The Coupling Mechanism Industry System of Ecological Agriculture and Ecological Tourism Based on The Constraints of Resources and Environment

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Abstract

Coupling development of ecological agriculture and ecological tourism based on the constraints of resources and environment is the upgrade and transformation for the traditional development pattern of agriculture and tourism in our country. Ecological agriculture improves agricultural productivity level, original ecological level of agricultural product and the income level of farmers. Ecological tourism advocates to abandon consuming resources disorderly and immoderately in traditional tourism, and to proceed tourism development under the constraints of tourism carrying capacity, thus to improve the high taste, environment protection and economical benefits. Establishing an industry system based on coupling development of ecological tourism and ecological agriculture, this paper realized the maximum of social benefit of industry system with this industry system, and the optimization of dynamic industry resources allocation under the constraints of resources and environmental carrying capacity. It also described the influence of different types of resources (eg. renewable and non-renewable resources, original resources and secondary resources), pollution (eg. different rate of decay and different environmental capacity) as well as parameters change such as technology progress, size change, structure change on industry growth pathway on the economical growth of coupling industry system. This study provides suggestions and helps for government to formulate development planning and macro policy of coupling industry system.

Keywords: Constraints of resources and environment, Ecological agriculture, Ecological tourism, Coupling industry system, Benefit maximum

1 Introduction

The waste and draining of resource, the damage and deterioration of environment, has made the problems of resources and environment become the biggest confusion in the process of China's economic and social development [1-2]. The coupling industrial upgrading of ecological agriculture and ecological tourism based on resources and environment constraint is an important breakthrough of addressing our country's current resources and environment constraints. Ecological agriculture is to enhance the level of agricultural productivity, ecological level of agricultural products and the income level of farmers' mainly through the approach of agriculture mechanization, large-scale of land, technology innovation and technology intensification [3]. While ecological tourism advocates abandoning the disordered and unrestrained resources consumption of traditional tourism, promoting tourism development under the constraints of tourism carrying capacity, so as to promote the high taste, environmental protection and economic benefits of tourism product [4]. At present, most of the research is to separate the two industry for making independent research [5-10]. So far, though ecological tourism and ecological agriculture has achieved fruitful results in separate areas, but it still lacks the coupling mechanism research of two industries, especially the research about optimal utilization problem of resources in industrial coupling system is much rarer [11-13].

This article is to analyze the optimal approach of industrial development and optimal configuration of elements based on dual constraints of resource and environment through using dynamic optimal control theory and constructing the coupling industry system model of open ecological agriculture and ecological tourism, thus provide reference basis for national industrial structure adjustment and economic growth mode transformation and building a new socialist countryside.

2 Coupling Development Model of Open Industrial System

2.1 COUPLING INDUSTRY SYSTEM STRUCTURE OF AGRICULTURE AND TOURISM

According to different classification basis, the structure of coupling industry system including agriculture and tourism can be divided into two categories, one is the system structure based on industrial functions, the second is the system structure based on constraint subsystem.

The system structure based on industrial functions is shown in Figure

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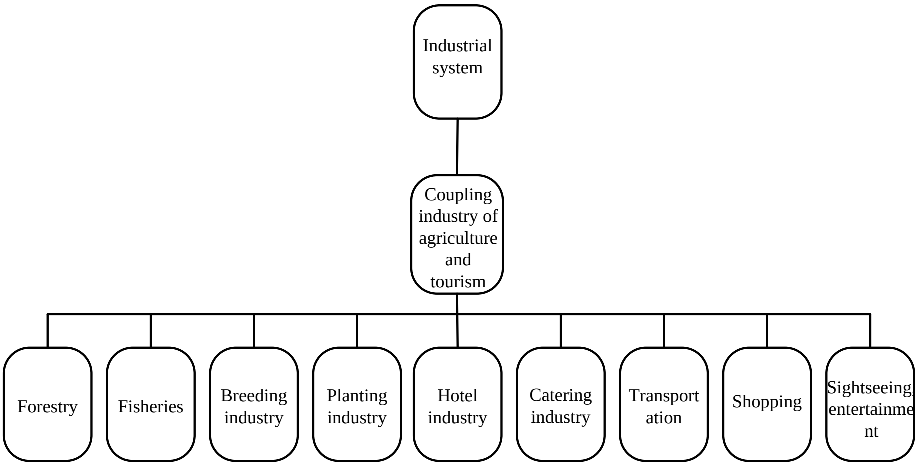


FIGURE 1: Systemic structure of wireless sensor network node

The system structure based on constraint subsystem is shown in Figure 2.

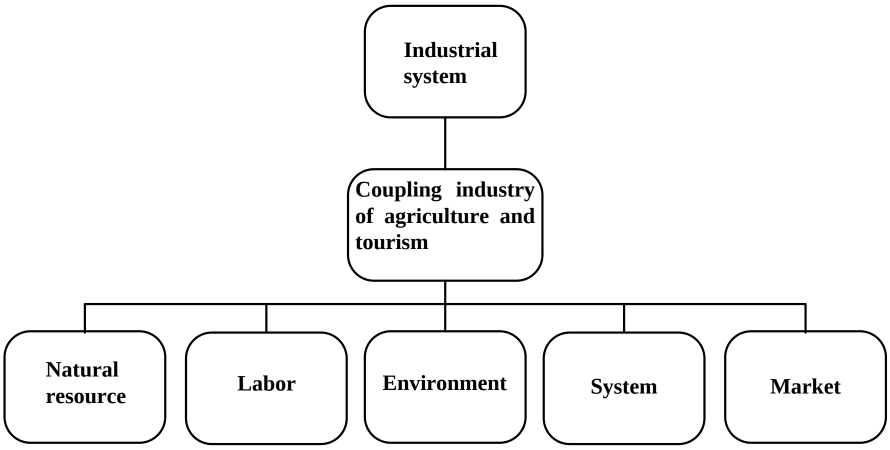
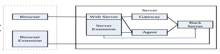


FIGURE 2: Communication mode of wireless sensor

2.1.1 Basic Relationship

Look from systematic perspective, industry refers to the collection composed of natural resources subsystem, population subsystem, market subsystem, environment subsystem (mainly including monitoring, calculation, analysis, forecast and control of pollutant), the government regulation, institution sub-system and many sub-systems. You can indicate it through using mathematical expression in type (1):

Industrial system=  (1)

Where X_i represents the different sub-system in industrial system, such as that X_1 represents sub-system of natural resource, X_2 represents population sub-system, X_3 represents market sub-system, X_4 represents environment sub-system (it mainly includes the monitoring, calculation, analysis, forecasting and control of pollutants), X_5 represents government monitoring, interest allocation and institution sub-system.

In open system, the relationship among different industries could be divided into three kinds including mutual competition, mutual complementation and uncorrelation.

2.1.2 Uncorrelation

The development of an industry does not affect the other industries; the correlation coefficient between the two industries is zero. In this case, industry could be regarded as a closed industry system, there is no matter, energy and information communication among them, the mutual influence coefficient is 0, this paper does not makes key analysis for this type.

2.1.3 Mutual Supplement Relationship

If an industry can promote the development of other industries, thus the relationship between the two industries is complementary, such as promoting tourism with agriculture or feeding agriculture with tourism.

2.1.4 Competition Relationship

The development of an industry will reduce or take up resources of another industry, thus causes the conflict of benefit allocation and regulation, weakens each other's development, such as the conflicts of tax revenue redistribution between agriculture and tourism, regional planning conflict between agriculture and tourism, regulation conflict or conspiring phenomenon based on the constraints of the environment.

In open system, the relationship among different industries is:

$$\frac{dX_A}{dt} = a_A X_A (N_A + c_{AB} N_B - X_A) \quad (2)$$

$$\frac{dX_B}{dt} = a_B X_B (N_B + c_{BA} N_A - X_B) \quad (3)$$

Where, a_A represents the developing speed of industry X_A; N_A represents the threshold of constraint variables such as natural resources, population, pollution levels and so on in industry X_A or the largest potential market; a_B represents the developing speed of industry X_B; N_B represents the threshold of constraint variables such as natural resources, population, pollution levels and so on in industry X_B or the largest potential market; c_{AB} represents the influence coefficient of industry X_B on industry X_A; c_{BA} represents the influence coefficient of industry X_A on industry X_B.

The Optimal Use of Resources in Coupled Systems of Open Industry

3.1 OPTIMAL ALLOCATION OF NON-RENEWABLE RESOURCES

3.1.1 The Optimal Consumption of Non-Renewable Resources

Suppose the time interval to be of unlimited time sequence, the following social welfare function of ordinal utility type will be obtained:

$$W = \int_{t=0}^{t=\infty} U(C_t) e^{-\rho t} dt \quad (4)$$

Consider the renewable property of resource, resources reserve is fixed and limited initial stock. Suppose the initial resources preserve is S_0, the rate of exploiting and using resource is R_t at time t, there is following constraint condition:

$$S_t = S_0 - \int_{\tau=0}^{\tau=t} R_\tau dt \quad (5)$$

Could be transformed to be differential form:

$$\frac{dS}{dt} = -R_t$$

Which indicates consumption rate of resources stock $-\frac{dS}{dt}$ equals the rate of exploiting and using resource R_t.

As the output is distributed between consumer goods and capital, the part which is not consumed in economic output would cause the change of capital stock. Thus, in continuous time series, it is expressed as:

$$\frac{dK}{dt} = Q_t - C_t.$$

But according to C-D function: $Q_t = Q(K_t, R_t)$, thus, $\frac{dK}{dt} = Q(K_t, R_t) - C_t$

To sum up, objective function:

$$s.t. \frac{dS}{dt} = -R_t$$
$$\frac{dK}{dt} = Q(K_t, R_t) - C_t \quad (6)$$

The present value of Hamilton function in model is:

$$H_t = U(C_t) + P_t(-R_t) + \omega_t (Q\{K_t, R_t\} - C_t) \quad (7)$$

Solution:

$$U(C_t) = \omega_t, P_t = \omega_t Q_{Rt}, \frac{dP}{dt} = \rho P_t, \frac{d\omega}{dt} = \rho\omega_t - Q_{Kt}\omega_t \quad (8)$$

Where, $Q_{Kt} = \frac{\partial Q}{\partial K}$ represents the partial differential of output on capital at t time; $Q_{Rt} = \frac{\partial Q}{\partial R}$ represents the partial differential of output on non-renewable resources at t time; P_t represents the shadow price of non-renewable resources; ω_t represents the shadow price of capital, both of them are function about time.

$U(C_t) = \omega_t$ represents the marginal utility of consumption at any time equals to the shadow price of capital, an optimal result should be that the marginal income which the output of a unit used in consumption equals to the marginal income which increases capital stock.

$P_t = \omega_t Q_{Rt}$ represents that the shadow price of capital stock at t time equals to the marginal product value of non-renewable resources . $\frac{dP}{dt} = \rho P_t$ and $\frac{d\omega}{dt} = \rho\omega_t - Q_{Kt}\omega_t$ represents that the resource and capital could get equal rate of pay at any time and point, and it is equal to the discount rate.

3.1.2 The Optimal Consumption of Non-Renewable Resources in Coupled System.

Then we consider the optimum utilization problem of non-renewable resources in coupled system of agriculture and tourism:

Objective function:

$$MaxW = \int_{t=0}^{t=\infty} \left(\frac{B_A}{L_A} + \frac{B_B}{L_B} \right) e^{-\rho t} dt \quad (9)$$

Where B_A, B_B represents the total revenue of employee in agriculture and tourism depending on the land resources to make a living respectively, L_A, L_B represents the quantity of employee in agriculture and tourism depending on the land resources to make a living respectively, $\frac{B_A}{L_A}$, $\frac{B_B}{L_B}$ indicate the concept of per capita.

Define following several variables:

$L_A = \frac{L}{2}\left(1 + e^{-1/d} - e^{-d}\right)$, d represents the competitive advantage of agriculture relative to tourist industry, suppose it equals to the competitive disadvantage of tourism relative to agriculture. When $d \to 0$, resource inclines towards tourism; when $d \to \infty$, resource inclines towards agriculture. That is to say, the smaller the value of d is, the smaller the utility of agriculture (expressed in per capita income) than that of agriculture will be.

Order $d = \alpha \frac{B_A}{B_B}$, suppose $\alpha = 1$, define $r = e^{-d} - e^{-1/d}$, $d \in (0, \infty)$, $r \in (-1,1)$

Then $L_A = L\frac{1-r}{2}, L_B = L\frac{1+r}{2}$ (10)

So, objective function could be transformed into:

$$MaxW = \int_{t=0}^{t=\infty} \frac{2}{L}\left(\frac{B_B}{1+r} + \frac{B_A}{1-r} \right) e^{-\rho t} dt$$

Constraint condition:

$$s.t. \frac{dS}{dt} = -R_t$$
$$\frac{dK}{dt} = Q(K_t, R_t) - \frac{2}{L}\left(\frac{B_B}{1+r} + \frac{B_A}{1-r} \right) \quad (11)$$

The present value of Hamilton function in model is:

$$H_t = \frac{2}{L}\left(\frac{B_B}{1+r} + \frac{B_A}{1-r} \right) + P_t(-R_t) + \omega_t \left(Q\{K_t, R_t\} - \frac{2}{L}\left(\frac{B_B}{1+r} + \frac{B_A}{1-r} \right) \right) \quad (12)$$

Get following through solution:

$$\frac{2}{L}\left(\frac{B_B}{1+r} + \frac{B_A}{1-r} \right) = \omega_t, P_t = \omega_t Q_{Rt}, \frac{dP}{dt} = \rho P_t, \frac{d\omega}{dt} = \rho\omega_t - Q_{Kt}\omega_t \quad (13)$$

$\frac{2}{L}\left(\frac{B_B}{1+r} + \frac{B_A}{1-r} \right) = \omega_t$ and $P_t = \omega_t Q_{Rt}$ is the static efficiency condition about efficient allocation of land resources .Where:

$\frac{2}{L}\left(\frac{B_B}{1+r} + \frac{B_A}{1-r} \right)$ represents that the marginal utility of agriculture and tourism based on resource consumption at any time equals to the shadow price of capital, an optimal result should be that the marginal income of both industrial unit output used in consumption equals to the marginal income which is used to increase capital stock.

$P_t = \omega_t Q_{Rt}$ represents the shadow price of resource stock at time t equals to the marginal product value of non-renewable resources.

$\frac{dP}{dt} = \rho P_t$ and $\frac{d\omega}{dt} = \rho\omega_t - Q_{Kt}\omega_t$ is the dynamic efficiency condition about effective allocation of land resources, which represents that resource and capital could get equal rate of pay at any time and point, and it equals to discount rate.

3.1.3 The Competitive Consumption and Cooperative Consumption of Non-Renewable Resources in Coupled System.

Then it considers the problem of competitive consumption and cooperative consumption of non-renewable resources under the coupled system of agriculture and tourism:

①Multi-period model of non-renewable resource consumption

Consider objective function:

$$MaxW = \int_{t=0}^{t=\infty} U(C_t) e^{-\rho t} dt$$

Constraint condition:

$$s.t. \frac{dS}{dt} = -R_t \quad (14)$$

With further deformation, it considers that non-renewable resources select its mining approach R_t within time t =0 and t = T, get:

Objective function:

$$MaxW = \int_{t=0}^{t=\infty} U(R_t) e^{-\rho t} dt$$

Constraint condition:

$$s.t. \frac{dS}{dt} = -R_t \quad 15)$$

As the constant improving of marginal discount, social welfare will rise continuously, so only the discount of marginal benefit is equal at any time, social welfare will be maximum. Suppose $U(R)=\int_0^R (R)dR$, then $\frac{\partial U_t}{\partial R_t}=P(R)_t$, that is to say, marginal benefit of non-renewable resources equals to the net price of non-renewable resources.

Then $P_t e^{-\rho t}=P_0$, in other words, $P_t=P_0 e^{\rho t}$.

Further assume that the demand function of non-renewable resources is nonlinear function:

$$P(R)=Ke^{-aR} \Rightarrow K=Pe^{aR} \quad (16)$$

When R =0, P = K. So the K in function represents that when such kind of non-renewable resources consume away, or when the price of such non-renewable resources is K, the society will use other alternative resources to replace such kind of non-renewable resources.

From $P_t=P_0 e^{\rho t}$ and $P(R)=Ke^{-aR}$, we could obtain

$$P_0 e^{\rho t}=Ke^{-aR} \quad (17)$$

Hamilton function of present value in above model is:

$$H=U(R_t)+P_t(-R_t) \quad (18)$$

Through solution: we get $\frac{dP}{dt}=\rho P_t, -\frac{dP}{dt}+\frac{dU}{dR}=0$ (19)

Through using optimal control theory of maximizing principle, the resource stock at time T is 0, at this moment, $P_t=K$, then $K=P_0 e^{\rho T}$, combining with $P_0 e^{\rho t}=Ke^{-aR}$, we get:

$$P_0 e^{\rho t}=P_0 e^{\rho T-aR} \Rightarrow R(t)=\frac{\rho}{a}(T-t) \quad (20)$$

As $S=\int_0^T R(t)dt$

$$\Rightarrow S=\int_0^T \frac{\rho}{a}(T-t)dt$$

$$\Rightarrow T=\left(\frac{2aS}{\rho}\right)^{1/2}$$

$$\Rightarrow P_0=Ke^{-(2\rho S)^{1/2}}$$

$$\Rightarrow P_t=\mathrm{Re}^{\rho(t-T)}$$

$$\Rightarrow R_0=\frac{\rho}{a}(T-0)=\left(\frac{2\rho S}{a}\right)^{1/2}, R_T=0, R_t=\frac{\rho}{a}(T-t) \quad (21)$$

②Competitive cost model of non-renewable resources under coupled system of agriculture and tourism.

Under coupled system, suppose both agriculture and tourism have a representative enterprise competing for non-renewable resources in market. Their consumption of resource is R_A, R_B respectively. Industry profits are $\pi_A=P\times R_A$ and $\pi_B=P\times R_B$ respectively, market interest rate is I, and as these two industries are in competing situation, it considers market price P to be exogenous and fixed.

Constructing objective function:

$$Max \quad \pi=\int_0^T (\pi_{At}+\pi_{Bt})e^{-it}dt$$

Constraint condition:

$$s.t. \quad S=\int_0^T (R_{At}+R_{Bt})dt$$
$$P(R)=Ke^{-aR} \quad (22)$$

If the exploiting rate of non-renewable resources is not equal to the obtained discount marginal profit in these two industries, so the increase of total profits could be increased by adjusting the exploiting rate. Therefore, maximization principle can be used to conclude:

$$\frac{\partial \pi_{At}}{\partial R_{At}}e^{-it}=P_0 \Rightarrow P_t e^{-it}=P_0 \quad (23)$$

The solution of above Hamilton function of present value in above model is: $T=\left(\frac{2aS}{i}\right)^{1/2}$

$$\Rightarrow P_0=Ke^{-(2iaS)^{1/2}}$$

$$\Rightarrow P_t=\mathrm{Re}^{i(t-T)}=P_0 e^{it}$$

$$\Rightarrow R_0=R_{A,0}+R_{B,0}=\frac{i}{a}(T-0)=\left(\frac{2iS}{a}\right)^{1/2}, R_T=R_{A,T}+R_{B,T}=0$$

$$R_t=R_{A,t}+R_{B,t}=\frac{i}{a}(T-t) \quad (24)$$

③The collaborative consumption model of nonrenewable resources under coupling system of agriculture and tourism.

Under the relations of cooperation, the two industry has performed unified management to the consumption of non-renewable resources by means of coupling method. As a result, the market price P is no longer exogenous, but the production of big industrial system after relying on coupling system. Assume that agriculture and tourism jointly set up a representative enterprise, and the consumption of non-renewable resources in the market cooperatively. Its consumption of resource is R_{AB}. Total profit is $\pi_{AB}=P_{AB}\times P_{AB}$, market interest rate is i .

Constructing objective function:

$$Max \qquad \pi = \int_0^T \pi_{AB} e^{-it} dt$$

Constraint condition:

$$s.t. \qquad S = \int_0^T R_{AB} dt$$
$$P(R) = Ke^{-aR} \tag{25}$$

The following could be obtained through maximization principle:

$$\frac{\partial \pi_{AB,t}}{\partial R_{AB,t}} = \frac{\partial P_t}{\partial R_t} R_t + P(R) = K(1-aR_t)e^{-aR_t} = Ke^{\ln(1-aR_t)}e^{-aR_t} = Ke^{\ln(1-aR_t)-aR_t} \tag{26}$$

$$\because R_t \in (R,0)$$
$$\therefore \ln(1-aR_t) \approx -aR_t$$
$$\Rightarrow \frac{\partial \pi_{AB,t}}{\partial R_{AB,t}} \approx Ke^{-2aR_t} \tag{27}$$

$$\Rightarrow P_t^{'} = \mathrm{Re}^{i(t-T)/2} = P_0 e^{it/2}$$

$$\Rightarrow R_0^{'} = R_{AB,0} = \frac{i}{2a}(T-0) = \left(\frac{iS}{a}\right)^{1/2}, R_T^{'} = R_{AB,T} = 0, R_{AB,t} = \frac{i}{2a}(T-t) \tag{28}$$

In the same way, the solution of above Hamilton function of present value in above model is:

$$T = \left(\frac{4aS}{i}\right)^{1/2} \quad \Rightarrow P_0^{'} = Ke^{-(iaS)^{1/2}}$$

In order to distinguish it from competitive industries, superscript" ' " is used to represent the consumption of cooperative industry to non-renewable resources. It is not difficult to find that:

$T < T^{'}, P_0 < P_0^{'}, P_t > P_t^{'}, R_0 > R_0^{'}, R_T = R_T^{'}, R_t > R_t^{'}$.

Through summing up above points, we find that for the big system after coupling two industries of agricultural and tourism, mutual cooperation is more sustainable than non-renewable resources in development and consumption of non-renewable resources. Coupling cooperative industry is to extend the exploiting and consumption time of non-renewable resources based on the price control on the products produced by non-renewable resources, therefore, it has delayed the consumption of non-renewable resources to a certain extent.

3.1.4 The Optimal Configuration of Renewable Resources

In the consumption of some resources in the coupled systems of agriculture and tourism, some resource belongs to the renewable resources, such as forestry, fisheries resources and so on. For simplicity, under the coupling system, only one or two renewable resource consumption is considered. When inspecting the coupling industry of ecological tourism and ecological agriculture, due to the typical property of ecological fishery sightseeing tourism, therefore, the following mainly takes fishery resources as example. Other situation can be done in the same manner. In addition to the above considered constraints of the resources and labor to the development of industry system, this section also increasingly considers the impact of environmental pressure on the sustainable development of multiple industry system.

3.1.5 The Optimal Use of Renewable Resources in Closed System

Build ecological agriculture system model in the type of fishery resource consumption as following:

Objective function:

$$MaxW = \int_{t=0}^{t=\infty} \left\{ \frac{B_A(g_t)}{L_A} - C_A(g_t, S_t) \right\} e^{-\rho t} dt$$

Constraint condition:

$$s.t. \frac{dS}{dt} = G(S_t) - g_t$$

$$\frac{dK}{dt} = Q(K_t, g_t) - \frac{B_A(g_t)}{L_{At}} - C_A(g_t, S_t) \tag{29}$$

Where B_A represents the total profit of agricultural employee depending on fishery resources for living. L_A represents the quantity of agricultural employee depending on fishery resources for living, $\frac{B_A}{L_A}$ expresses the concept of per capita.

Hamilton function of present value in above model is:

$$H_t = \frac{B_A(g_t)}{L_A} - C_A(g_t, S_t) + P_t(G(S_t) - g_t) + \omega_t \left(Q\{K_t, g_t\} - \frac{B_A(g_t)}{L_{At}} - C_A(g_t, S_t) \right) \tag{30}$$

The following is obtained through solution:

$$\frac{\partial H_t}{\partial g_t}=0\Rightarrow\frac{1}{L_A}\times\frac{\partial B_A}{\partial g_t}-\frac{\partial C_A}{\partial g_t}-P_t-\omega_t\left(\frac{\partial Q}{\partial g_t}-\frac{\partial C_A}{\partial g_t}-\frac{1}{L_A}\times\frac{\partial B_A}{\partial g_t}\right)=0$$

$$\frac{dP_t}{dt}=\rho P_t-\frac{\partial G(S_t)}{\partial S_t}+\frac{\partial C_A}{\partial S_t}$$

$$\frac{d\omega_t}{dt}=\rho\omega_t-Q_{Kt}\omega_t \quad (31)$$

3.1.6 The Optimal Utilization of Renewable Resources in Open Coupling System

Through summing up above derived results, then the limited renewable resources, labor supply, the optimal utilization problem under coupling system of agriculture will be considered.

The social welfare maximization model in the coupling system of ecological agriculture and fishery tourism based on the framework of fishery resources, labor supply and environmental constraint is shown as following:

Objective function

$$MaxW=\int_{t=0}^{t=\infty}\left(\frac{B_A(g_t)}{L_{At}}+\frac{B_B(g_t)}{L_{Bt}}-\frac{C_A(g_t,S_t)}{L_{At}}-\frac{C_B(g_t,S_t)}{L_{Bt}}-\frac{E_A(g_t,J_t)}{L_{At}}-\frac{E_B(g_t,S_t)}{L_{Bt}}\right)e^{-\rho t}dt$$

Constraint condition:

$$s.t.\quad \frac{dS}{dt}=\frac{G(S_t)-g_t}{L_{At}+L_{Bt}}$$

$$\frac{dJ}{dt}=\frac{M_A(g_t)}{L_{At}}+\frac{M_B(g_t)}{L_{Bt}}-\frac{\delta_A J_{At}}{L_{At}}-\frac{\delta_B J_{Bt}}{L_{Bt}}-\frac{N(V_t)}{L_{At}+L_{Bt}}$$

$$\frac{dK}{dt}=\frac{Q_A\left(K_t,g_t,E\left(g_t,J_t\right)\right)}{L_{At}}+\frac{Q_B\left(K_t,g_t,E\left(g_t,J_t\right)\right)}{L_{Bt}}-\left[\frac{B_A\left(g_t\right)}{L_{At}}+\frac{B_B\left(g_t\right)}{L_{Bt}}\right]-\left[\frac{C_A\left(g_t,S_t\right)}{L_{At}}+\frac{C_B\left(g_t,S_t\right)}{L_{Bt}}\right]-\frac{V_t}{L_{At}+L_{Bt}} \quad (32)$$

Where B_A, B_B respectively represent the total profit of the agriculture and tourism employee depending on fishery resources for living.

Introduce variable d, let $L_A=\frac{L}{2}\left(1+e^{-1/d}-e^{-d}\right)$, d represents the competitive advantage of agriculture relative to tourism based on fishery resources consumption, assume that it equals to the competitive disadvantage of tourism relative to agriculture. When $d\rightarrow 0$, resources inclines towards the tourism based on fishery resources consumption; when $d\rightarrow\infty$, resources inclines towards the agriculture based on fishery resources. That is to say, the smaller the value of d is, the smaller the agricultural utility (expressed with per capita income) than tourism utility based on fishery resources consumption will be.

Order $d=\alpha\frac{B_A}{B_B}$, assume $\alpha=1$, define $r=e^{-d}-e^{-1/d}, d\in(0,\infty), r\in(-1,1)$

So $L_A=L\frac{1-r}{2}, L_B=L\frac{1+r}{2}, L=L_A+L_B$.

So, the objective function could be transformed to be:

$$MaxW=\int_{t=0}^{t=\infty}\left\{\frac{2}{L}\left[\frac{B_A}{1-r}+\frac{B_B}{1+r}-\frac{C_A(g_t,S_t)}{1-r}-\frac{C_B(g_t,S_t)}{1+r}-\frac{E_A(g_t,J_t)}{1-r}-\frac{E_B(g_t,S_t)}{1+r}\right]\right\}e^{-\rho t}dt$$

Constraint condition:

$$s.t.\quad \frac{dK}{dt}=\frac{2}{L}\left[\frac{Q_A\left(K_t,g_t,E\left(g_t,J_t\right)\right)}{1-r}+\frac{Q_B\left(K_t,g_t,E\left(g_t,J_t\right)\right)}{1+r}\right]-\frac{2}{L}\left[\frac{B_A\left(g_t\right)}{1-r}+\frac{B_B\left(g_t\right)}{1+r}\right]-$$

$$\frac{2}{L}\left[\frac{C_A\left(g_t,S_t\right)}{1-r}+\frac{C_b\left(g_t,S_t\right)}{1+r}\right]-\frac{V_t}{L}$$

$$\frac{dS}{dt}=\frac{G\left(S_t\right)-g_t}{L},$$

$$\frac{dJ}{dt}=\frac{2}{L}\left[\frac{M_A\left(g_t\right)}{1-r}+\frac{M_B\left(g_t\right)}{1+r}\right]-\frac{2}{L}\left[\frac{\delta_A J_{At}}{1-r}+\frac{\delta_B J_{Bt}}{1+r}\right]-\frac{N\left(V_t\right)}{L} \quad (33)$$

Hamilton function of present value in above model is:

$$H_t=\frac{2}{L}\left[\frac{B_B\left(g_t\right)}{1+r}+\frac{B_A\left(g_t\right)}{1-r}-\frac{C_A\left(g_t,S_t\right)}{1-r}-\frac{C_B\left(g_t,S_t\right)}{1+r}-\frac{E_A\left(g_t,J_t\right)}{1-r}-\frac{E_B\left(g_t,J_t\right)}{1+r}\right]+P_t\left[\frac{G\left(S_t\right)-g_t}{L}\right]$$

$$+\omega_t\left\{\frac{2}{L}\left[\frac{Q_A\left(K_t,g_t,E\left(g_t,J_t\right)\right)}{1-r}+\frac{Q_B\left(K_t,g_t,\left(g_t,J_t\right)\right)}{1+r}\right]\right.$$

$$\left.-\frac{2}{L}\left[\frac{B_A\left(g_t\right)}{1-r}+\frac{B_B\left(g_t\right)}{1+r}\right]-\frac{2}{L}\left[\frac{C_A\left(g_t,S_t\right)}{1-r}+\frac{C_B\left(g_t,S_t\right)}{1+r}\right]-\frac{V_t}{L}\right\}$$

$$+\lambda_t\left\{\frac{2}{L}\left[\frac{M_A\left(g_t\right)}{1-r}+\frac{M_B\left(g_t\right)}{1+r}\right]-\frac{2}{L}\left[\frac{\delta_A J_{At}}{1-r}+\frac{\delta_B J_{Bt}}{1+r}\right]-\frac{N\left(V_t\right)}{L}\right\} \quad (34)$$

Through solution, we obtain: $\frac{\partial H_t}{\partial g_t}=0\Rightarrow$

$$\frac{2}{L}\left(\frac{\partial B_A}{\partial g_t}\times\frac{1}{1-r}+\frac{\partial B_B}{\partial g_t}\times\frac{1}{1+r}\right)-\frac{2}{L}\left(\frac{\partial C_A}{\partial g_t}\times\frac{1}{1-r}+\frac{\partial C_B}{\partial g_t}\times\frac{1}{1+r}\right)$$

$$-\frac{2}{L}\left(\frac{\partial E_A\left(g_t,J_t\right)}{\partial g_t}\times\frac{1}{1-r}+\frac{\partial E_B\left(g_t,J_t\right)}{\partial g_t}\times\frac{1}{1+r}\right)-\frac{P_t}{L}$$

$$+\omega_t\left\{\frac{2}{L\left(1-r\right)}\times\left(\frac{\partial Q_A}{\partial g_t}+\frac{\partial Q_A}{\partial E_A}\times\frac{\partial E_A}{\partial g_t}\right)+\frac{2}{L\left(1+r\right)}\times\left(\frac{\partial Q_B}{\partial g_t}+\frac{\partial Q_B}{\partial E_B}\times\frac{\partial E_B}{\partial g_t}\right)\right.$$

$$\left.-\frac{2}{L}\left(\frac{\partial B_A}{\partial g_t}\times\frac{1}{1-r}+\frac{\partial B_B}{\partial g_t}\times\frac{1}{1-r}\right)-\frac{2}{L}\left(\frac{\partial C_A}{\partial g_t}\times\frac{1}{1-r}+\frac{\partial C_B}{\partial g_t}\times\frac{1}{1+r}\right)\right\}$$

$$+\lambda_t\left[\frac{2}{L}\left(\frac{1}{1-r}\times\frac{\partial M_A}{\partial g_t}+\frac{1}{1+r}\times\frac{\partial M_B}{\partial g_t}\right)\right]=0$$

$$\frac{\partial H_t}{\partial V_t}=0$$

$$\Rightarrow \omega_t = \lambda_t \times \frac{\partial N}{\partial V_t}$$

$$\frac{dP_t}{dt} = \rho P_t - P_t \times \frac{1}{L} \times \frac{\partial G(S_t)}{\partial S_t} + \frac{2}{L} \times \omega_t \times \left(\frac{1}{1-r} \times \frac{\partial C_A}{\partial S_t} + \frac{1}{1+r} \times \frac{\partial C_B}{\partial S_t} \right)$$

$$\frac{d\omega}{dt} = \rho \omega_t - \omega_t \times \frac{2}{L} \times \left(\frac{1}{1-r} \times \frac{\partial Q_A}{\partial K_t} + \frac{1}{1+r} \times \frac{\partial Q_B}{\partial K_t} \right)$$

$$\frac{d\lambda_t}{dt} = \rho \lambda_t + \frac{2}{L} \lambda_t \left(\frac{1}{1-r} \times \delta_A + \frac{1}{1+r} \times \delta_B \right) + \frac{2}{L} \times \left(\frac{1}{1-r} \times \frac{\partial E_A}{\partial J_t} + \frac{1}{1+r} \times \frac{\partial E_B}{\partial J_t} \right) \quad (35)$$

$$- \frac{2}{L} \times \omega_t \left(\frac{1}{1-r} \times \frac{\partial Q_A}{\partial E_A} \times \frac{\partial E_A}{\partial J_t} + \frac{1}{1+r} \times \frac{\partial Q_B}{\partial E_B} \times \frac{\partial E_B}{\partial J_t} \right)$$

3.1.7 The Explanation and Analysis for Part of the Model

P_t, ω_t, λ_t represents the shadow price of fishery resources, capital stock, environment pollution stock based on constraints of three aspects including natural resources, labor and environment respectively, which is the static condition of optimum configuration; $\frac{dP_t}{dt}, \frac{d\omega_t}{dt}, \frac{d\lambda_t}{dt}$ represents the situation of various shadow price which varies along optimal path respectively, which is the dynamic condition of optimum configuration.

4 Conclusion

Coupling process of industry system is essentially the process of self-organization. It is the process of open, nonlinear competition and nonlinear cooperative process among different industries, and it will finally realize to make the system develop towards more orderly direction. This article has proposed that the mutual relationship among industries within system could be divided into three kinds of relationship including uncorrelation, complementary and competition. Then it performs classification discussion to the optimal configuration problem of non-renewable resources and renewable resources in open coupling industry system through building mathematical model and combining with the optimal control theory, distinguishes the difference between the two development approach of non-renewable resources including competitive consumption and cooperative consumption in coupling industry system, the derivation of model indicates mutual cooperation is more sustainable than mutual competition for the exploitation and consumption of non-renewable resources. Cooperative industry coupling is to extend the exploitation and using time through price control based on the products produced by non-renewable resources, which has delayed the consumption of resources to a certain extent. Finally, based on the condition of renewable resources, labor supply and environment constraints, this paper has constructed the optimal configuration model of coupling industry system including ecological agriculture and ecological tourism, it points out the reasonable competition relationship d between ecological agriculture and ecological tourism through making analysis and deduction, which is the key to depicting and describing the impact of coupling industry system on the economic, social and environmental impact. At the same time, changing the traditional single mode of farming, and coupling with ecological tourism related to industry will promote the overall economic strength of our country, and ease surplus labor force in countryside, improve the ecological environment, promote the leap-forward development of the underdeveloped areas.

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