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SUSTAINABLE DEVELOPMENT OF CROSS-BORDER REGIONS: A METHODOLOGICAL STUDY

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ABSTRACT: The exploitation and protection of natural and environmental resources have posed a growing challenge to cross-border regions. In this paper, a methodological study in relation to the sustainable development of cross-border regions is conducted. Our particular interest focuses on the locational characteristics of cross-border regions as well as their economic implications to the cross-border governments. Based on a sustainable development model from which the optimal outputs of different kinds of border-regions can be derived, we try to methodologically help cross-border governments to reach a final agreement of sustainable development of natural and environmental resources. It is concluded that the methods by which the net benefits among the sub-regions can be redistributed may be: 1) to equalize the absolute values of net benefit among all sub-regions concerned; and 2) to equalize the relative values of net benefit among all sub-regions concerned.

KEY WORDS: border-region; sustainable development; inter-governmental cooperation

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1 INTRODUCTION

BARRETT(1992) demonstrated a phenomenon in which the inter-governmental behaviors are effectively described by a number of slippery fishermen. The fishery dilemma illustrates a phenomenon that is common to many social and economic problems in which the private incentives of independent agents (like the slippery fishermen as above) prevent the agents from reaching an outcome which makes all the agents better off. If the resource is under the jurisdiction of a single government, the exploitation of it can be easily coordinated by the government itself. But if the resource is located at the border-regions and subject to open access to more than one regime, the problem can not be solved so easily by one side of the border alone. As a result, the consistent and effective cross-border cooperation between all parties concerned seems to be necessary. Besides the uncertain political condition and less-developed infrastructure, environmental issue has also been a growing challenge to the sustainable development in cross-border regions. In this paper, some problems in relation to the resource exploitation and environmental protection of the cross-border regions are raised.

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2 LOCATIONAL CHARACTERISTIC OF CROSS-BORDER REGIONS

Border-regions have the geographical disadvantages stemming from the peripherality in relation to their national cores, and the attendant remoteness from the centers of power and decision-making. Border-related barriers exist when the intensity of interaction in space suddenly drops at the places where a border is crossed (RUMLEY *et al.*, 1991). RIETVELD (1993) distinguished various reasons for the existence of the barrier effects of international borders: 1) weak or expensive infrastructure services in transport and communication for international links; 2) preferences of consumers for domestic rather than foreign products; 3) government interventions of various types; and 4) lack of information on foreign countries. To analyze the impact of borders, CATTAN and GRASLAND (1993) developed a framework in which two factors were distinguished to affect places in space: distance and borders. The impacts of distance and borders are specified for two types of variables: state variables relating to the situation in certain places, and flow variables relating to the interaction between different places. Two possible effects of borders were considered: 1) non-homogeneities between the places at different sides of the border, and 2) discontinuities in flow between the places at different sides of the border ①. After some necessary specifications, RATTI (1990; 1993) also developed two different approaches to overcome the existing barriers and border effects: 1) a micro-economic approach which examines the frontier through the analysis of the economic actor's strategy behaviour, and is based on the theory of industrial organization; 2) a meso-economic approach which considers the role of "frontier" within a specific supporting space or *milieu*.

Largely stemmed from the diversification of political identities, border-regions which are functionally incorporated by different kinds of political status and economic structures will therefore create different operational mechanisms for the resource exploitation and environmental protection of their own. Usually, the socio-economic complexity of a border-region is positively related to the political level of the border(s) involved in the border-region, i.e., the higher the political level of a border, the more complicated structure the border-region will have. A striking difference of functions between the international border-regions and the rest forms of border-regions is that, unlike dependent political units and other administrative subdivisions, there is no obvious central authority can which enforce agreements among nations over the transnational issues.

Geographically, if adjacent political authorities differing in number meet together, a border-region differing in spatial structure (or border dimension, i.e., the number of political authorities involved) will be formed correspondingly. In terms of spatial structure, border-regions may be generally classified into i-dimensional border-regions (an i-dimensional border-region is one which is bordered by i ($i = 2, 3, \ldots$, and N) political authorities respectively). While most border-regions are either 2- or 3-dimensionally formed (for example, the USA-Mexico border-region, the Tumen River Delta area between China, North Korea and Russia, and so on), areas with higher dimensional borders can be found throughout the world. For example, the Mediterranean Sea area can be known as a border-region shared by 18 independent countries including France, Spain, Morocco, Algeria, Tunisia, Libya, Egypt, Israel, Lebanon, Syria, Turkey, Cyprus, Greece, Albania, Yugoslavia, Italy, Croatia, and Bosnia and Herzegovina, when some transfrontier issues (such as the water environmental protection, etc.) are raised.

Given a set of border-regions with same natural, geographic, social and cultural conditions, when the number of independent sub-regions involved in a border-region increases, so does the complexity of the cross-border economic relation. In order to illustrate this hypothesis, let us suppose that the number of

① In addition, RATTI and REICHMAN(1993) formulated a theoretical hypothesis that emphases the overcoming of barriers through the construction of contact areas allowing interregional cooperation.

sub-regions involved in a border-region is expressed as 2, 3, …, and N respectively. If the stability of cooperation between any two sub-regions is r $(0 \leq r < 1)$, thus, the overall stability of economic cooperation of the border-region (R) is aggregated as

$R(2) = r$, for two sub-regions;

$R(3) = r^3$, for three sub-regions;

$R(4) = r^6$, for four sub-regions;

$R(5) = r^{10}$, for five sub-regions;

…

$R(N) = r^{\sum_{i=1}^{N-1} i}$, for N sub-regions.

Obviously, given that the value of r ranges between 0 and 1, we can easily conclude that $R(N)$ decreases with respect to N, that is, $R(2) > R(3) > R(4) > R(5) > \cdots > R(N)$.

3 MAXIMIZING THE SUSTAINABILITY OF BORDER-REGIONS

It is often asserted that inter-governmental agreement become less effective with respect to the increase of the number of countries involved. BARRETT (1992), for example, showed that as the number of countries increases, so do the differences between them. Agreement on the basis of simple rules like uniform abatement levels without side payments will then become very difficult to reach; and yet this is often the basis upon which treaties are negotiated. Even if agreement can be reached, it may not be sustainable. As the number of countries increases, the incentive for signatories to punish non-signatories falls, and free riding becomes more irresistible. With a consideration of N countries ($N \geq 2$) that interact in a common environment, CARRARO and SINISCALCO (1993) analyzed the profitability and stability of international agreements to protect the environment in the presence of transfrontier or global pollution by assuming that each country may decide whether or not to co-ordinate its strategy with other countries. They concluded that a coalition is formed when conditions of profitability and stability (free-riding) are satisfied. It is also shown that such coalitions exist; that they tend to involve a fraction of negotiation countries; and that the number of signatory countries can be increased by means of self-financed transfers. Their analytical framework was highly simplified, but the results showed a promising route for research and policy analysis between sovereign countries, especially in their common border-region. Furthermore, the environmental and technological cooperation between sovereign nations was also analyzed by CARRARO and SINISCALCO (1995) as two separate negotiations in which the environmental protection is proved to be profitable but unstable while technological cooperation is proved to be profitable and stable. The joint negotiation, however, is more profitable and more stable than the two separate negotiations as it uses the gains from technological cooperation to offset the environmental free-riding incentives and to reach full cooperation both on technology and on the environment. Theoretically, border-regions with different number of independent sub-regions will yield, *ceteris paribus*, different instrumental behaviors, as the adoption of a common standard and the socioeconomic coordination between different sub-regions are not likely to be emphasized if they have markedly differing economic attitudes as well as social values. In order to maximize the economic sustainability of different border-regions, we stipulate that a border-region is composed of N independent sub-regions. Each sub-region has different standards of economic policy-making from the others. To simplify our analysis, we additionally use five assumptions (GUO, 1996):

(1) All necessary production factors (such as labor force, capital, technology, natural resource, information, etc.) are both scarcely and unevenly distributed within the border-region.

(2) The production factors can be allocated more efficiently within each sub-region than between the N sub-regions when $N \geq 2$.

(3) Each of the N sub-regions has at least one comparatively advantageous (or disadvantageous) sector over the other(s) when $N \geq 2$.

(4) The transport and communication cost within each sub-region is too little to influence the sub-region's preference in allocating its production factors.

(5) The objective(s) of the sub-region(s) involved in the border-region is(are) to maximize its(their) profit(s).

In fact, the first two assumptions are not *ad hoc* in the real world. Instead, they have basically characterized all economic activities in which the border-related barriers exist. Assumption 3 is the *sine qua non* for the sub-regions to develop interregional cooperation after the border-related barriers are removed. Assumption 4 allows the intraregional cooperation to become profitable within each of the N sub-regions when N decreases to 1. Using Assumption 4, the economic analysis can be highly simplified. Finally, Assumption 5 serves as an indispensable condition under which the output of each sub-region and the total output of the border-region as a whole can be maximized respectively. Based on the above assumptions, we may build the following model to maximize the economic sustainability of cross-border regions.

Assume that a regional space (S) is composed of N autarkic sub-regions (i. e., $S = S_1 + S_2 + \ldots + S_N$). For the sake of expositional ease, m policy variables are used here to denote the inputs of natural and environmental resources. The policy variable set of the ith sub-region (S_i) is defined as $X_{ni} = (X_{ni1}, X_{ni2}, \ldots, \text{and } X_{nim})$ ($i = 1, 2, \ldots, N$). The production constraints for the ith independent sub-regional systems are noted as $g_{ni}(X_{ni})$ (where $i = 1, 2, \ldots$, and N). In addition, as all sub-regions are economically separated each other, the N-d production constraints may be expressed as $g_{ni}(X_{ni} \subset g_1$ ($i = 1, 2, 3, \ldots$, and N), and $g_{n1}(X_{n1}) \cup g_{n2}(X_{n2}) \cup \ldots \cup g_{nN}(X_{nN}) = g_1$. $f_{ni}(X_{ni})$ ($i = 1, 2, \ldots$, and N) stands for the objective function of the ith independent sub-region. The economic outputs of the N sub-regions in the N-d border-region are independently maximized by the N policy-makers respectively, i. e., max $\{f_{n1}(X_{n1}), f_{n2}(X_{n2}) \ldots, \text{and } f_{nN}(X_{nN})\}$. Finally, a N-goal programming model for the border-region may be writtenas

$$\min \sum_{i=1}^{N} P^{ni} d_{ni}$$

$$\text{subject to} \begin{cases} f_{ni}(X^{ni}) + d_{ni} = M_{ni} \\ g_{ni}(X^{ni}) \in g_{ni} \\ X^{ni} \in (0, \infty) \\ d_{ni} \in (0, \infty) \\ M_{ni} \to \infty \\ P^{ni} \in (0, \infty) \\ (i = 1, 2, \ldots, N) \end{cases}$$

In the above model, P^{ni} is used to identify the priority under which the ith sub-regional system ($i = 1, 2, \ldots$, and N) is economically maximized. Obviously, when $P^{ni} \neq P^{nj}$ ($i = 1, 2, \ldots$, and N; $j = 1, 2, \ldots$, and N; and $i \neq j$) it implies that the ith and jth sub-regions (S_i and S_i) are unequally treated and that the larger the parameter of P^{ni} ($i = 1, 2, \ldots$, and N), the higher priority is given for the economic maximization of S_i, ($i = 1, 2, \ldots$, and N); when $P^{ni} = P^{nj}$ S_{ii} and S_j are equally treated. Similarly, the model yields an optimal solution for S_i, i. e., $F_{ni}{}^* = f_{ni}(X^{ni*})$, where $X^{ni*} = (X_{ni1}{}^*, X_{ni2}{}^*, \ldots, \text{and } X_{nim}{}^*)$. The total output value of the N-d regional system is $F_N{}^* = F_{n1}{}^* + F_{n2}{}^* + \cdots + F_{nN}{}^*$. Applying the approach by GUO (1995), we may prove that, under assumptions (1) – (5), the largest output of an i-d regional system (F_i) decreases with respect to i, i. e., $F_N{}^* \leqslant F_{N-1}{}^* \leqslant \ldots F_i{}^* \leqslant \ldots F_2{}^* \leqslant F_1{}^*$, *with* $F_i{}^* \geqslant 0$ and $i = 1, 2, \ldots$, and N.

4 REACHING A FINAL AGREEMENT

We have found an optimal solution for the border-region as a whole. However, the optimal solution does not mean that the problems faced by the governments involved in the border-region have been solved. This is because that even though the overall optimized output (that is, $F_N{}^*$ as derived from Section 4) of the border-region is larger than the individually optimized output (that is, $F_N{}^{\#}$ as shown in Table 1), the overall optimized output (that is, $f_i{}^*$ as derived from Section 3) of sub-region i is not necessarily larger than its individually optimized output (that is, $f_i{}^{\#}$ as shown in Table 1), that is, $f_i{}^* > f_i{}^{\#}$. In some cases, $f_i{}^* < f_i{}^{\#}$ (GUO, 1995). If the overall optimized outputs of some, even if not all, sub-regions are not larger than the individually optimized ones, the incentive for these sub-regions to participate the cross-border cooperation therefore disappears.

In order to enable all sub-regions involved in the border-region to implement the cross-border cooperation plan that is optimized for the border-region as a whole (in all cases, $F_N{}^* > F_N{}^{\#}$), the redistribution of the after-cooperation benefits seems to be necessary. In general, methods by which the net benefits among the sub-regions can be redistributed may be: 1) to equalize the absolute values of net benefit among all sub-regions concerned; and 2) to equalize the relative values of net benefit among all sub-regions concerned (as shown in Table 1).

Table 1 Redistribution of benefits among all sub-regions of a border-region

Sub-region (i)	Overall optimized output (f_i^*)	Individually optimized net output ($f_i^{\#}$)	Net benefit transference (increase or decrease) after cooperation	
			In absolute term	In relative term
1	f_1^*	$f_1^{\#}$	$f_1^* - f_1^*$	$(f_1^* - f_1^{\#}) / f_1^{\#}$
2	f_2^*	$f_2^{\#}$	$f_2^* - f_1^*$	$(f_2^* - f_2^{\#}) / f_2^{\#}$
3	f_3^*	$f_3^{\#}$	$f_3^* - f_1^*$	$(f_3^* - f_3^{\#}) / f_3^{\#}$
…	…	…	…	…
N	f_N^*	$f_N^{\#}$	$f_N^* - f_N^*$	$(f_N^* - f_N^{\#}) / f_N^{\#}$
Total	F_N^*	$F_N^{\#}$	$F_N^* - F_N^*$	$(F_N^* - F_N^{\#}) / F_N^{\#}$

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