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MODELING ECOLOGICAL CONSTRAINTS ON TROPICAL FOREST MANAGEMENT: COMMENT

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ABSTRACT

We comment on four aspects of Albers' [1] model of ecological constraints on tropical forest management. Albers structures her model in a highly *asymmetric* manner, with strong, uniform biases against development and in favor of preservation. Despite Albers' repeated claims that her model is "complete" and that it has significant implications for tropical forest management, we contend instead that the results of a truly general, empirically defensible model are inherently ambiguous. Spatial and intertemporal dimensions clearly matter, but they do not point as neatly in favor of preservation as Albers would have us believe.

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Seniority of authorship is shared equally.

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I. Introduction

We offer this comment on Albers' [1] recent contribution to tropical forest management in order to emphasize the complexity of the subject and to qualify the usefulness of her method. Albers [1] presents a model in the spirit of the Arrow-Fisher-Henry[1] models of land development under temporal uncertainty in the presence of potential irreversibilities. To this basic two-period construct, Albers adds (i) a third time period, and (ii) a notion of spatial interdependence. She then explores the implications of these additions for the general question of tropical forest management. Her basic point is that a forest manager who is flexible (i.e., one who recognizes the possibility of acquiring information about the future benefits of forest preservation) *and* spatial (i.e, one who recognizes the interactions between alternate land uses on adjacent forest lands) will choose to manage a forest quite differently than will a “traditional” forest manager. We applaud Albers for pressing for a more integrated approach to tropical forest management which explicitly incorporates spatial and intertemporal aspects. This notwithstanding, our central concern is that although she depicts her model as “a ‘complete’ model of the ecological characteristics of tropical forests and their impact on the benefits from land use patterns” [1, p. 79], in fact, her model is quite heavily structured, and in a biased way that casts doubt on (i) the usefulness of her findings as rules of thumb, and (ii) her method as an appropriate analytical tool for tropical forest managers.

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[1] See Arrow and Fisher [3], and Henry [6].

In what follows, we divide our concerns into five broad areas. First, we focus on the essentials of the Albers model. Next, we turn to four issues that are central to her paper: spatial interdependence, irreversibilities, uncertainty, and the nature of choice. We conclude by summarizing our concerns.

II. Tropical Forest Management: Five Key Issues

IIa. Model Essentials

Albers' model has four plots, three time periods, and four potential land uses: development (D), management (M), recuperation (R), and preservation (P). All plots begin with land in P. This model has four key features. First, there are positive returns to particular spatial configurations involving P and negative returns to D over space and time. Second, D is irreversible, M can be converted directly to D or to P with an intervening period in R, but P is perfectly flexible. Third, the benefits to D, M and R are certain, but the benefits to P in future periods are stochastic, with information accruing exogenously. Fourth, the forest manager makes "all or nothing" choices over exogenously defined land parcels.

The problem of modeling tropical forest management is necessarily complex, and Albers wisely imposes some structure to maintain tractability. However, she structures her model in a highly *asymmetric* manner, with strong, uniform biases against development and in favor of preservation. She then claims repeatedly that her model is "complete," and that it has significant implications for tropical forest management. We disagree and argue instead that the results of a truly general, empirically defensible model are inherently ambiguous. Spatial and intertemporal dimensions clearly matter, but they do not point as neatly in favor of preservation as Albers would have us believe.

IIb. Spatial Interdependence

Perhaps the most innovative part of Albers' paper lies in the fact that she explicitly models the dependence of optimal forest management on activities on neighboring land. This dependence can arise due to minimum necessary habitat size, edge effects, or both. In Albers' model, contiguous plots in P add nonnegative "P-annex" value to forest preservation due to the assumed existence of "nonlinear benefits" from the preservation of large areas. Of course, it is quite possible that if the exogenous plot sizes are sufficiently large, the P-annex value may instead be negative.

More curiously, Albers' model admits P-annex values only for preserved land. Consider the case of land in one kind of D, i.e., agriculture. There are substantial sunk costs to rural infrastructure provision (e.g., feeder roads, electrification), which often require a minimum density of marketable produce or consumer purchasing power to make investment cost-effective. In this case, contiguous D (agricultural) plots can generate precisely the sort of P-annex value Albers describes for land in P, albeit for entirely different reasons. A burgeoning literature on "agglomeration" economies emphasizes such effects' importance to economic development [7,9].

Not only does Albers ignore the potentially positive P-annex value of development, but instead she assumes that the value of land in D declines over time. Clearly, the appropriateness of this undefended assumption fundamentally depends on the type of development pursued and the plot sizes involved. Moreover, Albers' own sensitivity analysis reveals that once the assumed period-on-period decline in returns to D is dampened from -50%, her benchmark, to -27%, still an unrealistically high value, it becomes socially optimal to develop all land [1, Figure 4]. Apparently, Albers' results turn on the outlandish magnitude of an unjustified assumption of intertemporally declining returns to D.

The second way in which spatial interdependence enters the model is through a nonnegative site-specific externality, S, associated with the borders between managed and preserved land. It is unclear why S must be nonnegative, or, for that matter, why S associated with the borders between developed and preserved land must be zero. Surely adverse relationships such as wildlife damage to crops and livestock, or the accommodation of pathogens in tropical forests proximate to human settlements are as possible as favorable interactions. Particularly baffling is the implicit value of zero assigned to S associated with the borders of developed and preserved land, despite the fact that her own study [2] found a positive value for S in this situation.

Finally, Albers' prose demonstrates confusion about option value in general, and the AFH notion of option value—also called quasi-option value (QOV)—in particular. She makes several strong, but unfortunately false, statements like "[t]his intertemporal approach, therefore, encourages preservation and other flexible land uses that traditional approaches undervalue" (p. 78). An intertemporal approach, in itself, does not encourage preservation; after all, the traditional methods Albers assails are also intertemporal. Rather, preservation is encouraged when a forest manager uses a closed loop control rule as opposed to an open loop control rule. Moreover, QOV is the value of perfect information conditional on there being no initial development [5]. It has nothing to do with externalities emanating from factors associated with spatial interdependence, despite Albers repeated references to the QOV generated by the spatial terms in her model.

IIc. Irreversibility

In Albers' model, development represents an irreversible kind of land use. However, is development really irreversible? While certain kinds of development activities may indeed be irreversible, in many other instances, development followed by afforestation is a realistic option. However, Albers would have us believe that any kind of land use beyond shifting cultivation or "careful, selective logging" constitutes irreversible development. As a result, sedentarized agriculture, ranching, plantation forestry and any sort of nonagricultural pursuit "prohibits the land from functioning as part of an ecosystem and represents an intense and irreversible land use" [1, p. 75]. Although development is irreversible in Albers' three period "complete" model, this is clearly not true over more socially relevant periods of decades, much less centuries. Many projects are reversible and one really needs to look at the gains from eliminating irreversibility constraints through active, albeit costly restoration [10]. Furthermore, in models with many periods the timing of land development is as much an issue as is the question of whether or not to develop [4, 10]. While these insights are obscured in Albers' paper, the same cannot be said about the effects of her irreversibility constraint on development. This constraint, imposed *only* on land in D, biases land use against development.

A further bias arises from the land manager' assumed ability to freely move from P to either M or D, while the reverse move from M to P can only be made via one period in R. Given that it typically takes time to put infrastructure in place to support either D or M, it seems there should be analogous delays in moving from P to D, if not to M. The gains from economic activity—of the D or M kinds—cannot be reaped instantaneously, as implied by this aspect of Albers' model structure. Once again, the model's asymmetric structure, not the underlying theory, favors preservation over other kinds of land use.

IId. Uncertainty

Albers imposes zero option value for D and M by assuming away the stochasticity of their returns and by ignoring that valuable information can accrue endogenously. In Albers' model, only the benefits from P are stochastic; the benefits from M or D are certain. This obvious asymmetry is never explained; when (if ever) does one know the future benefit stream from development or intermediate management land uses? Since stochastic returns are necessary (but not sufficient) for positive QOV, Albers imposes her finding of superior QOV from preserved land.

Moreover, if one moves beyond the AFH assumption of exogenous information accrual, land in D or M might yield option value even if returns to such uses are certain. Miller and Ladd [8] demonstrated that a land manager can generate useful information about the relative returns to alternative land uses by developing initially. Alternately put, by not developing, the same land manager *loses* the opportunity to obtain information endogenously about the (uncertain) value of development. The manner in which Albers models information accural and the stochasticity of returns to alternative land uses again skew results against development and substantially diminish the practical significance of her model.

Iie. The Nature of Choice

Albers posits a discrete choice over land use on exogenously defined plots. In most circumstances, forest managers exercise choice over both the size and the use of public lands, i.e., they face a continuous choice over how much land to place in each type of use. This continuous choice leads to the possibility of negative AFH quasi-option values for preserved land [5]. Moreover, if the forest manager's choice is continuous, a discrete choice model will generate socially suboptimal solutions with probability one, since optimal plot sizes almost surely change in response to exogenous shocks [10]. This too calls into question the usefulness of Albers' tropical forest management model.

III. CONCLUSIONS

“The complete model, by combining the spatial and intertemporal dimensions of tropical ecology, leads to more preservation or more use of reversible options than do other approaches” [1, p. 87]. Such statements notwithstanding, one cannot establish whether the advantages Albers claims for forest preservation policies are indeed attributable to her laudable extension of the traditional two period AFH construct, or to the extreme modeling strategies she employs and their uniform bias against development options. There is no question that she exaggerates the returns to forest preservation. Spatial interdependence and temporal uncertainty in the presence of irreversibilities certainly affect optimal forest management policies, but they do so in an analytically ambiguous manner.

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