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Natural resource stocks, flows, and regional economic change: seeing the forest and the trees

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Abstract. In this article we examine and critique issues affecting natural resource-dependent regions and focus on the increased importance of nonmarket uses of natural resources. We suggest that because most of our regional science tools are market-based, nonmarket uses of these resources are overlooked in policy analysis. We also outline a method that captures the nonmarket aspects of natural resources within a regional economic model.

1. Introduction

Over the latter half of this century rural resource-dependent regions in the United States and Canada have experienced dramatic change in their economic, social, and environmental fabrics. Development of infrastructure and general increases in both leisure time and disposable incomes have led to increased tourism demand in rural areas. This trend, coupled with an increased sensitivity of environmental issues, has made many individuals and groups more aware of, and willing to challenge, traditional land management activities. This general shift in attitudes and behaviors has led to a relative decline in the importance of resource-extractive land uses and a relative increase in the importance of recreation and other nonmarket uses.

At the same time, public policy on the management of natural resources has experienced a dramatic paradigm shift. Take, for example, the management policies of the USDA Forest Service which controls more than 88 million acres of U.S. forest lands—roughly 20 percent of the total commercial forest land in the United States. Timber production was the primary driver of forest management policy during the early and middle part of the century. Since the Monongahela and Bitterroot controversies of the late 1960s and early 1970s,[1] however, policies of the USDA Forest

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[1] The Monongahela National Forest is located in West Virginia, and the Bitterroot National Forest is located in Idaho and Montana. Both controversies occurred during the mid to late 1960s and were the result of increased use of even-aged management coupled with user activist concern over the apparent

Service have changed from an even-aged timber production focus to multiple use and ecosystem-based approaches to land management. Extractive land management activities are scrutinized for their spatial disturbance patterns and their compatibility with recreation and other nonmarket uses. Public lands in remote resource-dependent rural regions are increasingly being managed for non-extractive uses and nonmarket values.

These policy shifts have affected how regional households generate income. The value of returns and respective ownership patterns have changed as the economic mix of industries in local regions has changed. From the perspective of regional economic activities, this shift is characterized by a relative decline in manufacturing activity and relative increases in service and retail sectors.

Furthermore, there is growing concern for how income is distributed among regional households. This distributional effect is a direct result of the productivity and ownership of land, labor, and capital resources. Many rural residents argue that jobs in the tourism sector are seasonal, dead-end, and of lower wage compared to those in resource-extractive industries. How has this shift in resource use affected household income and its distribution within rural resource-dependent regions? Another important distributional dilemma is the transfer of benefits associated with resource use to outside of (sic) the region itself. Many argue that management of natural resources for nonmarket goods in remote regions primarily benefits nonlocals from more urban areas who hold higher nonmarket values for certain environmentally based goods and services such as aesthetics or biodiversity. Both intra- and interregional distributional issues are associated with this shift in resource use.

There is a perception that resource-extractive industries and recreational use are mutually exclusive; specifically, that development policy makers must recognize a trade-off between the two and plan accordingly. If recreation-based tourism development requires pristine forest conditions and the wood products industry requires fiber generated through intermittent harvesting activities, what is to be done? Do we trade output of wood products for output of tourism? Or are there interrelationships that (when understood, combined, and nurtured) develop a complementary association?

Contemporary regional analysis needs to address the issues of compatibility and distribution to assist with policy prescriptions in resource-dependent regions. One such analysis lies in the ability to describe and predict regional impacts of changing resource use on rural economic well-being. In these rural resource-dependent regions, the management of natural resource stocks provides raw material flows for a variety of regional wood products manufacturing activities in addition to the demands for service and retail activities created by recreational use. The effectiveness of policies that address natural resources from a regional perspective is typically analyzed using aggregate economic measures that include total number of jobs created or total impact on value added. The contributions of natural resources to regional development, however, are becoming increasingly more complex.

Shifts in resource use from market to nonmarket activities have impacts to regional economic linkages and to regional household income generation and distribu-

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environmental degradation resulting from clearcutting. See Robinson (1975) for a good historical account of these and other federal forest policy controversies.

tion. Thus, one complexity involves the distribution of economic impacts by household income level. Also, if we view forest management as a spectrum that varies from extensive (lower levels of human input) to intensive (heavier reliance on the application of silvicultural[2] treatments), we realize there are significant differential combinations of market and nonmarket outputs. A second example of the complex nature of natural resource impacts on regional economies is the differential production of nonmarket goods given alternative management regimes. As a natural resource is managed in different ways, the flow of nonmarket goods is altered, thus changing the impact on the regional economy. These two complexities are not well understood or explained within our current framework for modeling economic problems.

Regional analysis can assist with public policy, but is limited by the importance we place on market-based economic centrism and financial flows. Our understanding of remote regions is masked by a myopic focus on agglomeration and central place. We base analysis on regional proximity to population centers and the impacts these centers have on peripheral regions. These linkages are important for accurate modeling, but this focus on market-based regional dependency detracts from the attributes of rural resource-dependent regions. These unique attributes describe the activities of these regions. Careful assessment of these attributes is required to analyze regional aspects of public policy in resource-dependent regions.

Regional science has not been mute on activities and interrelationships within rural resource-dependent regions. Much regional science theory is drawn from the attributes of remote resource-dependent regions. Take, for example, the pioneering work on export-base theory developed by North (1955) and Tiebout (1956) in which early arguments on stages of regional growth are presented. Using the historical experience of rural resource-dependent regions, both North and Tiebout argue a key basis for export-base theory—that of the benefits associated with specialized attention to exporting resources that are endowed to the region. Other geographers and economists have translated regional economic theories and techniques to the analysis of environmental issues (Isard 1972; Miller and Blair 1985, Chapter 7), recreation (Clawson and Knetsch 1966, Part IV; English and Bergstrom 1994), and tourism (Smith 1987 and 1993). There is, however, a need to continue and improve the focus on unique attributes of rural resource-dependent regions.

There is a dearth of usable generalizations available from the extensive forest economics literature. There is a wide body of literature that characterizes market-driven aspects of timber production (Lewis 1976; Newman and Wear 1993; Wear and Newman 1991; Wear 1994) and its market-based linkages (Stier 1980; Merrifield and Haynes 1983). The notions of joint production of both market and nonmarket goods from the forest resource (and the economically heretical aspects of nonmarket land management objectives), however, have dissuaded widespread applications of models that view natural resources in a more integrative and comprehensive fashion. The literature on combined influences of tourism and forestry is not well developed.

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[2] *Silviculture* refers to the art and science of growing trees.

On the one hand, we have a growing literature on community stability and natural resource dependence (Bryon 1978; Machlis and Force 1988; Overdevest and Green 1995) and the tourism values of forests (Brown 1987; Walsh, Ward, and Olienyk 1989; Ribe 1990; Bostedt and Mattsson 1995), but the two have not been integrated since the seminal work of Marion Clawson and Jack Knetsch (Clawson and Knetsch 1966; Clawson 1974). Although a limited literature on land use compatibility and the collaborative relationships that exist between forestry and tourism exists (Clawson and Knetsch 1966; Clawson 1974; Chappelle 1995), its incorporation into regional policy analysis is virtually nonexistent.

Many questions remain unanswered. How can we develop regional models that incorporate the latent inputs and outputs that characterize remote resource-dependent regions? What land use trade-offs exist, and how would we model these trade-offs in impact assessment? How do we account for stock resources from which we draw resource flows? How can we approach the opportunity costs of nonmarket goods? What additional values are missed with an opportunity cost approach to nonmarket goods valuation? How can we regionalize estimates of nonmarket goods? These questions must be answered before we can formulate pragmatic public policy prescriptions for resource-dependent regions.

This review of the literature is meant to stimulate ideas and organize thoughts around the notion of integrating traditional timber production with the tourism components of forest-dependent regional economies. This shift is a critical input into future policies that address the unique characteristics and issues of rural natural resource-dependent regions.

2. Rural resource-dependent regions and the need for a broader modeling framework

Addressing the economic, social, and environmental issues of rural resource-dependent regions requires a fundamental departure from the traditional regional delineations based on functional economic areas or urban fields. Natural resource-dependent regions typically are situated in remote locations with less well-developed infrastructure and limited regional economic diversity. Regional delineations that focus on natural resource base characteristics allow descriptive, analytical, and policy assessments that match the unique situations faced in rural resource-dependent regions.

Recent advances in interregional economic modeling illustrate the market-based relationships between central places and their periphery. David Holland and colleagues have developed usable core-periphery models to explain these effects (Waters *et al.* 1994; WRDC 1996). Market-based models, however, fail to capture the latent inputs and outputs of regional industrial activity. Market-based approaches overlook resource policy prescriptions that identify trade-offs in the production of market and nonmarket goods. Furthermore, a market-based approach is unable to incorporate the interregional import/export position of nonmarket values that is important in land management policies.

One of the key needs in regional economic analysis is the tacit incorporation of both market and nonmarket goods and their respective production and consumption activities. Previous economic assessments of resource-dependent regions fail to capture the unique attributes of land tenure and the history of the reliance of local economic bases on these resources.

2.1 Problems with market-based approaches to resource-dependent regions

Many question the use of market-based analysis to assess natural resources, particularly resources characterized by dynamic production and long-term stock characteristics. The core arguments deal with the manner in which we value benefits and costs over time; our ability to analyze common pool resources; incongruities in the analytical theory that deals with joint production, externalities, and the linkage among productive activities; and market domination by special interests and their power over management decisions.

The primary objective of much of the U.S. private sector is maximization of profit in short planning horizons. Ensuring the long-term productivity of resource-based stock assets could be a societal goal, but its importance is diminished for those interested in short-term gain. In benefit-cost analysis, this distinction is quantified through differences between private and social discount rates. Private investment decisions typically are based on higher discount rates applied to cash flows. Higher discount rates weight cash flows with more emphasis on short-term returns and typically are specified using the market-clearing risk-adjusted cost of capital (currently around 7 percent). Proponents of private discount rates base their position on the belief that all factors of production (including land, labor, and environmental stocks) should enjoy the same returns as the marginal productivity of capital.

Social discount rates, on the other hand, typically are lower. These more socially optimal discount rates implicitly weight cash flows with more value (emphasis) placed on future returns. Proponents of social discount rates argue that there are fundamental differences in factors of production that preclude the assumption that marginal productivity of capital be the leading basis for expected primary factor return. For example, capital (and technology) is more mobile than any other productive factor which allows capital to pursue its highest return in any location. Other factors are fixed and slow to change. Forest assets (including most natural resources) and the costs associated with their management contain primarily longer-term returns. In addition, some argue against the use of any positive discount rate in benefit/cost assessment on the basis that existence and option values exist as fundamental characteristics of natural resource stocks.[3] Any positive discount rate diminishes the future importance of natural resources as we currently experience them. Valuing benefit/cost streams into the future is a dilemma for market-based analysis of resource-dependent regions.

Another imperfection associated with strict market-based assessment is the inability to efficiently allocate open access, common property resources. (For discus-

[3] These are typical arguments made by environmental ethicists.

sion, see Barlowe 1986 or Hartwick and Olewiler 1986.) Many of the benefits derived from natural resource-based recreation, particularly on public lands, are open to all and allocated as common property resources which precludes the market system from efficient allocation mechanisms. The system of rights, represented by institutional arrangements, provides a basis for the concept of property. To derive a meaningful market-based assessment of the economic potential natural resource-based outdoor recreation provides, property rights that assign ownership are required. There are flows of nonmarket goods from the forest resource that have characteristics similar to public goods.[4] Public goods are characterized by ill-defined property rights.

There are externalities associated with natural resource use. (For a discussion of externalities, see Mishan 1982, Part III.) When one activity financially impacts another activity within a regional economy without due compensation, market imperfection exists. For example, the intensive production of timber through even-aged practices such as clearcutting can impose negative externalities on tourism and recreationally-based activities through aesthetic disturbances. On the other hand, more sensitive silvicultural practices such as the provision of buffer strips or uneven-aged silvicultural practices are complementary (and provide positive externalities) to recreation and tourism uses.

Fundamental to our current argument is the notion that tourism-sensitive firms in natural resource-dependent regions benefit from the natural amenities present in the region. These amenities are created or influenced through natural resource management and exist as positive externalities of the resource base. For example, in northern Wisconsin the tourism industry produces its goods and services relying on the forests, lakes, and publicly provided recreational opportunities of the region. It is unlikely that persons travel to northern Wisconsin because it has excellent restaurants or uniquely wonderful hotel beds (even though they may exist!). Rather, it is the natural amenities of the region that attract.

These amenities are nonpriced primary inputs in tourism-sensitive industry output. Like labor use or capital returns, environmental goods and services are flows that draw upon the available environmental stocks of local regions; the distinction is that environmental resources are nonmarketed goods and services. Also, if we accept the positive and negative forest-based externality arguments associated with tourism, the value of the nonmarket goods used to produce tourism are related to the opportunity costs associated with more intensive timber production. These inputs are nonpriced and therefore costless to the tourism firm. Although these inputs are not overlooked by tourism researchers (Pearce 1985; Farrell and Runyan 1991), how these inputs are produced has not been addressed. Furthermore, the regional science literature has been slow to embrace the importance of nonmarket goods and services in regional modeling.[5]

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[4] These include nonrival and non-exclusionary characteristics that typically are associated with purely public goods.

[5] One notable exception can be found in Kigyóssy-Schmidt (1989). There has been a growing interest in the importance of public goods to regional economic structures. Much of the previous literature has

Assumptions of competition in market-based efficiency analysis often are violated when assessing natural resources and economic development of remote rural regions. Power and domination by interest groups is evident in the resource policy arena, particularly among important public institutions (West 1994; Oakerson 1995). These factors dramatically affect the manner in which natural resources are managed. Furthermore, problems associated with the prevalence of industrial forest land ownership and large processing facilities, particularly in remote regions, include traditional market imperfections such as monopoly/oligopoly and monopsony/oligopsony. Factor input markets for labor, technology, land, and capital often are dominated by single large corporate interests in remote rural regions which precludes assumptions of competition embedded within market-based models of efficiency. Markets for timber are vulnerable to domination due to factors of production and hauling costs. Mead (1966) assessed the behavior of buyers in the market for federal timber through analysis of factor-input supply and demand nearly three decades ago. His results indicate that whereas lumber markets are competitive, markets for raw material inputs of roundwood are characterized by factor supply functions that are relatively inelastic which leads to market domination by single controlling interests. This is due to cost structures and the narrowly circumscribed geographical nature of timbersheds.

2.2 Uniqueness of rural resource-dependent regions

Rural resource-dependent regions defy traditional generalizations in modeling. Natural resource-dependent regions differ from other rural agricultural regions in many ways. Latent inputs and outputs exist to the productive activities of these regions. These are characterized by the joint production of private market-based goods (consumed as raw material inputs to forward-linked processing industries) and non-market goods that are both public and common pool (consumed by recreationists, local enthusiasts, and nonlocal environmentalists).

In addition to joint production, rural resource-dependent regions are unique from the standpoint of land ownership. The regional analysis of resource management would be simplified if there were homogeneous ownership patterns within rural regions. The checkerboard of forest tenancy eludes generalization of management objectives and regulatory ability. Large tracts of federal, state, and county lands are common in these regions due to a history of tax reversions and early programs to establish a land conservation ethic. These public ownerships are interspersed with smaller landholdings of private agricultural producers. Also widespread are small woodlots owned privately for recreational purposes. Finally, there are significant lands owned corporately by industrial private forest owners. This mixture of ownerships helps delineate the scope of public land management policy.

Land ownership is an important distinguishing characteristic of resource-dependent regions because each ownership group has underlying land tenure objectives that differ along a spectrum from intensive to extensive management interests.

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focused on the role of infrastructure and education in models of regional growth (Garcia-Milà and McGuire 1992; Goss 1994; Nadiri and Mamueas 1994; Morrison and Schwartz 1996).

Intuitively, management of natural resources should differ by land ownership. This has been shown through empirical analysis (Wallace and Newman 1986; Newman and Wear 1993). Natural resource-dependent regions generally have a higher incidence of public landholdings. Public forests typically have embraced multiple use goals that drive forest management. Management decisions of public lands are made within a public context. Industrial ownership of forest land, on the other hand, primarily is focused on intensive silvicultural production of fiber. These industrial private forest ownerships are typically large, larger than corporate agricultural landholdings. Land management decisions of industrial private forest landowners typically are made within a private context. Public regulation of industrial private forest land management activities varies by state but tends to be lax, often relying on voluntary guidelines. Interspersed within these public and industrial private forest landholdings are smaller private ownerships that are managed by persons referred to as *non-industrial private forest* land owners. These non-industrial private forest (NIPF) landowners have widely varying objectives and intensities of management. Many NIPF landowners own forestland as an afterthought to agricultural production, some own forestland for strictly recreational purposes, others rely upon timber management for financial return. Public regulation of rural NIPF land management activities often is nonexistent. Given the joint production of environmental goods and a diverse ownership pattern with correspondingly diverse management objectives, societal conflicts over land use and the compatibility of alternatives are widespread and contentious.

Natural resource-dependent regions in the United States differ in land ownership patterns. For instance, regions in the southern United States have relatively higher levels of industrial ownership. The western United States has a predominance of public ownership, primarily lands controlled by the USDI Bureau of Land Management and the USDA Forest Service. The northern and eastern United States have a mixture of ownerships. Empirical evidence also suggests that natural resource outputs within these regions are experiencing significant change. For instance, a major regional shift is underway in the source of U.S. timber supplies due primarily to land ownership patterns, decision control, and site productivities. Increases in timber production in the south are due to highly productive industrial private forest lands as well as to restrictions in timber harvesting from public lands in the west (Haynes and Adams 1992; Alig and Wear 1992). Furthermore, there is growing evidence that industries are beginning to realize the potential of second growth forests in the lake states, given expanding levels of growing stock. Thus, it is difficult to derive generalized implications of natural resource attributes among regions of the United States.

Land ownership and the forest uses resulting from management are tied to social and economic structures of small regions (Alward 1987). The competing and complementary aspects of resource use determine the regional economic viability of resource-dependent regions. This viability hinges upon societal acceptance of various practices and the creativity of resource management professionals in adapting to societally determined needs and wants. These ideas of land use compatibility and societal acceptance are the hallmarks of early pioneers, many of whom have, or had, ties to Resources for the Future. For example, Marion Clawson (1974) outlines important concepts of compatibility that need to be revisited. Clawson's three forest use categories include uses to forest land but not necessarily for forest products (including mining of subsurface minerals, road building and other rights of way, residential construction, or forest land grazing). The second forest use is intolerant of other uses (commonly timber harvesting, wilderness use, and intensive recreational use). One of these forest applications is generally antithetical to others. His third category is use that occurs irrespective of man's effort, but that is influenced by man's actions (i.e., forests used as a source of water or for wildlife production).

Resolving the conflicts of forest use incompatibilities has often been approached as a zero-sum game. Alternative dispute resolution techniques increasingly are being used to achieve positive-sum resolutions to natural resource conflicts (i.e., that participants can compromise and build consensus to generate a combined value sum that is positive). Conflicts arising from incompatible forest uses can be managed, thereby making it possible to integrate forests, and their alternative uses, into broader strategies concerned with economic growth and community development (Caton-Campbell and Floyd 1996).

2.3 Valuing nonmarket goods and services

Traditional modeling approaches are hampered by the lack of regional valuation measures for nonmarket goods and services. Valuation of nonmarket goods has taken various meanings. For example, Peterson and Driver (1990) identify various definitions of value such as psychological value, anthropocentric (human-based) value, and economic value. Important to this discussion is economic value which is "simply the amount of money (or the goods that could be purchased with money) that one is willing to give up in order to get a (good or service) or that one requires in compensation for the loss of a (good or service)." (Peterson and Driver 1990, p. 3).

The economic value of commodities that are not traded (such as recreation, wildlife, and aesthetics) presents difficulties. Two key problems arise when assessing the economic value of nonmarket resources derived from forests. First is the notion that resources such as aesthetic quality, existence value, and other quantifiably vague commodities are common property resources. The ability to possess exclusive property rights that allow appropriate application of microeconomic efficiency criteria to the management of these resources is rarely addressed in regional modeling. The second problem is the lack of an operating market structure for active trading of these goods. Modelers are unable to identify and incorporate supply and demand pressures at the firm management level. These commodities generally do not have directly observable prices.

A classic work pertaining to the economics of nonmarket resources focusing on outdoor recreation is Clawson and Knetsch (1966). Recently efforts have been made to qualify and quantify the economic value of nonmarket resources through methods using direct (or stated preference) and indirect (or revealed preference) techniques. Indirect methods, sometimes referred to as *hedonic* or *implicit price methods*, include the travel cost method and the land valuation method. A direct method is contingent valuation.

Indirect, or revealed preference, models tend to be more widely accepted among economists and regional scientists. The general travel cost model as applied to recreation presumes that users maximize utility subject to time and budget constraints with choice of trip length and destination. The theory behind the travel cost method is discussed in Clawson and Knetsch (1966, Chapter 5); recent adaptations can be found in Fletcher *et al.* (1990) and Ward and Loomis (1986). Land valuation methods presume that the value of an environmental feature is reflected in the difference between prices that consumers are willing to pay for property with versus without the specific feature. An early application of the specific hedonic methodology to food characteristics is made by Ladd and Suvannunt (1976). Land value methods are applied to recreational values by Musser and Ziemer (1979). In this study, researchers consider consumer income levels, land qualities, and alternative demand specifications to estimate demand for hunting in Georgia. Lansford and Jones (1996) apply hedonic methods to water values.

One of the more controversial (Diamond and Hausman 1994) nonmarket valuation techniques is contingent valuation (CV). Contingent valuation is a direct method that surveys individuals for contingent circumstances posed in artificial markets. These markets are characterized by contingent payments based upon hypothetical changes. Valuation of the nonmarket commodity is assessed by experimentation. There have been numerous applications of contingent valuation methodology to nonmarket natural resources (Bowker and Stoll 1988; Bostedt and Mattsson 1995; Randall *et al.* 1983). Survey bias (including strategic, information, starting point, and hypothetical) is an important component of value accuracy (Boyle *et al.* 1985).

Current efforts to quantify nonmarket resources by the USDA Forest Service are extensive. Of primary importance are standardized forest inventory procedures that allow for identification and comparison of nonmarket forest-based characteristics. Rudis and Tansey (1991) use the current Southern Region Forest Service inventory to assess the distribution of human influences on forest lands. Future needs include a standardization of suitability indices for recreational opportunities and wildlife productive potentials, visual preference models, and other nonmarket areas. Visual preference models for forest stands are discussed in Rudis *et al.* (1988). Rudis (1990) also has compiled summaries of nontimber values for various forested regions.

The range of complicating factors in modeling nonmarket outputs from natural resources located in remote rural areas partially explains why these factors are overlooked in regional economic analysis; including them greatly complicates the analysis. Nonmarket products do not fit neatly into our techniques, so they are ignored. But because these nonmarket products are becoming important to consumers and land management decision makers, overlooking their contributions to economic well-being results in biased analysis and inferior policies.

3. A framework for analysis of forested regions

A general accounting approach that become popular in regional analysis is an extension of input-output analysis referred to as *social accounting matrix* (SAM) analysis (Pyatt and Round 1985; Pyatt 1988; Holland and Wyeth 1993; Marcouiller, Schreiner and Lewis 1996). This extension is the result of general dissatisfaction with sectoral input-output analysis in the estimation of regional development policy on local economies (Keuning and DeRuijter, 1988). SAMs are used to analyze regional economic development (e.g., Cole *et al.* 1989), with particular emphasis on the distribution of income (Leatherman and Marcouiller 1996). SAMs also allow for a more explicit accounting of production sectors, factors of production, institutions, and households. SAMs can explicitly account for nonmarket uses of natural resources in economic analysis. We suggest a conceptual approach to incorporate these nonmarket goods (inputs) is in terms of factors of production.

A SAM is constructed as a square matrix with rows tracking receipts and column accounts specifying expenditures. While the organization of SAMs may vary, they generally include accounts related to production, factor income, institutional income, household income, and commodity demand. The accounts are arranged to illustrate the flow of income through the economy. To investigate the impacts of a change in an economy, the SAM is partitioned into endogenous and exogenous components. Leakages and infusions to the system are shown as taxes, savings, transfers, capital finance, and labor migration (Holland and Wyeth 1993; Leatherman and Marcouiller 1996).

These models traditionally contain three factors of production: land, labor, and capital. We suggest a fourth factor that encompasses the production and consumption of public goods. Capital can take two forms: private and public. Private capital captures the traditional factors of regional modeling, such as industrial machinery. But there also exists public capital that is explicitly used in the production process (such as transportation services afforded by our highway system or educational expenditures spent on public schools).[6] In the case of natural resources, the nonmarket or public good aspects of the resource are part of the public capital that fits directly into the production structure of tourism and recreational business sectors. In the case of forest resources, a region characterized by sensitive forest management creates (or possesses) a nonmarket factor of production that contributes to the production of local tourism and recreational business sector output. On the other hand, the implicit relationships should also hold for regions intensively managed for timber production.[7] Regions with lands being managed using primarily even-aged silvicultural strategies with correspondingly high levels of clearcutting have a more degraded natural quality that negatively affects tourism output. Our contention is that traditional regional eco-

[6] Our framework is consistent with previous work that attempts to capture public goods as a factor of production. For example, Garcia-Milà and McGuire (1992) modeling transportation and educational expenditures choose a Cobb-Douglas production function that includes financial capital, labor, highway expenses, and educational expenses. Other related models can be found in Nadiri and Mamueas (1994) and Morrison and Schwartz (1996).

[7] We have no empirical evidence to substantiate this converse assumption. Further empirical research similar to that done by Chappelle (1996) will require attention to forestry and tourism indices but should provide evidence of these relationships among rural economic structures. A negative relationship may not hold.

nomic analysis fails to capture this production and consumption of nonmarket goods and services.[8]

Although nonmarket resources as primary factors of production have not received attention within the literature on regional development, they have been given increased priority within the natural resource economics literature. Early work by Calish *et al.* (1978) attempts to incorporate nontimber values in determining optimum rotations for Douglas Fir in the Pacific Northwest. Calish falls short of identifying nontimber resources as primary factors of production in related industries. More recently, work by Ficklin *et al.* (1996) advances nontimber values into management alternatives for forests within an ecosystem management framework. A key problem in valuing nonmarket goods is the subjective nature of aesthetics. Whereas general models that quantify economic value for visual preferences of forest management alternatives are being developed (Ribe, 1991; Brown, 1987), they are insufficient in linking the production of related regional industries such as tourism. The contingent valuation work of Bostedt and Mattsson (1995), however, attempts to quantify the value of forests for tourism in Sweden.

Nonmarket interindustry linkages are a further research need, but they have not been overlooked in the input-output literature (Kigyóssy-Schmidt 1989) and represent empirical difficulties and questions of general system stability. For our purposes, public goods are produced by forest management, with market proxy values representing returns to landowners. These returns to landowners from producing public goods are transferred to service industries as regional assets used in recreation-related institutions.[9]

The extension of the SAM into an integrated market/nonmarket model is referred to as an *environmental social accounting matrix* (ESAM). The ESAM incorporates a measure of nonmarket goods as a factor of production (component of value added) within the services/retail sector that balances with components of demand (consumed both within the region and exported). A serious difficulty is the mixed results of matrix analysis. This problem could be overcome by assessing differences between a market-based SAM and the ESAM. Forthcoming refinements include the separation of timber production into alternative management regimes and the incorporation of relative trade-offs within the interindustry transactions matrix. Another parallel effort attempts to characterize and model the generation and distribution of nonmarket goods by splitting capital accounts into human and natural origins. This effort may more explicitly account for forest growing stock and environmental asset change.

[8] We are not the first to suggest introducing public goods into static regional models. Kigyóssy-Schmidt (1989), for example, suggests a method for introducing nonmarket services into a traditional input-output model, and Kim (1993) assesses sustainability issues for Mexico by incorporating environmental stock values of forest resources into a SAM.

[9] There are no market mechanisms within which these transfers occur. We argue, however, that many of the resources that support recreational-related businesses are considered public endowments and are nonpriced. From a regional export-base argument, primary demand for recreation-related goods and services originates from outside the region and depends upon the perceived quality of regional forest land activities. Thus, land owner decisions with respect to forest management are tied to the production of recreation-related business opportunities and justify a nonmarket transfer between institutions.

3.1 An opportunity cost approach for estimating the value of nonmarket goods

Initially, our empirical concept of nonmarket goods is simplistic. Regional growing stock, labor, and land involved in forest management are analyzed through factor share analysis (Marcouiller, Lewis, and Schreiner 1996). The public good component of the forest resource is measured from a financial cost viewpoint and is calculated as the opportunity cost of foregone harvesting. We assume that less than optimal private returns represent the nontimber management objectives of landowners. These nontimber management objectives provide a base proxy for the value of nonmarket goods and services resulting from forest management.

In an opportunity cost approach, alternative forest management regimes would be expected to use different combinations of factors based upon ownership patterns and to generate income from these factors at different rates of return. Returns to timber production vary among owners of land, labor, and capital, with private forest owners being characterized by both high factor shares for human inputs and high rates of return on their investments in land and capital. In contrast, public forest lands provide lower rates of return on land and capital due to nontimber objectives. These differences reflect the alternative management intensities (regimes) within which timber is produced. Our graduate student summed up the rationale for an opportunity cost approach as follows:

> If the next best activity would bring me \$1 million, but I stay with my current activity, it is necessary that the latter have a value to me of at least \$1 million, whether or not I actually earn that amount as income.

This approach makes the regional linkages between growing stock and nontimber goods explicit. Stand management financial analysis shows a strong positive relationship between level of forest management intensity and output of private goods. An inverse relationship between level of forest management intensity and output of nontimber goods also is reasonable.

The framework for empirically estimating a regional opportunity cost for nontimber management objectives adapts and extends an earlier factor shares method for timber production (Marcouiller, Lewis, and Schreiner 1996). It involves the allocation of net returns to factor inputs of land, labor, and capital. The data used in this analysis include regional value-added estimates, national labor-output ratios for timber production, average regional wage rates, regional forest inventory data (including silvicultural treatments), and commodity price data. Rental rates are imputed for two separate factors (bare land and capital growing stock). Empirically, these values are estimated using the form:

$$(1)\ OC_f = \Sigma[(i_{max}\,(SV_t + KV_t) + q\,LV_{max}) - VA_t] \quad (t = 1, \ldots, c)$$

Where opportunity cost for nontimber forestry production (OC_f) is the sum across tenancy groups ($t = 1, \ldots, c$) of the differences between returns experienced by the management regime with the highest financial return and the current management regime of each tenancy group. This opportunity cost by land tenancy group is calculated using the maximum imputed rate of return (i_{max}) for land and capital assets applied to the values of factor stocks by tenancy group t where SV_t is bare land value and KV_t is the wholesale value of growing stock. Annual value of labor resources used in the timber production regime yielding maximum imputed rates of return for land and capital assets (LV_{max}) is used to represent the flow component of labor adjusted using the ratio of acreage in the assessed regime to the maximum yield regime (q). The returns to foregone production are represented by estimates of annual value added by tenancy group (VA_t).

For ease of calculation, the return experienced by industrial forest owners serves as a proxy for the maximum rate of return. Assuming that the value of nontimber goods and services produced by industrial private forest owners is zero, the value of foregone production can be inferred. Assigning industrial private lands zero value for nonmarket goods (to provide an analytical base) overlooks the potential nonmarket goods produced on these lands, which, in many cases, are significant. Further refinements are needed to correct for this oversight. The empirical factor share/opportunity cost analysis for the 101 lake states counties in this resource-dependent region is presented in Table 1.

Table 1. Regional factor shares, imputed rates of return, and opportunity costs by land tenancy group[1]

Tenancy group	Timberland acreage (million acres)	Value added[2] per acre 1993 ($)	Imputed[3] rate of return to land and capital (%)	Factor share: Land	Factor share: Labor	Factor share: Capital	Opportunity cost 1993 (million $)
Industrial private	3.4	4.72	1.8	0.39	0.22	0.38	0.0
National forest (public)	5.6	3.45	0.9	0.26	0.49	0.25	7.1
Other public	11.7	2.39	0.8	0.33	0.42	0.25	27.5
Nonindustrial private	18.8	2.43	0.9	0.32	0.38	0.30	43.0
Total/all owners	39.5	2.76	0.9	0.33	0.39	0.29	77.6

[1]Data sources include forest inventory data on regional growing stock and removals obtained from the USDA Forest Service FIA database available at "http://www.srsfia.usfs.msstate.edu/scripts/ew.htm"; approximate regional land values, commodity prices, and wages rates; and hybrid MicroIMPLAN regional datafiles. The fundamental method used to derive factor shares is found in Marcouiller *et al.* (1996)

[2]Net of indirect business taxes

[3]Calculated as the ratio of residual gross income (after payments to labor) to value of bare land plus value of growing stock

The use of opportunity costs as a proxy for the value of the public good is a first approximation of the value of the public good produced by the forest resource. Work by Willis (1990) assessing the public good value of farmland converted to a wildlife refuge suggests that the frame of reference adopted and the technique employed for valuation can alter the dollar value of the public good. He finds that contingent valuation (expressed preferences) places a higher value on the public good when compared to opportunity costs, while the travel cost method (revealed preference) results in a much smaller valuation. The goal of this current effort, however, is not to determine the correct valuation measure of the public good aspect of the forest resource, but to address the issue if ignoring the public good in regional analysis alters our policy recommendations.

Factors are compensated through forestry and nonforestry institutions. Furthermore, forestry is disaggregated into timber production and wood-processing activities. Timber production institutions are further disaggregated into industrial private, nonindustrial private, and public ownership. Recreation-related institutions include eating/drinking, hotel/overnight accommodations, and related services. Households receive compensation from institutions and are disaggregated into three income groups: low (less than $20,000 annual household income); medium (between $20,000 and $40,000 annual household income); and high (over $40,000 annual household income). The balanced SAM equates regional receipts with respective regional expenditures.

3.2 The empirical ESAM

Our empirical ESAM work focuses on a 101 county region based on forest type. It covers northern Minnesota, northern and central Wisconsin, and the upper/northern lower peninsula of Michigan. This represents the lake states forested region and encompasses the majority of regional growing stock, commercial harvesting activities, and wood-processing facilities. Furthermore, it is a relatively homogenous region characterized by general outdoor recreation and nature-based tourism demand. The region is predominately rural with Duluth/Superior included as the primary SMSA located within the regional boundaries. The twin cities of Minnesota, Madison and Milwaukee in Wisconsin, Chicago in Illinois, and Detroit in Michigan are located outside the regional boundaries.

Data sources used in the construction of the lake states ESAM include IMPLAN (IMpact analysis for PLANning) hybrid input-output model (Minnesota IMPLAN Group 1995), forest inventory data (USDA, Forest Service 1996), 1993 forest product prices, household income distributions (Rose *et al* 1988; USDC 1990), wage rates, transfer payments (USDC 1996; Peterson 1991), and factor shares (Koh 1991; Robinson *et al.* 1991; Marcouiller *et al.* 1996). The ESAM is balanced using a current accounting framework that incorporates rest-of-world linkages. A full discussion of the estimation procedures used in constructing the lake states environmental social accounting matrix is beyond the scope of this manuscript. The fundamental aspects of construction procedures are described in companion articles (Marcouiller *et al.* 1993 and Marcouiller *et al.* 1996). Our initial fully balanced ESAM is presented in Table 2.

TABLE 2.

Environmental social accounting matrix for 101 counties within the forested portion of the Lake States (U.S.A.) (in MM of 1993 $).

	Production sectors								Factor accounts			
	1	2	3	4	5	6	7	8	1	2	3	4
Production sectors												
1. Agricultural prod.	224.3	9.5	58.7	1133.0	21.5	26.3	13.3	2.4				
2. Timber prod. and serv.	57.1	20.8	.7	.3	171.4	0	0	0				
3. Manufacturing	195.0	19.4	4804.1	224.5	1093.3	1369.3	842.3	417.7				
4. Food/fiber process	13.3	5.9	11.7	975.8	2.1	261.3	0	9.1				
5. Wood processing	11.1	.2	551.4	91.9	1087.2	30.2	1.1	4.6				
6. Retail/services	96.1	5.2	2779.9	233.3	673.2	1183.2	409.2	148.7				
7. F.I.R.E.	90.1	12.9	770.0	26.4	110.1	609.4	934.2	102.5				
8 Government	2.9	.5	125.1	7.9	42.8	104.3	113.4	35.2				
Factor accounts												
1. Labor (total)	441.7	42.2	8091.7	579.8	2207.2	10717.7	1343.3	7084.6				
2. Capital	344.3	31.4	5339.8	521.4	1342.4	4683.6	3662.4	62.4				
3. Land	585.8	35.5	0	0	0	0	0	0				
4. Nonmarket Assets	0	0	0	0	0	77.6	0	0				
Institutions												
1. Timber Production												
a. National Forest									8.2	4.2	4.5	7.1
b. IPF									3.1	5.3	5.7	0
c. Other Public									11.9	6.1	6.6	27.5
d. NIPF									15.3	11.7	13.1	43.0
2. Commercial Recreation									1514.5	642.7	0	0
3. Wood Processing									1929.0	1151.1	0	0
4. All other									23125.3	11946.3	492.2	0
Households												
1. Low (<$20K)												
2. Medium ($20 - 40K)												
3. High (>$40K)												
Government												
Government revenue sources	40.7	4.0	620.0	31.3	159.1	1880.9	1390.0	15.9	3900.9	2220.5	99.1	0
Capital Savings												
Rest of world	1263.6	76.7	11099.8	1393.3	2473.5	4001.5	2229.1	576.9				
Total	3357.1	225.2	34252.9	5218.9	9383.8	24945.3	10938.3	8460.0	30408.3	15987.8	621.3	77.6

TABLE 2 (continued)

Environmental social accounting matrix for 101 counties within the forested portion of the Lake States (U.S.A.) (in MM of 1993 $).

	Institutions							Households						
	1a	1b	1c	1d	2	3	4	1 low	2 med	3 high	Government	Capital	Rest of world	Total
Production sectors														
1. Agricultural prod.								62.3	108.8	52.0	30.4	19.1	1595.5	3357.1
2. Timber prod. and serv.								2.7	7.2	4.3	0	2.6	6.1	264.2
3. Manufacturing								223.8	519.8	308.1	2147.7	5958.3	16129.6	34252.9
4. Food/fiber process								255.1	432.9	200.9	51.8	5.7	2993.3	5218.9
5. Wood processing								17.9	43.1	30.4	21.1	166.6	7327.0	9383.8
6. Retail/services								3470.5	7896.1	4212.3	710.2	359.0	2768.4	24945.3
7. F.I.R.E.								1050.3	2473.2	1433.9	247.0	34.7	3043.6	10938.3
8 Government								301.6	713.5	518.2	5945.0	.9	548.7	8460.0
Factor accounts														
1. Labor (total)														30508.2
2. Capital														15987.8
3. Land														621.3
4. Nonmarket Assets														77.6
Institutions														
1. Timber Production														
a. National Forest											0			24.0
b. IPF											0			14.1
c. Other Public											0			52.1
d. NIPF											0			92.8
2. Commercial Recreation											9.7			2157.2
3. Wood Processing											0			3080.2
4. All other											0			35563.8
Households														
1. Low (<$20K)	1.5	.9	3.2	5.7	133.3	190.3	2197.3				5614.4		700.7	8847.2
2. Medium ($20 - 40K)	9.4	5.5	20.3	36.1	840.0	1199.4	13848.7				3592.0		1863.7	21415.1
3. High (>$40K)	5.9	3.5	12.8	22.7	529.1	755.5	8723.2				1509.1		5093.0	16654.8
Government														
Government revenue sources								564.3	2663.2	3049.2			3239.3	19878.4
Capital Savings	7.1	3.8	27.5	43.0	175.0	312.2	3423.5	278.9	1313.8	1509.5				7094.2
Rest of world	.2	.5	-11.7	-14.9	479.7	622.7	7371.2	2619.8	5243.6	5336.0		547.3		45308.9
Total	24.0	14.1	52.1	92.8	2157.2	3080.2	35563.8	8847.2	21415.1	16654.8	19878.4	7094.2	45308.9	

4. Summary and policy implications

This paper has focused on the unique attributes of rural resource-dependent regions that dictate a broader regional modeling framework capturing both market and nonmarket goods. Our current efforts are directed toward implications important to land management and development policy in forested regions. Forest management policies result in tacit impacts on regional household incomes. They also result in differential outputs of public and private goods. Our work investigates the effects of alternative forest land management policies on income distribution incorporating both market and nonmarket goods. The environmental social accounting matrix approach in this paper suggests one modeling framework with which to analyze the impact of policies on development.

Public policy (or regulation) directs forest land management. Certain public policies that target federal land management, such as ecosystem management approaches, are classified as more extensive management regimes. Other policies that encourage extensive management regimes include state-level stewardship incentives programs (SIP) that cost-share recreation-related capital expenses or land set-aside programs of the private sector such as those that result from efforts of the Nature Conservancy and other land trust institutions. On the other hand, public policies that encourage more intensive land management regimes include the traditional federal forestry incentives programs (ACP, FIP, SIP) that cost-share plantation establishment/maintenance and the Conservation Reserve Program (CRP) that cost-shares treatments and pays land rents to agricultural producers to convert agricultural lands to tree plantations or to permanent grass cover. Private forest industries have programs that encourage active intensive management of non-industrial private lands through direct landowner consultation. Also, the USDA efforts in forest management have addressed the adoption of more intensive silvicultural technologies by non-industrial owners through forest management workshops and financial management transfer activities.

The effect of these policies on the production of nonmarket goods is important to the service and retail sectors of the regional tourism industry. We argue that important positive and negative externalities of timber production have impacts on tourism development that need to be factored into the policy assessment process. Modeling this latent set of interactions is one contribution this work makes to the growing body of literature dealing with the regionalization of nonmarket goods and the greening of regional accounts.

Our extension of the SAM modeling framework focuses on these latent inputs and outputs and their joint production characteristics. Our questions focus on forest policy trade-offs. One set of questions addresses the range over which current policies and programs produce tradable and nontradable forest-based goods. Is there some locally optimal (maximum) solution to this production mix? To what extent would policies and programs be required to attain these alternative levels? Another set of questions concerns the distributional consequences of forest management policy. Given that decisions by policy makers have de facto influence on income distribution, what would be alternative forest production regimes for different household income groups? This research allows us to assess market/nonmarket trade-offs regarding who benefits and who pays for the range of land use alternatives available to forest owners.

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