The Tradeoffs in Ecosystem Management: The Case of Logging and Recreation in the Southern Appalachians.

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Abstract: The US Forest Service is adopting ecosystem management, but the potential impact on local economies is unknown. Analysis via a recursive system of regression equations reveals that some ecosystem management variables have an influence upon recreational visitation which, in turn, has a net negative impact on county employment levels.

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Introduction

The Forest Service of the United States' Department of Agriculture has recently adopted a new philosophy for managing its lands. One way to characterize the goal of this philosophy, Ecosystem Management (EM), is that it seeks to maximize the value of multiple forest resources over time, subject to the constraints of achieving given levels of ecosystem health and quality. Swallow (1996) has summarized the economic issues that EM raises. Despite his and others' characterization of EM as ". . . one of the vaguest ideas or mandates of the decade," he has identified several contributions that economists can make. Foremost among these is identifying and quantifying unavoidable tradeoffs that the application of EM would entail.

One area of unavoidable resource tradeoffs that we feel is important is: what is the net effect of management changes associated with EM on the local economies that surround Forest Service lands? For example, if the rate of tree harvest were to decrease how might local employment be affected? Obviously, timber industry employment would be lower, but would reduced tree harvest cause more recreational visitation and would the employment loss in the timber sector be offset by gains in the tourism sector? This paper describes an empirical analysis that addresses these issues.

Conceptual Framework

Forest Service management areas are quite varied in their attractiveness to users. Some areas are adjacent to major highways that offer improved access by users from metropolitan areas while other areas are very remote. Some areas contain developed camp sites and/or scenic attractions such as waterfalls and rock formations, while other areas offer almost no recreation facilities or developments. County-level attributes including size, scenic attractiveness, logging activity, and/or resource quality have often been used in travel cost models of recreation demand (Caulkins, Bishop and Bowes 1986; Smith 1989).

In order to affect recreation-related employment, ecosystem management should have perceptible impacts upon the attributes of forest land that are related to recreation use. Management techniques that increase: (1) biological diversity, (2) the population and geographic range of desirable non-game species, and (3) improvements in game species to increase hunting and wildlife viewing opportunities, should result in more visitation. In summary, if proposed management changes result in differing forest area attributes that are perceptible to visitors, then a regression analysis of forest area use should yield significant estimates of each attribute's marginal impact on use.

The relationship between ecosystem attributes, recreational demand and recreation related employment can be formalized by a recursive system[1] of regression equations:

$$Y_1 = B_1(a) + u_1 \qquad (1)$$

$$Y_2 = B_2(Y_1) + u_2 \qquad (2)$$

where recreational use of Forest Service land in a county (Y_1) is a function of attributes in the vector a, including attributes that reflect the results of ecosystem management. Each coefficient B_{1i} in equation 1 is an estimate of an attribute's marginal impact on the public's use of Forest

[1] The system is recursive because it can be shown that the matrix of coefficients of endogenous variables is triangular and if $cov(u_1,u_2) = 0$, then each equation can be estimated by OLS.

Service land in a county. Equation 2 explains county recreation-related employment as a function of visitation.

For the dependent variable in equation 1, the best measure of the demand for Forest Service areas, i.e. visitor days, may not be reliable due to differences in how these numbers are estimated from one area to another. Some Forest Service areas devote great attention to making accurate visitation estimates, while others do not. If this is the case then the estimates in equation 1 would suffer from the errors-in-dependent-variable problem, i.e. they would be unbiased but inefficient. More seriously, since Y_1 is an independent variable in equation 2, those estimates would probably be biased and inconsistent.

With these estimation problems in mind, a second best measure for Y_1 can be Y_2, the counties' recreation-related employment. With this formulation the regression equation to estimate would be:

$$Y_2 = B_3(a) + u_3 \qquad (3)$$

This abbreviated formulation should yield unbiased, efficient estimators if recreation employment is correlated with the true but unknown visitation variable and uncorrelated with u_1 or the measurement error in Y_1. Also, this formulation would yield essentially the same economic information as the first one, only now the coefficients for each attribute will yield the marginal contribution to employment, rather than the marginal contribution to visitation.

It is crucial to obtain reliable data for Y_2 that represent recreation employment that is generated by non-local demand. As suggested by export base theory, a prime determinant of economic growth is non-local demand which serves to inject "new" dollars into a small, open economy. The jobs that are related to non-local demand represent the direct impacts of the recreation sector, and the economic impact multipliers that are estimated within an input-output model can be applied to this number of jobs to yield the total employment impacts of recreation.

This problem has been the topic of a recent article that attempted to improve the measurement of tourism's share in the local economy from secondary data. Leatherman and Marcouiller (1995) used a four-step procedure to obtain better estimates. In the first step, they gathered data on factors that were thought to influence the level and type of tourism. The second stage employed principal components analysis to summarize the variables into a smaller set of variables that are interpreted as representing distinct types of tourism. The third step used cluster analysis to group the geographic units of observation into classifications of shared characteristics. Finally, the fourth step used the minimum requirements technique to calculate the export share of employment in industry *i*. This approach is implemented in this research.

With regard to the forestry sector, the Forest Service has often used timber sales and harvests as policy instruments to attempt to stabilize a county's employment (Schweitzer and Risbrudt 1989). However, several research efforts have shown that forest markets are driven more by demand forces than by Forest Service policy (Burton and Berck, 1996). Still, harvests and employment are related. In a time series study in Oregon, Burton and Berck found that harvest levels on National Forests were significant predictors of forest sector employment, and vice versa. Since the forestry sector is fairly well-defined, the equation to estimate is straightforward:

$$Y_4 = B_4(a) + u_4 \qquad (4)$$

where Y_4 is the export employment in the forestry sector, and the other variables are as previously defined.

Data

This research estimates a series of regression models utilizing cross-sectional data from USDA-Forest Service sites in the Southern Appalachian Region. Concerning data for the independent variables in equations 3 and 4, a good deal of information describing the resource base has been assembled in conjunction with the Southern Appalachian Assessment (SAA) project funded by the Forest Service. The SAA data has been made available on a set of five CDs, in a series of ARC/INFO coverages (Hermann, 1996). From a list of over fifty candidate variables, the equations were estimated with variables that are described in Table 1. These data are reported for years over the period 1992-1994. For the employment data required, we used the county-level data from the IMPLAN input-output model, using the method detailed in the next section. Employment data are for 1993.

The availability of employment data necessitated using counties as the unit of observation in all of the regression models. In the SAA region there are 81 counties with Forest Service land and all of these counties were used to make the data set for subsequent regression analysis. These counties are distributed across Virginia, North Carolina, Tennessee, South Carolina, Georgia and Alabama. Some of the variables in Table 1 were given in the SAA CDs at the county level of observation while other variables, such as the mining activity data, were given as specific geographic points. For this latter group of variables, the ARC/VIEW software contains a 'spatial table join' function that enables the analyst to summarize point data at the county level.

Concerning specific hypotheses for the ecosystem attributes as they relate to recreation employment, we expect that most variables should have a positive influence. The exceptions are as follows. The variable for large game population should be negative because two of the main species in question, bear and turkey, are intolerant of high human contact levels[2]. The logging activity variable should be negative because of its negative short-term impact on scenery, as should the variable for the number of active and inactive mines in a county.

For forestry employment, we expected positive relationships with logging activity and population (as a demand driver). Because recreation development and logging are generally considered mutually exclusive, we expected negative relationships between forestry sector employment and both campsite development and total public land acres, which includes state parks and National Park Service lands. For the remaining variables, it was not clear a priori what the relationship was likely to be.

Analysis

Regressions models were estimated to examine the relationship between the ecosystem management variables and export employment for both the forestry and recreation sectors. For each model, the regressors included a constant, county population (in 1000's), and seven ecosystem variables. These variables are described in Table1. Both models were initally estimated with OLS.

Spatial autocorrelation has been recognized as a common occurrence at various scales for many geographic, economic, and ecological processes. It seemed likely that the level of export recreation-related jobs in one county might depend on the concentration or absence of such jobs in adjacent counties, and that forestry sector employment might depend on either the level of employment or logging activity in adjacent counties. Using residuals from the initial OLS

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[2] For each of the three species, the population categories are 0=none present, 1=low, 2=moderate, and 3=high population categories. Thus, values of this variable range from 0 to 9. The SAA metadata file does not indicate any numerical ranges for the population categories.

regression, we constructed a Moran I coeffcient (Cliff and Ord 1973; Griffith 1987), which focuses on the covariation of adjacent county values.

The Moran coefficient for the forestry employment indicated the presence of positive spatial autocorrelation (z = 1.855). However, in the recreation jobs model, the value for the z test statistic was -1.714 (significant at 0.10). Consequently, we developed another variable for each model to capture the spatial relationship for jobs per capita, and re-estimated the model. The additional variables (ADJREC and ADJFOR) measured the export jobs in the recreation and forestry sectors, respectively, in adjacent counties.

The models were examined for both multicollinearity and heteroskedasticity. Neither model exhibited evidence of any large degree of multicollinearity. However, there were several correlations among the regressors that may be important to later discussions. Goldfeld-Quandt tests for heteroskedasticity indicated its presence in both models. Subsequent analyses showed that variances were closely (and negatively) related to the percent of the county that was forested for both models. As a result, weighted least squares models were estimated.

Results

A. Recreation Sector

The model for export recreation-related employment performed very well, with an adjustred R-square of 0.723 (Table 2). Quite clearly, nonresidentiary recreation jobs are very closely tied to population. That is, even after accounting for residentiary demand, population and employment in recreation-related industries are closely linked. Three of the ecosystem variables were also strongly related to recreation employment. As expected, both the number of campsites and the kilometers of native trout streams were positively correlated with recreation employment.

Total acres of public lands was negatively related to export recreation employment. Although the relationship was not as strong as the other ecosystem variables, the level of logging activity was negatively related to recreation employment.

B. Forestry Sector

As expected, both population and logging activity were positively related to forestry sector export employment. That is, it seems that population driven demand and Forest Service harvests do affect employment in this sector in this part of the country. Further, since the spatial autocorrelation variable (ADJFOR) was significant and positive, there appears to be a noticeably high level of multi-county clustering in this type of activity. However, none of the ecosystem variables had a significant level of predictive power on employment. It may be that a sufficiently high proportion of timber is harvested from private lands that changes in management of Forest Service lands have no appreciable effects on timber and related industries. It is also possible that timber harvesting and ecosystem management activities may be targeted to occur on separate tracts.

Employment Tradeoffs

Using the results from Table 2, it is possible to examine the tradeoffs that might occur given a change in management. For example, if tree harvest were to decrease from the average figure of 11.25 mfc per 1000 acres (from Table 1) down to 6 mfc, then nonresidentiary recreation-related jobs would increase by about 70. Since the employment multiplier for recreation in this region is about 1.35 (from the IMPLAN input-output model), the reduced timber harvest would generate about 95 jobs throughout the economy. The impact on forestry sector employment would be a loss of 195 jobs. The overall impact on the average county's employment is a net decrease of 195-95 = 100 jobs.

Reduced logging activity may allow increases in the availability of native trout streams, at least in the long run. In such a case, the job loss will be offset by greater increases in recreation-related export jobs. Trout streams are in themselves attractants to recreation visitors. Moreover, the conditions necessary for trout habitat (shade, clean water, etc.) are the kinds of places that many visitors like to have to camp. Because camping involves overnight stays, visitors have greater opportunities to spend money, thus creating jobs in recreation-related sectors. In addition, if increased trout streams make an area more desirable for retirement, second home development, or amenity seeking migrants, then recreation sector jobs will see further increases.

On the other hand, the effect of the observed spatial patterns indicates that the total effect of reduced logging in one county will not be limited to that county. If recreation jobs rise in one county, then that would appear to have a damping effect on employment in adjacent counties. Further, a decline in forestry jobs also has a depressing effect on surrounding counties. Thus, these effects would seem to magnify the losses.

Summary and Conclusions

This research has demonstrated the feasibility of conducting economic analysis with the resource data base constructed under the Southern Appalachian Assessment project. Similar assessments are underway or are being planned in other regions by the Forest Service. These sorts of multi-disciplinary efforts can produce data that allow the kind of analysis explored here. As agencies become better at understanding the range of effects of managing ecosystems, these sorts of analyses will become more necessary.

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Table 1. Definitions and summary statistics for ecosystem and economic characteristics for 81 counties in the Southern Appalachian Assessment area.

Variable	Definition	Mean	Std.Dev
Population	Total population (1000's) in county	35.01	30.78
Income	Per capita income	10827	1597
Interstate Highway	1= county has an interstate highway. 0= otherwise	0.41	0.49
Large Game	Aggregate population ranking of deer, turkey and bear, 0=lowest 9=highest.	4.69	1.13
Special Areas	1= county hosts a NPS site, Appalachian Trail, Indian Reservation, etc., =0 otherwise	0.56	0.49
Camping Sites	Number of public and private camping sites	243.75	411.24
Wild Trout Streams	Kilometers of wild trout streams	515.4	413.5
Logging Activity	MFC harvested per 1,000 acres, pulp & saw logs	11.25	7.77
Burned Forest	Prop. of NFS land burned since 1991	0.0013	0.0020
Public Land	Total acreage (1000's) of land publicly owned	59.59	51.14
Mining Activity	Number of active and inactive mines.	66.18	70.07
Recreation	Number of jobs in recreation-related businesses.	2520	2803
Visitor Days	Number of RVDs on Forest Service land.	206,777	232,542

Table 2. Regression Results for predicting export employment as a function of ecosystem characteristics.

Variable	Recreation		Forestry	
	Beta	Std.Err.	Beta	Std.Err.
Population (1000's)	33.350	2.813*	12.555	6.172*
Large Game	85.474	78.392	-252.012	179.850
Camping Sites	0.759	0.183*	-0.506	0.405
Wild Trout Streams (km)	0.989	0.266*	-0.104	0.568
Logging Activity	-13.337	10.018	37.093	22.234*
Burned Forest (%)	41.372	39.240	-44.667	86.272
Public Land (1000 ac)	-6.192	2.111*	4.388	4.558
Mines (Number)	0.396	1.128	-3.665	2.468
Export jobs in adjacent counties in the sector	-0.197	0.120	0.780	0.228*
Intercept	-1027.6	558.628	755.638	1148.036
R^2	0.754		0.344	

Note: N=81 counties in SAA region.
* indicates rejecting the one-tailed hypothesis at the 0.10 significance level.