. 3 Quad. 4	0.0581 0.4912* 0.0989	0.810 0.020 0.658
		Quad. 3	Quad. 1 Quad. 2 Quad. 4	-0.4331* -0.4912* -0.3923*	0.015 0.020 0.010
		Quad. 4	Quad. 1 Quad. 2 Quad. 3	-0.0408 -0.0989 0.3923*	0.833 0.658 0.010
Personal Per Capita Income Change 1990 to 1998	0.170	-	-	-	-
Ag., For., Fish., &other Emp. Change 1990 to 1998	0.345	-	-	-	-

Table 9 (continued) Model Quadrant Difference for Primary Wood Products Sector.

Population Change 1990 to 1998	0.000	Quad. 1	Quad. 2 Quad. 3 Quad. 4	-0.0296 0.0082 -0.0498*	0.079 0.507 0.000
		Quad. 2	Quad. 1 Quad. 3 Quad. 4	0.0296 0.0377* -0.0203	0.079 0.010 0.194
		Quad. 3	Quad. 1 Quad. 2 Quad. 4	-0.0082 -0.0377* -0.0580*	0.507 0.010 0.000
		Quad. 4	Quad. 1 Quad. 2 Quad. 3	0.0498* 0.0203 0.0580*	0.000 0.194 0.000
Forestry Earnings Change 1990 to 1998	0.473	-	-	-	-
Recreational Housing Total Units	0.000	Quad. 1	Quad. 2 Quad. 3 Quad. 4	-2825.2759 -31970.2501* -25371.6715*	0.752 0.000 0.000
		Quad. 2	Quad. 1 Quad. 3 Quad. 4	2825.2759 -29144.9742* -22546.3956*	0.752 0.000 0.007
		Quad. 3	Quad. 1 Quad. 2 Quad. 4	31970.2501* 29144.9742* 6598.5786	0.000 0.000 0.240
		Quad. 4	Quad. 1 Quad. 2 Quad. 3	25371.6715* 22546.3956* -6598.5786	0.000 0.007 0.240
4 Digit Wiener Index 1993	0.000	Quad. 1	Quad. 2 Quad. 3 Quad. 4	0.01285 -0.02846* -0.02520*	0.180 0.000 0.001
		Quad. 2	Quad. 1 Quad. 3 Quad. 4	-0.01285 -0.04131* -0.03805*	0.180 0.000 0.000
		Quad. 3	Quad. 1 Quad. 2 Quad. 4	0.02846* 0.04131* 0.00326	0.000 0.000 0.587
		Quad. 4	Quad. 1 Quad. 2 Quad. 3	0.02520* 0.03805* -0.00326	0.001 0.000 0.587

- Calculations based on 341 Forested Counties in the 20 Northeastern States.
- Model Quadrant Definitions: Quadrant 1 = High Forestry, Low Tourism; Quadrant 2 = High Forestry, High Tourism; Quadrant 3 = Low Forestry, Low Tourism; Quadrant 4 = Low Forestry, High Tourism.

* Indicates the mean difference is significant at alpha = 0.05. Mean differences calculated by subtracting the mean of the listed quadrant in column B by the mean of the listed quadrant in column A. Multiple comparisons based on the Least Significant Difference Post Hoc Test.

Significant differences by quadrant were found for the regional descriptor *poverty change*. There was a significant but negative relationship between Quadrant 1 vs. Quadrant 3 and Quadrant 1 vs. Quadrant 4. Stated another way, the poverty change was greater (more poverty) in forested counties with low forestry-low tourism and low forestry-high tourism. The same was true for Quadrant 2 where there was a significant by negative relationship between Quadrant 2 vs. Quadrant 3 and Quadrant 2 vs. Quadrant 4 demonstrating higher poverty in forested counties with a relatively small primary forest sector.

For *proprietor income change*, there was a significant but negative relationship between Quadrant 1 vs. Quadrant 2, Quadrant 3, and Quadrant 4. In other words, the change in proprietor's income was higher in high forestry-high tourism counties and low forestry-high tourism counties when compared to high forestry-low tourism counties. A puzzling result was that the change in proprietor's income was also greater in Quadrant 3, low forestry-low tourism when compared to Quadrant 1.

For *hotel earnings change*, there was a significant difference between Quadrant 2 vs. Quadrant 3 and Quadrant 4. The change in earnings for hotels were lower for low forestry-low tourism and low forestry-high tourism than they were for the ideal Quadrant 2, high forestry-high tourism.

Tourism earnings change showed a positive significant difference between Quadrant 1 vs. Quadrant 3 and Quadrant 2 vs. Quadrant 3. The high forestry-low tourism and high forestry-high tourism quadrants showed a positive tourism earnings change when compared to the low forestry-low tourism counties. In addition, Quadrant 4 vs. Quadrant 3 showed a significant positive relationship, which would be expected.

The *population change* descriptor was also significantly different between quadrants. Interestingly, Quadrant 1 vs. Quadrant 4 showed a negative relationship. In other words, high forestry-low tourism counties showed less growth than low forestry-high tourism counties. Quadrant 3 vs. Quadrant 2 and Quadrant 4 showed negative relationships. Again, the least favorable quadrant showed the least growth.

Differences in *recreational housing total units* proved interesting. Significant negative results were found between Quadrant 1 vs. Quadrant 3 and Quadrant 4. Recreational housing units found a smaller increase in high forestry-low tourism counties than in low forestry-low tourism and low forestry-high tourism. Likewise, Quadrant 2 vs. Quadrant 3 and Quadrant 4 found high forestry counties to have smaller increases in recreational housing units.

Finally, the *4 digit Wiener Index* showed differences by quadrant. Quadrant 1 vs. Quadrant 3 and Quadrant 4 showed significant negative relationships and Quadrant 2 vs. Quadrant 3 and Quadrant 4 showed significant negative relationships. The high forestry counties showed lower economic diversity overall.

4. Summary and Policy Implications

In this report, we constructed regional location models for the wood products and tourism sectors that highlighted issues of rural resource dependency. Although lacking specific firm-level profit components, our empirical models contained significant explanatory variables that served as gross proxies to the generic location decision framework. Results suggested that the location of two of the three wood-products sub-sectors were significantly related to timber removals with intra sector location important as both intermediate demand and input suppliers.

The theoretical linkages between the primary, secondary, and reconstituted wood products sub-sectors are straightforward. The primary and reconstituted sectors depend upon an abundant forest resource to supply their raw material needs. The secondary sector depends upon the primary (lumber) and reconstituted (panel products) sectors for its raw material needs. The models developed here address these raw material demands. The final demand for the primary sector can be explained by the secondary and reconstituted sectors. The final demands for the secondary and reconstituted sectors are more difficult to measure; however, the Beale Code performed well as a general indicator of final demand.

Our models do a fair job of providing empirical evidence in support of raw material dependency and intra-sectoral linkages among the three sub-sectors. The broader determinants of firm location in these three sectors involve raw material availability, transportation costs (dependent on infrastructure), demand market conditions, and more qualitative aspects of locational decisions. Indeed, this latter component includes issues such as behavioral, historic, cultural, social, and quality-of-life factors that could be particularly important and are not captured in our initial modeling efforts.

Institutional aspects are another locational attribute that could potentially be important and are not included in these initial models. Locational incentives available to a particular firm in a particular county or municipality were not considered in the models discussed in this paper. Although very much a part of the decision process utilized by firms in establishing their location, the inclusion of incentives such as tax incremental financing, discounted property values, community-based economic development grants, and industrial revenue bonds are issues to be considered by a much more defined and specific model.

Future efforts will focus on improving the fit of the models. Other variables such as a more accurate measure of final demand or the availability of trained workforce may have a positive impact, especially in the secondary sector model. Separating the paper product producers from the panel product producers in the reconstituted sector should improve the model. Both have similar raw material demands; however, final product demand for each sub-sector differs greatly.

In addition to satisfying theoretical curiosities, research addressing firm location has several practical applications. A basic understanding of where and why forest products firms locate is of interest to rural economic development specialists and natural resource managers. States with significant forest resources have a unique comparative advantage in attracting and retaining forest products firms. This manufacturing base can be the economic foundation for many rural communities.

In recent years, economic pressures and public perceptions have brought change upon the forest products industry. Competition from foreign manufacturers has impacted many firms. Differing values on the use of our forest resources has caused disputes between various interest groups. A clear understanding of location factors can help address the array of issues facing the forest products industry today.

It is reasonable to assume that more diverse economies would represent both tourism and forest sector based industries. To validate this assumption, we used location quotients, as defined in equation (1), as a proxy to describe the impact of the tourism and forestry sectors on a given region's economy. Our specified Forestry-Tourism Diversity Model takes the initial steps in explaining the diversity in resource dependent regions.

This paper focused on resource dependency and issues of economic characteristics including diversity. We found that spatial patterns exist in the location of both wood products and tourism firms in the Northeastern United States and we were able characterize these regions into homogeneous groupings through the use of our Forestry-Tourism Diversity Model. We look forward to the further refinement of this model and its application to resource dependent communities.

In addition to satisfying theoretical curiosities, research addressing the impact of forestry and tourism on regional diversity has several practical applications. A basic understanding of stable rural economies is of interest to rural economic development specialists and natural resource managers. States with significant forest resources have a unique comparative advantage in attracting and retaining forest products firms and provide tourism opportunities. This manufacturing and tourism base can be the economic foundation for many rural communities. In recent years, economic pressures and public perceptions have brought change upon the forest products industry. Competition from foreign manufacturers has impacted many firms. Differing values on the use of our forest resources has caused disputes between various interest groups. A clear understanding of economic factors can help address the array of issues facing the forest products industry today.

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