MODELING THE REGIONAL ECONOMIC ASPECTS OF FOREST MANAGEMENT ALTERNATIVES

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ABSTRACT. — Regional economic assessments of forest management alternatives provide complex modeling problems for policy analysts. Two specific empirical complexities involve income distribution and output trade-offs within a market-based neoclassical economic framework. This paper develops a social accounting matrix (SAM) model to investigate distributional impacts and differential outputs of alternative forestland management regimes of the Upper Great Lakes forested region. Extensions to computable general equilibrium (CGE) models are outlined. Whereas SAMs provide a comprehensive empirical accounting structure, they lack market-based prediction ability. CGE models are better equipped to handle markets but lack an empirical basis for parameter estimation.

INTRODUCTION

As we increasingly strive to manage forests for a wide range of goods and services, we affect the structure of local economies in rural forested regions. This has important implications for both those who reside within forested regions and societally demanded forest-based public-goods benefits. In rural forested regions, timber resources provide important raw material inputs into regional value-added activities of wood products manufacturers and regional tourism interests. Policies that address forest resources from a regional perspective are typically analyzed in fixed-price aggregate terms using economic measures such as total number of jobs created or total change in regional income measures. The contributions of forest resources to regional development, however, are more complex.

Shifts in forest use can have important impacts on regional economic linkages and the manner in which income is generated and distributed to regional households. Thus, one type of complexity involves the distribution of benefits by household income level (Wear and Hyde 1992). Also, alternative forest management regimes use different combinations of land, labor, financial capital, and growing stock inputs. Management choice of input combination determines output levels of both private goods (timber stumpage) and public goods (recreational values, non-use values, etc.) Thus, another important aspect of regional development that represents the complex nature of forest resource impacts is the differential production of nonpriced public goods under alternative management regimes (Hyde and Amacher 1996; Bostedt and Mattsson 1995) and the resulting dilemma of who benefits and who pays for the production of public goods (Piggott and Whalley 1991).

This paper investigates analytical options used to model distributional impacts and differential outputs of alternative forestland management regimes. We limit the discussion to two contemporary regional science methodologies. First, we construct and critique a small stylized social accounting matrix (SAM) of the forested Upper Great Lakes States economy. In doing so, however, we identify a general inability to capture production differences and resulting factor market influences as a primary shortcoming. These influences lead us to seek more flexible modeling choices. Extensions into more flexible techniques that model regional factor substitution among forest management regimes will be outlined. A plausible single-region computable general equilibrium (CGE) model will be outlined that elaborates markets and appropriate policy questions.

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CORE SET OF PROBLEMS

In developing a more general framework to assess forest management, we begin by noting that the level of management intensity determines both income distribution and output trade-offs. Thus, modeling the regional economic impacts of forest production alternatives requires a focus on critical issues of management intensity. Forest managers implicitly choose alternative silvicultural regimes based on landowner objectives. Although difficult to generalize, the range of alternatives varies from optimal fiber production using even-aged silviculture to reliance on fully natural, nonsilvicultural, options. To many, the level of silvicultural input would provide a basis for defining "intensive" forest management. It is the choice and application of a management alternative that dictates the use of production inputs; results in income being generated and distributed to owners of primary factors; and determines both the type and extent of forest outputs.

Although past research has identified production differences among land ownership groups (Newman and Wear 1993; Wallace and Newman 1986), we have few standard definitions for characterizing the "intensity" of management. Any definition of management intensity would need to be based on how landowners combine production inputs to produce output. On the one hand, intensive silviculture would most likely relate to methods designed to increase productivity by expending more labor and capital rather than by increasing the scope (or the use of land inputs) of production. On the other hand, extensive silviculture might constitute growing trees using large tracts of land with minimal expenditure of labor or capital. There is a considerable amount of confusion, however, over what measures we could use to characterize this type of management intensity.

This simple static definition of management intensity has some serious shortcomings. Primary among these is the notion that growing stock is a dynamic, not static, input into the production of timber. Dismissing nonsustainable options, definitions of intensity must somehow incorporate the growth of and removal from growing stock assets over time. In addition, the initial and residual conditions of growing stock need to be specified. If not accounted for, satisfying an intensity definition would not allow us to distinguish output trade-offs among alternatives. A good example of this is the inability to distinguish outputs among two dichotomous intensive silvicultural options: even-aged and uneven-aged silviculture.

In an intensive even-aged silvicultural regime that begins with bare land, foresters plant genetically improved seedling stock at optimal spacing to provide for fully stocked conditions. Over time, competition is controlled, seedlings grow, the canopy closes, intermediate thinnings are timed and applied so that optimal spacing is maintained, multiple timber products are removed, and, ultimately, the stand is returned to bare land to start the process over again. Here, growing stock is initially zero and ultimately returns to zero. Growing stock accumulates based upon the financial and biological growth characteristics determined through management input. While it is an efficient way to produce private goods (timber), many argue that this alternative generates low levels of public goods (aesthetics, biodiversity, and recreational value).

The alternative regime utilizes high initial levels of growing stock and maintains these stocks through uneven-aged silvicultural techniques. The maintenance of a perfectly J-shaped diameter distribution through regular selective harvests could attain high financial private yields per acre in timber, thus falling within our input-based definition of intensity, but the type and extent of outputs could be very different. Proponents of this type of silvicultural option point to high output values of public goods. Even- and uneven-aged silviculture options generate very different stand conditions, yet could indeed generate similar timber values. Thus, the question remains: how do we characterize management intensity? Certainly, models that continue to treat forest management practices as homogeneous are gross oversimplifications of reality and, when used for policy analysis, lead to erroneous results and biased implications.

Many of the core policy and planning questions that deal with forest management incorporate more than maximum financial return to timber products generated. There are sets of less tangible benefits to forest management that are overlooked in strictly market-based financial analysis. These include biodiversity, spatial disturbance patterns, and recreational benefits. The key issues for policy analysis include integrating these less tangible, societally

determined benefits into the economic assessment of management alternatives. For this paper, these translate into how we model shifts in management policy between extractive and nonextractive uses.

Another modeling problem needs to account for both markets of goods and services as well as factors of production. The factors of production we consider include land, labor, financial capital, and growing stock. Intensive and extensive management regimes utilize these factors of production in different combinations. What effect do shifts in management policy have on initial factor endowments, factor prices, and residual factor endowments? Given that returns to factors of production accrue to owners of these productive factors, how do management alternatives generate and distribute income?

Finally, a core modeling problem deals with how to incorporate output trade-offs associated with alternative management regimes within a policy analysis model. This is particularly acute for nontimber management objectives, outputs of which include common property public goods. Is there a transfer of benefits that accrue to those outside of the forestry production process, perhaps to regional tourism firms? What is the opportunity cost associated with financial nonoptimality? Who benefits from financial nonoptimality? How do we account for the opportunity cost associated with timber management at less than financially optimal levels? Are there opportunities to shift the incidence of public-goods production costs onto those who benefit. If we were able to accomplish this, how would the production and use of public goods be impacted? These are questions left unanswered by current policy models that require further research. Though only partially complete, the following discussion outlines two methods that have potential to address some of these issues.

METHODS

Literature on the economic development of forested regions has included (1) the identification of forward and backward industry linkages (Sartorius and Henle 1968), (2) export-based theory of forest product-led regional growth (Connaughton et al. 1985; Schuster and Medema 1989), and (3) analysis of forested regions using input-output methods (Flick and Teeter 1988; Pedersen et al. 1989). Recent literature has tied development of forested regions to questions of income distribution (Rose et al. 1985) and factor market equilibrium (Boyd and Hyde 1989; Daniels et al. 1991).

From a regional economic modeling perspective, two related methods appear to have promise in their ability to address the core set of issues identified above. These include an extension of input-output analysis known as SAM analysis and its extension as a base data set for regional CGE models. In this section, we empirically estimate and critique a SAM for the Upper Great Lake States forested region that specifies two alternative forest production regimes. We then address the ability to extend this SAM into more flexible forms through a single-region CGE model.

A Social Accounting Matrix Approach

The estimation and analysis of SAMs have developed a significant following during the past 25 years.[2] However, there have been few applications of SAM analysis to natural resource-based income distribution (see e.g. Rose et al. 1988; Marcouiller et al. 1995).

Analytically, rows of the SAM track receipts (revenues) and columns track expenditures. In producing output, production sectors use and compensate factor inputs specified as labor, capital, and land. These factors are compensated through forestry and non-forestry enterprises. Furthermore, forestry is disaggregated into timber

[2] Regional input-output analysis is a fundamental tool used in sectoral analysis of regional economies (Richardson 1985; Miller and Blair 1985). Extending input-output to SAM analysis is more recent (Pyatt and Round 1985; deMelo 1988; Pyatt 1988). This extension is the result of general dissatisfaction with sectoral input-output analysis in the estimation of regional economic development criteria (Pyatt and Round 1985; Keuning and DeRuijter 1988). SAMs are used to more fully analyze regional economic development (Cohen 1988; Cole et al. 1989) with particular emphasis on the distribution of income (Adelman and Robinson 1986; Esparza 1989).

production and wood processing activities. Timber production enterprises are then disaggregated into industrial private, nonindustrial private, and public ownership categories. Households receive compensation from enterprises and are disaggregated by income group. The balanced SAM equates regional receipts with respective regional expenditures.

Transforming the SAM into a predictive model requires several steps. Cohen (1988) discusses these as (1) subdividing the SAM into exogenous and endogenous accounts, (2) expressing flows as average propensities of their corresponding column totals, and (3) generating multipliers through matrix inversion. Technical coefficients from the production accounts through the household accounts of the SAM are calculated in a_{ij} form where a_{ij} is calculated as z_{ij}/X_j and denotes the flow, z_{ij}, (measured in dollars of value) from SAM sector i to SAM sector j, and X_j is the total gross output of SAM sector j.

Our empirical SAM focuses on a 101-county region delineated based upon the extent of forest area. It basically covers northern Minnesota, northern and central Wisconsin, and the Upper and Northern Lower Peninsulas 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 represents a relatively homogenous region based upon tourist type characterized by general outdoor recreation and nature-based tourism demand. The region is predominantly rural with Duluth/Superior included as the primary standard metro statistical area (SMSA) located within the regional boundaries. The Twin Cities of Minnesota; Madison and Milwaukee in Wisconsin; Chicago, IL; and Detroit, MI are located outside of the regional boundaries. We believe this regional delineation to be useful for developing a more focused analysis of rural forested regions.

In short, data sources used in the construction of the Lake States SAM include an IMPLAN (IMpact analysis for PLANning) hybrid input-output model (Minnesota IMPLAN Group, Inc., 1996), forest inventory data (USDA Forest Service 1996), 1993 forest product prices, household income distributions (Rose et al. 1988; USDC 1996 wage rates, transfer payments (USDC 1996; Peterson 1991), and factor shares (Koh 1991; Robinson et al. 1991; Marcouiller, et al. 1996). The SAM is balanced using a current accounting framework which incorporates rest-of-world linkages. A full discussion of the estimation procedures used in constructing the Lake States SAM would extend beyond the page limitations of this manuscript and is available from the authors.

Alternative forest management regimes would be expected to (1) use different combinations of factors based upon ownership patterns and (2) 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 largely reflect the alternative management intensities (regimes) within which timber is produced. Conceptually, this approach makes the regional linkages between growing stock and non-timber goods explicit. Stand management financial analysis shows a strong positive relationship between level of forest management intensity and output of private goods. It would be reasonable to also forward an inverse relationship between level of forest management intensity and output of nontimber goods. For this work, the framework for empirically estimating a regional opportunity cost for non-timber 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:

$$OC_f = \sum \left[\left(i_{\max}(SV_t + KV_t) + qLV_{\max} \right) - VA_t \right] \qquad (t = 1, \ldots, c), \tag{1}$$

where opportunity cost for nontimber forestry production (OC_f) is simply the sum across tenancy groups (t = 1, ..., 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 can serve 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 thus be inferred for other ownerships. Obviously, assigning industrial private lands zero value for nonmarket goods (done to provide an analytical base) totally overlooks the potential nonmarket goods that are produced on these lands, which, in many cases, are quite significant. Further refinements are needed to correct for this oversight. The empirical factor share/opportunity cost analysis for the 101 Great Lake States' counties making up this forested resource-dependent region is presented in Table 1.

Table 1. —Regional Factor Shares, Imputed Rates of Return, and Opportunity Costs by Land Tenancy Group (USDA 1996; Mercoullier et al. 1996)[a]

Tenancy Group	Timberland acreage	Value added[b] per 1993	Imputed[c] Rate of Return to Land and Capital	Factor Share			Opportunity cost1993
				Land	Labor	Capital	
	million acres	*Dollars*	*percent*		*proportions*		*million dollars*
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

[a] Data sources include forest inventory data on regional growing stock and removals obtained from the USDA Forest Service Forest Inventory and Analysis database; approximate regional land values, commodity prices, and wage rates; and hybrid MicroIMPLAN regional datafiles. The fundamental method used to derive factor shares is found in Marcouiller et al. (1996).
USDA, FOREST SERVICE. 1996. North central forest inventory and analysis database. Oracle database of county-level forest resource data for 101 counties in Lake States. Available at <http://www.srsfia.usfs.msstate.edu/scripts/ew.htm>
[b] Net of indirect business taxes.
[c] Calculated as the ratio of residual gross income (after payments to labor) to value of bare land plus value of growing stock.

Clearly, the use of opportunity costs as a proxy for the value of the public goods represents a first approximation to the true value of the public goods produced by the forest resource. Work by Willis (1990) on assessing the public-goods value of farmland converted to wildlife refuge suggests that the frame of reference adopted and the technique employed for valuation can greatly alter the dollar value of the public goods. He found that contingent valuation (expressed preferences) placed a much higher value on public goods, when compared to opportunity costs, while the travel cost method (revealed preference) resulted in a much smaller valuation. The goal of this current effort, however, is not to determine the correct valuation measure of the public-goods aspect of the forest resource, but rather to determine if ignoring public goods 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 then 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 groups based on annual household income: low (less than $20,000),

medium (between $20,000 and $40,000), and high (over $40,000). The balanced SAM equates regional receipts with respective regional expenditures.

Our initial fully balanced SAM is presented in Table 2. Of particular interest is the introduction of the nonmarket assets (or public goods) created by the existence of the forest itself. Note that we model it as a fourth factor of production and under current design, it enters as a factor of production in the recreational industry (production sector 6: retail/services), but that it does not enter into timber production and services (production sector 2). The value of producing these public goods (derived through the opportunity cost approach) is tracked in the institutional row by tenancy group reading down the public-good factor of production column. As the SAM stands, it reflects a conservative estimate of nonmarket values.

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	0.7	0.3	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	0.5	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		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	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
Institution														
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	0.2	0.5	-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	

The SAM shows that growing trees (timber production) and wood processing represented roughly 264 million dollars and 9.38 billion dollars respectively of total output in the Upper Great Lake States during 1993. These accounted for roughly 10 percent of the total 96.5 billion dollar gross product of the regional economy. Household income of the region was roughly 47 billion dollars. The total service and retail sector output accounted for about 25 billion dollars, of which, roughly 3.5 billion could be attributed to demand from out-of-region sources (tourism). Calculated using our opportunity cost approach, public goods from forest lands totaled roughly 80 million dollars during 1993.

A multitude of policy analyses is possible given the fully specified and balanced SAM. For the sake of brevity and as a means of illustrating the distributional consequences of forest policy impacts, a simple exogenous shock consisting of a 100 million dollar increase in public-goods output is applied to the SAM multiplier matrix as factor income.[3] This could be thought of as resulting from a shift in forest management to producing higher levels of nontimber benefits.

This increase in public goods could be accomplished in numerous ways. A naive way to justify this increase in public-goods production is to interpret it as a direct result of reducing the output of harvestable timber products (if translated directly into timber output, this total amount would represent a 38 percent decline over current output levels). To accomplish this assessment, one would be required to adjust timber output downward in a manner consistent with land use incompatibility. Currently, there are no models that would allow us to empiricize this trade-off. Also, even though this method would be consistent with the opportunity cost of producing public goods, it overlooks the ability to apply silvicultural treatments in a more sensitive manner.

Another approach to modeling this change would be to produce public goods using alternative management strategies that rely on uneven-aged selective silvicultural techniques, such as those practiced by the Menominee tribe in northern Wisconsin. Were we to manage forests for timber outputs in a less “aggressive,” more sensitive manner, how would the increased levels of public goods translate to regional economic impacts? This is the question that is initially modeled in this paper. The results are presented in Table 3.

Table 3. —Effect on Regional Households of a 100 million dollar increase in public-good output (101 counties in forested portion of Upper Great Lake States in millions of 1993 U.S. dollars)

Account	Initial Household Income Distribution		Fixed Price Impact	
	Million dollars	*Percent*	*Million dollars*	*Percent*
Households				
Low income	8,847	18.9	7.84	8.9
Medium income	21,415	45.6	49.44	55.9
High income	16,655	35.5	31.14	35.2
Total	46,917	100.0	88.42	100.0

Public goods are linked to the production of tourism activities (retail/services). These have important connections to finance, insurance, and real estate activities. As a result of increased output, these activities employ more labor and capital inputs. There are also benefits that accrue to the timber production regimes themselves as differentiated by institutions. Given the structure of the SAM, it is important to realize that these benefits are not accruing to landowners as market-based receipts but as public-goods assets. Finally, as shown in Table 3, the distributive

[3] Our model is endogenized through the set of household institutions, thus, interpretation of the impact assessment would include direct, indirect, and induced effects. A complete description of SAM analysis is beyond the scope of this paper. Interested readers are referred to Pyatt and Round (1985) or Holland and Wyeth (1993) for general discussion or to Marcouiller et al. (1995) for a discussion relative to timber production.

impacts resulting from public-goods production increases are disproportionately focused within the medium- and high-income households.

The strength of this approach to modeling the policy problems presented earlier is its comprehensive snapshot of the regional economy detailing timber production and its linkages to tourism. The empirical procedures for estimating the model are relatively straightforward. The drawback is the SAM's inability to deal with market influences in anything but fixed price terms. Price effects within a supply and demand framework are overlooked, thus leading to overestimates of quantity change. Furthermore, a SAM doesn't allow feedback linkages within a regional economic circular flow between the market for goods and services and the market for factors of production. Also, results suffer from the inability to differentiate market from nonmarket benefits.

A General Equilibrium Approach

Production within a SAM is limited to a Leontieff production form that characterizes output as resulting from the use of inputs in fixed technical coefficient terms given constant prices. A traditional SAM cannot mimic the flexible substitution among primary factors that characterizes management decisions. This model is unable to capture alternative rates of return to various production technologies. For example, the intensity of forest management, particularly the use of even-aged silvicultural practices, influences the rate of return to forest management practices. The development of fast-growing hybrid trees, the dramatic technological improvements made in harvesting equipment, and the technical progress of wood processing have focused on efficiency gains, namely through cost minimization and profit maximization of the firm. Furthermore, given scarce resources, steady to increasing demand for outputs, and technical progress in production, one would expect significant price effects for land, labor, capital, and growing stock. Thus, SAMs are limited in their ability to model regional economic structures from a neoclassical market perspective.

Although in its early stages, we have begun to extend the SAM into more price-flexible production forms utilizing CGE methods. There are many forms of CGE models that address similar core issues (e.g. Boyd 1984; Adams and Parmenter 1995; Piggott and Whalley 1991.) For example, the small stylized general equilibrium model developed by Coxhead and Warr (1991) appears to provide a feasible framework. Developed to assess production technology differences between irrigated and unirrigated rice in the Philippines, these authors use a Johansen-type CGE model to assess three factor technology biases. To be adapted to the set of forest production problems outlined above, the Coxhead and Warr model can assess regional timber production that takes place under two management intensities characterized by fixed land resources, and which accordingly experience differential rates of silvicultural inputs even while facing the same prices for output and variable inputs. On the surface, this model would appear able to generate distributional results for several classes of households distinguished by their ownership of factors and by their patterns of consumption. Specifically, modeling components include complete specification of (1) factor demand and product supply, (2) factor supply, (3) household income and expenditures, and (4) price setting and market clearing.

Several significant empirical difficulties are evident in developing CGE models. Whereas SAMs provide empirical estimates of initial factor endowments, household consumption levels, and other benchmark data on the regional economy, there is a dearth of secondary data that allows us to easily parameterize a model. Chief among these parameters are elasticities of demand for factors with respect to factor and output prices, elasticities of supply for goods with respect to factor and own prices, and expenditure elasticities by household group. For timber production, Newman and Wear (1993) can provide a start for two landowership groups (industrial private forests (IPF) and nonindustrial private forests (NIPF)) and two product classes. Whereas gross sectoral parameters at the national level can be gleaned from other studies (e.g. Robinson, et al. 1991), there is an inevitable need to estimate these for the Upper Midwest. This parameterization provides many avenues for future research.

DISCUSSION

As remote natural resource dependent regions explore alternative uses of their resources, the nonmarket value of those resources will play an increasingly important role in the local economy. Traditional economic models of regional structure completely miss the role of these public goods in the local economy. Using forest resources as an example, we suggest a simple and direct means for explicitly modeling nonmarket uses of these natural resources. Within our framework we identify a number of empirical issues that remain to be addressed. Our challenge then is to acknowledge the importance of non-market goods in the local economy and move towards building them into our analysis.

In terms of this particular effort, it should be considered midstream. We hope to better address the issues of local consumption and exports of the nonmarket goods resulting from alternative forest management regimes. Parameterization of the CGE model will entail significant work both identifying usable values from other studies and performing our own empirical estimates that are more region-specific. Our policy questions remain focused on regional economic consequences of alternative forest management regimes. Results of this work begin to provide us insights into the important questions that deal with how to best manage forests to attain both privately and societally determined demand for a wide array of goods and services.

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