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Index of the Economic Interaction Effectiveness between the Natural Monopoly and Regions. I. Math Model

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Abstract

In this paper, we proposed option indicator that determines the quality of the interaction regions with natural monopolies. In fact, assessing the effect of the implementation of projects of the program interaction. Evaluation is carried out from the point of view of natural monopoly.

Keywords: Natural monopoly, interaction index

1 Introduction

Throughout the development of economic science many scientists were dealing with improving the methods of cost-effectiveness analyses of investments into projects. Fairly complete survey of these methods can be found in the researches [1-4].

The proposed in this research effectiveness ratio and the method of its determination are free from this major disadvantage. The effectiveness ratio except financial profitability indexes of the invested project (or a group of interrelated projects) also includes the most important stability factors of the invested enterprise, its reliability and, in addition, it allows considering the extent

of linkage among the invested project and other projects and regional programs, their influence and interdependence.

2 Elementary model

Let's consider the simplest case of the relationships among the sandwich-model (layered model) elements when interaction takes place within the selected elementary tube between two economic entities – nodes P_0 and P_1, lying on the different functional planes – the natural monopoly plane and the other economic entities plane, fig. 1.

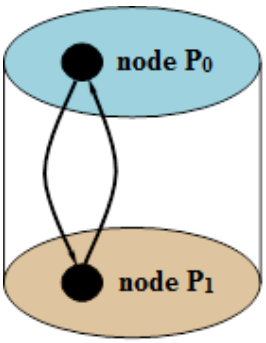

Fig. 1.An elementary tube. The simplest case.

Let's describe a considered situation. The node P_0 stimulates the company's development project. Stimulation is carried out by means of intersubjective funds redirection that this region is bound to the node P_0 in the form of compensations, for instance, for passenger transfer or for the low-density lines content or for other social-important programs realization. It is obvious that, in particular, the latter can be implemented by the node P_0 in order to get an opportunity of participation into the commercial projects involving enterprises of this region. Participation of the node P_0 in such projects will seem appropriate only if on the one hand, it meets the requirements of the natural monopoly in this region and, on the other hand, can recover the incurred costs and also bring additional revenue. One form of such participation can be a transmission of enterprise bonds P_0 from entity government to the node P_0. These bonds were issued in order to raise funds for the development of production with bonds redemption after time T and one-time payment of loan interest. The volume of such indirect investments is S_{inv}, the lending interest rate is $m\%$ and the total amount of the refund loan (considering loan interest) is S_{ref}.

3 Economic interaction effectiveness index

The economic-mathematical requirements to the definable coefficient k from the point of view of the node P_0 (i.e. the natural monopoly) are the following:

1. $0 < k < 1$ is the effectiveness ratio normalization;

2. Let t_{cr} is the time of indirect lending. The smaller t_{cr} is, the greater value of the effectiveness ratio k should be.

3. Let S_{inv} is the volume of indirect landing in rubles, S_{ref} - the refund amount (including the interest) after the time of the indirect lending expected by the node P_0, μ is the expected (forecasted) inflation rate (so $\mu \cdot S_{\text{ref}}$ is really refundable funds volume in the current price level). Thus, the revenue $S_{\text{d}}^{(1)}$ from indirect lending of the node P_1 is:

$$S_{\text{d}}^{(1)} = \mu S_{\text{ref}} - S_{\text{inv}}$$

The greater the direct revenue from such redirection $S_{\text{d}}^{(1)}$ is, the greater value of the effectiveness ratio should be.

4. Let p_1 is the stability factor of the involved enterprise. The greater the stability factor p_1 is, the greater value of the effectiveness ratio k should be.

5. Let $\Delta V^{(1)}$ is the total increase of the produced production volume at the invested enterprise P_1 planned in the result of project implementation. Therefore

$$\frac{\Delta V^{(1)}}{t} = \frac{V_{\text{prod}} - V_{\text{out}}}{t}$$

is the increase of the produced production volume at the enterprise P_1 per unit of time (for example, per year) expected from the project implementation. Here V_{prod} is the volume of the produced production at the enterprise P_1 after project implementation, V_{out} is the initial volume of the output.

The value $\frac{\Delta v^{(1)}}{t}$ is the aftereffect, the measure of the expected benefits to the node P_0 from the project implementation with the P_1 node participation. The greater the measure of the aftereffect $\frac{\Delta v^{(1)}}{t}$ is, the greater the effectiveness ratio k should be.

6. Let D_{dep} is the possible guaranteed income from the alternative funds placement required to redirection of funds in a project of the enterprise P_1.

7. Let $0 < \lambda < 1$ is a dimensionless coefficient, i.e. the extent of linkage the invested project with other projects and programs of the region. The coefficient of the extent of linkage reflects the extent of the directive influence

(pressure) to the natural monopoly by the regional authorities insisting on the indirect investment of the node P_1.

The method of determination the coefficient of the extent of linkage is the subject of the following researches. It is natural that the greater the coefficient of linkage λ is, the greater the effectiveness coefficient k should be.

The formula, satisfying all formulated above economic-mathematical requirements, for determination the effectiveness coefficient is proposed below:

$$k = \frac{\frac{1}{T}\sum_{i=1}^{T}\left((S_{\mathrm{d}}^{(1)})_i + \alpha \cdot (\Delta v^{(1)})_i\right)}{\frac{1}{T}\sum_{i=1}^{T}\left((S_{\mathrm{d}}^{(1)})_i + \alpha \cdot (\Delta v^{(1)})_i\right) + \frac{1}{T}\sum_{i=1}^{T}(D_{\mathrm{dep}})_i} \cdot p_1 \cdot \frac{1+\lambda}{2}$$

Where T is the depth of forecast (range of planning) expressed in the number of the reporting units (periods) of time of the covered perspective. (For instance, $T = 10$ years); α is any introduced by us dimensionless coefficient of the extent of importance of the aftereffect from the implementation the project for the node P_0, i.e. the coefficient showing the significance (importance, urgency) that we attach to the aftereffect. For different projects and industrial problems index α can vary in dependence, for example, from the kind of produced production by the enterprise P_1 (It is required just deliver production to a consumer or the natural monopoly is interested in this production too, i.e. for the natural monopoly this production is strategically important).

$\sum_{i=1}^{T}\left((S_{\mathrm{d}}^{(1)})_i + \alpha \cdot (\Delta v^{(1)})_i\right)$ is the total benefit from funds redirection to the project (the node P_1), i.e. the profit calculated from the standpoint of the node P_0 - the natural monopoly. The summation in this formula is made by the number of reporting periods; P_1 – the stability of the project implementer, i.e. the node P_1. (see, for ex. [1, 5-9])

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