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Dynamic model of Sustainable Tourism

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1. Introduction

Over the past few decades, a considerable of studies have been conducted on economic sustainability and its relationship with natural resources. In recent years, it has been recognized by tourism economists that tourism is constrained by the natural resources in the area, so-called common pool resources (CPRs). Although the issue is characterized by the optimal intertemporal use of the resources, very few attempts have been made at dynamic approach. In this paper, we shall characterize a optimal tourism model and then analyze the local stability property of a nonlinear optimal control problem.

2. The Model

The concept of "Sustainable Tourism" (hence-forth, ST) has been introduced in the line of the debate about environmental sustainability. But, in fact, the term used by the tourist industry has involved a definition of tourism business profitability. To formulate the idea, we consider the following problem:

$$\max W = \int_0^\infty [\pi(R) + \alpha E(N) + \beta V(B)] e^{-\delta t} dt \qquad (1)$$

subject to

$$\dot{N}(t) = g(1 - B - N)N - R \qquad (2)$$

$$N(0) = N_0$$

$$B(0) = B_0$$

where variables are

$N(t)$; stock of CPRs (state variable),

$R(t)$; CPRs as input (control variable), and

$B(t)$; subtractive factors (control variable).

The objective of the social planner is to maximize the social welfare, which consists of tourism revenue, $\pi(R)$, benefits from natural environment $E(N)$ and subtractive factors, $V(B)$. In this connection, it is assumed that all benefits are subject to the law of diminishing return.

As far as (2) is concerned, change of natural environmental stock is determined by net regeneration capability, where g (parameter) is a intrinsic rate of reproduction.

3. Results

The current value Hamiltonian of the optimal control problem is:

$$H = \pi(R) + \alpha E(N) + \beta V(B) + \lambda[g(1 - B - N)N - R].$$

The necessary optimality conditions are

$$\frac{\partial H}{\partial R} = \pi'(R) - \lambda = 0$$

$$\frac{\partial H}{\partial B} = \beta V'(B) - \lambda g N = 0$$

$$\dot{\lambda} = -\frac{\partial H}{\partial N} + \delta\lambda = -\alpha E' + [\delta - g(1 - B - 2N)]\lambda \ .$$

These equations reduced to

$$\begin{aligned} 0 &= \beta V'(B) - \pi'(R) g N \\ \dot{R} &= \frac{1}{\pi''(R)}\{-\alpha E'(N) + [\delta - g(1 - B - 2N)]\pi'(R)\} \ . \\ \dot{N} &= g(1 - B - N)N - R \end{aligned}$$

For the simplicity, we assume that

$B = B(R, N)$,

$$\frac{\partial B}{\partial R} \equiv B_R = \frac{\pi'' g N}{\beta V''} > 0, \ \frac{\partial B}{\partial N} \equiv B_N = \frac{\pi' g}{\beta V''} < 0 \cdot$$

The Jacobian matrix of system at the steady state is

$$J = \begin{bmatrix} \frac{1}{\pi''}\{(\delta - g(1 - B - 2N))\pi'' + g B_R \pi'\} & \frac{1}{\pi''}\{-\alpha E'' + g(B_N + 2)\pi'\} \\ -g B_R N - 1 & g(1 - B - (B_N + 2)N) \end{bmatrix}.$$

Hence, the determinant of J can be calculated:

$$\det J = \frac{1}{\pi''}[(\delta - g(1 - B - 2N))\pi'' g(1 - B - (2 + B_N)N)$$
$$+ g^2 B_R \pi'(1 - B) - \alpha E''(g B_R N + 1) + (2 + B_N) g \pi'].$$

For a negative determinant, (i.e. the system has a saddlepoint), we assume that

$$B > 1 - (2 + B_N)N$$

$$B_N > -2 \ .$$

These sufficient conditions are almost satisfied when B_N close to zero.

4. Concluding Remarks

This paper investigated a dynamic model of Sustainable Tourism. However, we limited the discussion to the supply factor of tourism service sector. A further direction of this study will be to analyze the demand side for tourism.

References

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