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Contribution to the Economic Analysis of Hydrocarbon Exploitation in the Eastern Mediterranean Region

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The present paper is a contribution to the economic analysis of the exploitation of depleted natural resources and in particular hydrocarbons in the wider Eastern Mediterranean region. The methodological tools used are both the marginal economic analysis, the application of the Hotelling rule and the multi-criteria choice of exploitation of a natural resource with sensitivity analysis of the first and second optimal solution. The choice of natural resource used to be based on a single criterion, cost. Today, the multi-criteria method is followed, according to which many criteria are taken into account at the same time. The return on investment from the exploitation of a mineral resource in the wider Eastern Mediterranean region is obtained through multi-criteria selection and sensitivity analysis of the prevailing solution.

Keywords: economic analysis, hydrocarbons, multi-criteria selection, Hotelling Rule, Eastern Mediterranean

Introduction

Natural Resources Economics detects, identifies and identifies cause and effect relationships between the most important variables and parameters. Going from the general to the specific, economic rules for the optimal use of natural resources are formulated. In this case there is a theoretical construction that indicates mechanisms of approach and operation of economic thought and draws rational conclusions by adopting, modifying and adapting a separate relevant theory. This paper examines the Hotelling Rule for the exploitation of hydrocarbons in the wider Eastern Mediterranean region (Duncan, 1986).

According to annual data from the BP Statistical Review of World Energy and the Association for the Oil and Gas Peak (ASPO), natural gas and crude oil reserves in Gbbls * (billion barrels) are currently at the same level. This is due, on the one hand, to the efforts that have resulted in finding large reserves of natural gas and, on the other hand, to the environmental problems created by oil from its use, resulting in a shift towards the consumption of natural gas. Annual consumption is expected to increase exponentially at a rate of 2.2% $year^{-1}$ for oil (r_{oil} = 2.2% $year^{-1}$) and 3.8% for natural gas (r_{ng} = 3.8% $year^{-1}$). Both of these rates are lower than they were a few years ago. Recently, a large number of studies have presented data on the substitution of future annual demand for oil by 20% and gas by 10% from other alternative sources, mainly for energy production. According to these data, the percentage increase of the time of depletion of the natural reserves of oil and gas is estimated at 20% and 10%, respectively (Feigenbaum, 1991).

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The question that arises is whether Economics and Technology can provide optimal solutions to meet the above condition that must characterize the business of exploitation of natural resources. The answer is given by a methodology for the identification, identification of conflicting dependent variables that create a tug of war, the result of which is the discovery of an extreme point or equilibrium of the tug of war, which corresponds to the optimal value of the independent variable under investigation (Juran,1988).

The Case Study of the Eastern Mediterranean

An example is given of determining the optimum maximum depth of extraction of D_{opt} ore or energy mineral based on the criterion of maximizing the total benefit. B. First, data must be collected and estimates made of both stocks at different depths of the field and their texture rocks, in order to make a cost budget, e.g. drilling, in the case of oil extraction. Then, the individual dependent profit variables B_1 (D) and B_2 (D) are identified, referring first to the economies of scale achieved in the extraction and on-site processing of the extracted raw material, while the second to the increase in marginal costs as a function of depth.

The function B_1 (D) is increasing at a decreasing rate due to the force of the law of diminishing returns, i.e.: $dB_1/dB > 0, d^2B_1/dB^2 < 0$. The function B_2 (D) is decreasing with increasing absolute due to the increase of the differential cost, which becomes more intense at a greater depth due to increasing difficulties, i.e.: $dB_2/dB < 0, d^2B_2/dB^2 < 0$. It is obvious that the optimal mining depth is the intersection of the point where the total profit becomes maximum.

Application of the Hotelling Rule in the Case of the Eastern Mediterranean

The simplest form of the Hotelling rule for the exploitation of non-renewable natural resources is given by the relation $P_t/P_t = \rho$, which states that the relative increase in price—value of the respective product, i.e. the ratio $P_t/P_t = (\Delta P_t/\Delta_t)/P_t$, is constant over time and equal to the interest rate ρ is constant over time and equal to the interest rate. The rate ρ used to determine the social prosperity function $W = W(U_o, U_1, U_2, \ldots U_T)$, where U_t the total utility during the period t = 0, 1, …., T, by the method of reduction to present value: $W = U_0 + U_1/(1 + \rho) + U_2/(1 + \rho)^2 + \ldots + U_T/(1 + \rho)^T$ (Montgomery, 1991).

The Rule of Hotelling derives from concepts—relationships referred to in neoclassical Economic Theory, where it is stated that the present value of any effectively managed asset remains constant over time. Its application, however, in the Economic Analysis of non-renewable natural resources in the form of useful quantitative relations, either for forecasting or for interpretation, presupposes confirmation of its validity. Analysts who dispute its validity argue that the status of "non-renewable" does not imply increasing supply tightness or scarcity, as the predictions (i) for depletion of stocks of specific natural resources and (ii) for the increase of prices of raw materials that are the product of the holding (Scilling, 1982).

In fact, they attribute both the non-exhaustion and the non-impact on the prices of raw materials to the possibility of substitution of materials and corresponding products with the help of technology and market mechanisms. In their view, the innovations that contribute to this substitution are categorized as follows: 1. Innovations that allow new uses of natural resources. 2. The development of new materials, such as synthetic fibers. 3. The development of technological equipment that increases productivity in mines, quarries and quarries e.g. excavators. 4. The scientific discoveries and applications of these that make the exploration of underground and underwater wealth more efficient and cheaper. 5. The development of technologies aimed at increasing the efficiency and effectiveness of production methods of industry that uses specific natural resources as a raw material. 6. The development of techniques that make geological formations economically exploitable of minerals, that is widespread in nature with low contents of useful components. 7. Innovations in technology and organization of recycling materials, which save corresponding natural resources. 8. The substitution of extracted and exploited natural reserves of high content of useful components by other natural reserves of low content in them. 9. The replacement of depleted natural resources by innovative fixed assets of production equipment.

The validity of the Hotelling Rule is also disputed on the grounds that the prices of basic raw materials derived from non-renewable natural resources, namely metals and fossil fuels, have not changed in the long run. These prices are calculated not only deflated, but also based on the prices of other goods and services, in order to assess whether the fair value or purchasing power, with the amount of deflated currencies corresponding to these deflated prices remains constant. The argument is this: if we are in a state of depletion of non-renewable natural resources, then the prices of their direct products should increase. But because the chronological order of prices of certain fossil fuels and ores or metals does not seem to show a clear upward trend for several decades of the 20th century, it is concluded that the Hotelling Rule does not make sense since it is based on the concept of depleted natural resource.

It is clear from the literature that the study of price developments and the detection of trends offer only limited help to confirm, or not, the validity of the Hotelling Rule. In contrast, the analysis of the cost of exploiting non-renewable natural resources provides more solid ground for drawing conclusions. These analyzes have most often led to the confirmation of the validity of the Hotelling Rule, indicating an increase in cost, when, as a product of time, we are forced to exploit depleting natural resources that present either greater difficulties in accessing the site or less concentration useful components containing either a proportionately lower calorific value for energy minerals.

Finally, the validity conditions of the Hotelling Rule are mainly confirmed around cost analyzes, so the variable P_1 of the rule must be identified mainly as a value. But also in terms of prices, starting with oil, it seems that in the past there have been strong upward trends compared to previous years (Wadsworth et al.,1986).

Discussion

The problem of choosing a natural resource for exploitation arises in the following cases: 1. When the price of a mineral raw material increases and a new mine has to be opened, then it has to be chosen between similar mines in terms of the exported raw material. The mines from which the selection can be made either exist as inactive holdings, or appear as potential holdings of certain natural reserves in known accessible deposits, in which case the development cost of the mine must be included in the operating costs. The corresponding problem applies when the price of a mineral raw material decreases and one of the operating mines has to be closed. 2. When a natural resource must be chosen between disparate resources, but which give the same final product. 3. When a combination of natural resource exploitation should be chosen.

The choice of natural resource used to be based on a single criterion, cost. Today, the multi-criteria method is followed, according to which many criteria are taken into account at the same time. After calculating the relevant, we rank the options in descending order of preference and when the score is given by q experts, and then each score is averaged, so it would be possible to calculate the corresponding standard deviation. In this case we can use instead of the simple weighted degrees $w_i * \alpha_{ij}$ (i = line j = column) the corresponding degrees with double weighting $w_i * a_{ij} / e_{ij}$, where e_{ij} is the standard deviation corresponding to the mean value a_{ij}.

The logic of this variant is to reduce the effect of a degree, which appears to be of lesser reliability (the greater the dispersion of the scores given by q experts to a particular choice with the same criterion the greater the standard deviation, hence the lower the reliability). The condition of double weighting is that there are no standard deviations in the area of zero, because some double weighted scores increase too much, resulting in biased assessments.

In order to investigate the effect of the change of the value of a certain degree of a_{ij} on the solution S_j, that is, whether this solution remains constant, we can change the value of a_{ij} either in a predetermined area e.g. $a_{ij} \pm 0.25\ a_{ij}$ or in the area [min a_{ij}, max a_{ij}], defined by the minimum and maximum scores given by q experts, and to study the effect on the difference Sh_1-Sh_2. If this difference remains positive throughout the a_{ij} price range under consideration, then the proposed alternative is stable over the period under consideration. If at some value of a_{ij} the difference is zeroed and then becomes negative (which means that the second proposed alternative becomes first), then it must be borne in mind that the first proposed alternative is unstable. Therefore, we use the sensitivity analysis of the best option to determine the stability of the proposed solution.

Conclusions

A company that generates electricity by exploiting a domestic natural resource of fossil coal or hydrocarbons (i.e. natural gas or oil) differs from another company that generates electricity by burning similar imported raw materials, in the following: 1. It is obliged to pay compensation to a state body (as rent) after consuming a good that belongs to society as a whole. 2. Must pay compensation to those who suffer the effects of this exploitation (e.g. due to land expropriation). 3. It must use economic criteria to exploit these natural resources rationally on a long-term basis with the best available technique that does not involve increased costs, determining optimal values for the independent variables and parameters taken into account in the mining and the production process. 4. Obliged by national and international law to protect the environment throughout the operation and to restore the environment to its original state when the exploitation of the natural resource is completed or the work is stopped, etc. It is taken into account that provided that there will be monopoly situations, the coexistence of private or public companies are allowed.

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