NEW APPROACHES TO THE MANAGEMENT OF NATURAL RESOURCES (1): THE EXPLOITATION

MARIUS BULEARCA, Ph.D.
CENTRE FOR INDUSTRY AND SERVICES' ECONOMICS, ROMANIAN ACADEMY, BUCHAREST, ROMANIA,
e-mail: mariusbulearca@yahoo.com

CATALIN POPESCU, Prof.
PETROLEUM-GAS UNIVERSITY FROM PLOIESTI, PLOIESTI, ROMANIA,
e-mail: cpopescu@upg-ploiesti.ro

Abstract

Natural resources are not homogeneous in nature, having certain features in the productive process that require grouping them into different categories by different criteria. Consequently, natural resources cannot be addressed all at once, but only distinctly, according to relevant criteria selected based on the proposed goals. This criteria selection process requires special features and econometric models representing the core of the present paper. Furthermore, the paper also intends to cover the social importance of understanding resources misuse, and alongside with the types and sources of inefficiency in resource management

Keywords: *economic management principles, mining industry, models, depletion time, time-production trend, profit rate.*

Clasificare JEL: *N5, O13, P28, P48*

1. Introduction

Economic analysis of extractive industry fundamentally differs compared to agriculture, manufacturing and services analysis. The main reason is that mineral resources are exhaustible resources [9]; in other words, in the mining industry an initial stock of reserves will exhaust over time. Consequently, if we start from the premise that the owner of a resource, like any other owner, is seeking maximum gain, we must then take into consideration multiple factors specific to the mining industry. Until now, economic analysis in general, and especially that related to the natural resources market, has been characterized by the concept of natural resource scarcity [6], much of the methodological concept being closely related to resources allocation problems at micro and macro-economic level.

Based on these considerations, it should be noted that in the economic literature, the idea of resource reserves depletion related to sustainable development has been often accredited to the extent of economic and demographic development [8]. But it must be taken into account that natural resources are not homogeneous in nature. They have features in the productive process which requires grouping them into different categories by different criteria.

Therefore, because of their diversity, natural resources can not be addressed all at once, but only distinctly grouping them according to relevant criteria based on the proposed goals as there are many factors affecting the price-production trend in the mining industry. And such special features will be revealed in this analysis.

2. Exploitation of natural resources and factors affecting the reserve depletion level

There are many factors that affect the price-production trend in the mining industry [7], the most important being: fluctuations in profit rates; fluctuations in extraction cost; taxes introduced

by the Government. Some, such as taxation and the profit, can be treated as variable pricing policy introduced by the government to influence the extraction of non-renewable mineral resources.

2.1 Changes in profit rate

Profit level fluctuations may have strong effects on the price-production trend in the mining industry. To start, let us suppose that the profit market rate increases. This means that the revenue rate obtained from an alternative investment project, say term cash deposits, increases. If owners do not undertake any changes of the originally conceived plan, the reserves stock will lead to achieving sub-optimal rates of income over time.

The way to avoid these losses is to move production today. This means that the owners will extract and sell more now, which will lead to a lower price asked on the market. Therefore, the less is extracted, the higher the net price of the remaining reserves could rise. This means that reserves would be exhausted in less time than it would take the profits to increase.

Figure 1 illustrates this situation. The curve "ab" is the price-production trend before increasing the profit rate. Immediately after the increase, owners should make an adjustment by increasing production, and then prices start to fall at moment t(0) to the "a" level. For the remaining time left the owners will extract less so that the rent of the reserves left would grow at a higher rate [4]. This will shorten depletion time from "T" to "T '". The new price-production trend "a'b" will be steeper than the previous one "ab".

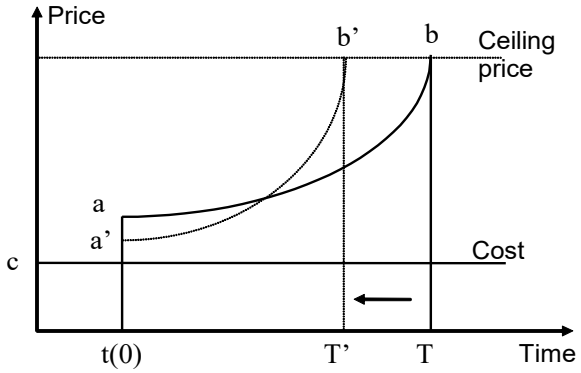

Fig. 1 Effect of profit rate growth on the price-production trend, and on deposits depletion time

If the profit rate falls, the opposite phenomenon will occur. Original price will increase as owners push their production into the future by reducing current extraction. This is because lowering profit rates makes stocks return more attractive than current production. This is obvious also in that a lower profit rate would show a lower growth trend than in the previous case. This means that depletion time increases, as shown in fig. 2.

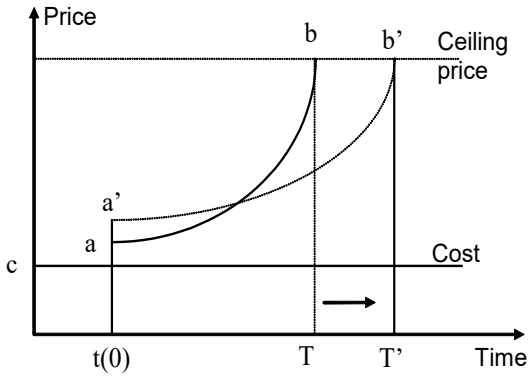

Fig. 2 Effect of profit rate falling on the price-production trend, and on deposits depletion time

2.2 Fluctuations in extraction cost

To begin, let us assume that extraction cost increases. This can happen for a variety of reasons such as lack of skilled labor, wage growth in the mining industry and basic resources decline as owners start extraction from fields with difficult access.

An increase in mining costs will reduce the current production level and therefore will increase the starting price, but will reduce future prices. This situation, in turn, will reduce the demand in the near future while increasing the future demand. The net effect will be the increased depletion time. The situation is shown in fig. 3. As the cost of extraction increases, the rent will be reduced. In response, resource owners will reduce the current production and will increase, at moment t(0), the initial price "a" to the new price "a'", so that the new price-production trend will be "a'b'".

Conversely, a decrease in the extraction cost will have the opposite effect, by increasing the initial value of the rent. If no adjustment is made, it could lead to a situation in which the cancellation price would be reached faster than desired, leaving owners with unsold stocks.

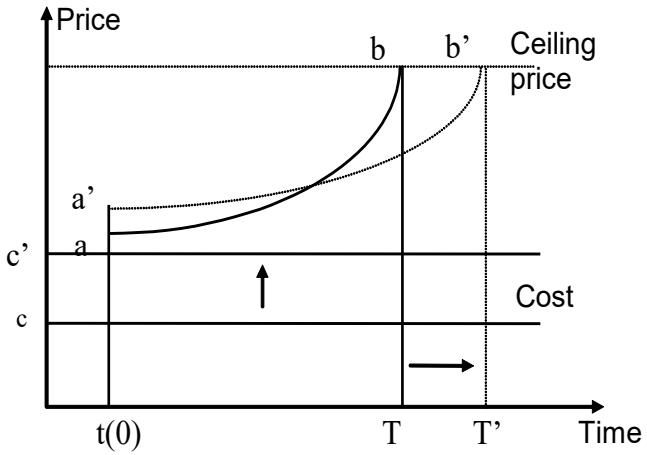

Fig. 3 Effect of extraction cost on the price-production trend, and on deposits depletion time

To avoid such a situation, the owners should lower the starting price. The gain will be that when extraction costs fall, the immediate production level increase, which in turn will reduce the initial price and depletion time (as seen in fig. 4).

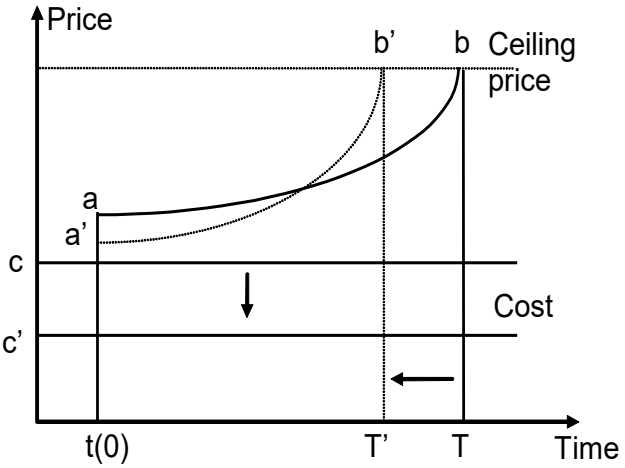

Fig. 4 Effect of extraction cost lowering on price-production trend, and on deposits depletion time

2.3 The charging system

The charging system may have strong effects on the policies used in the mining industry. In this respect we can mention several charges:

2.3.1 Excises

Taxing the value of mining production will increase costs, which will have an effect similar to that shown in fig. 3. For a mine owner, a tax on income is a cost that will reduce the current extraction and enhance deposits depletion time. Moreover, this type of charge will cause mining companies to postpone extraction so as to delay (or suspend) payment of taxes. Therefore, they prefer to keep reserves in deposits, where there are no taxes to be paid.

2.3.2 Ad-valorem tax

This is a fixed tax on the price of each unit of production, usually a certain percentage of the value of extracted production. The effect of this tax is to reduce the deposits depletion rate and increase their depletion time. Therefore, there is a difference between the effects of ad-valorem tax and excise tax, in that the depletion rate reduction is lower in the first taxing case.

Let us suppose that the owners are proposing to postpone payment of taxes by lowering the rates of extraction. Where ad-valorem tax is chargeable, it will be observed that as sales prices are higher, taxes paid on these sales will therefore be higher. Hence, in the case of ad-valorem tax, the depletion rate reduction is not preferable to the one from excises.

The difference between specific and ad-valorem taxes can significantly influence decisions in the mining industry. If the government feels that the country's natural resource reserves are depleting too quickly, then a strong measure as excise tax may appear appropriate for a moderated depleting reduction of deposits. An action with a lower impact is the use of ad-valorem tax, as an opposite alternative to taxing through excises. This is the main reason for which conservatives prefer excise tax in the mining industry.

2.3.3. Property Tax

This kind of tax will reduce the depletion time of deposits. From equation (1) inherently results that the stocks value on the capital market is the present value of future net profits to be obtained by the extraction and sale of these stocks. This equilibrium value will increase in time at the level of profit market rate, thus providing incentives to owners to keep them.

$$\frac{\delta L}{\delta Q(t)} = \left[P(t) - C\right](1+\gamma)^{-t} - \lambda = 0 \qquad (1)$$

where:

L = Lagrange multiplier;
Q (t) = amount extracted at time t;
P (t) = resource price at time t;
C = cost of extraction, is constant;
t = time in years;
r = rate of return;
λ = absolute mining rent, is constant.

Ceteris paribus, an annual tax on the value of the resources will strongly reduce this incentive because the longer the deposit is kept intact, the greater the taxes to be paid on it. One way to avoid paying this tax on all future periods would be extracting as quickly as possible and investing money in areas where there is no charge similar to this.

3. Other economic considerations

Operating with the basic economic principle is restricted by numerous real world constraints. For example, fluctuations in profit market rates; if these increase, ceteris paribus, the extraction will increase, and conversely, if rates fall, then there will be a slowdown in the mining extraction rhythm. It is well known that the profit market rate may increase or decrease quite rapidly in a short time. In this case, do we expect an automatic adjustment of the output whenever the profit rate changes?

It seems quite unrealistic to expect that resource owners will have an automatic response to profit rate changes. Let us consider that the profit market rate increases sufficiently enough to constrain owners to increase the extraction so that the accrued money would be invested in deposits with high interest. In general, an increase of income production in mining, petroleum and natural gas extractive industries requires an expansion of production capacity, which requires time. Moreover, the period with high profit rates may not be so long, leading resource owners to think twice before engaging in the costly action of extending the production capacity.

A similar problem may occur in connection with the tax system. In many countries, national level fiscal policies change with the change in government leadership. Therefore, resource owners cannot be certain of the sustainability of a particular fiscal policy. If production capacity and production levels in the extractive industries are based strictly on current tax law, when this suddenly changes, resource owners may remain with excess capacity or inadequate structures with which to operate in an optimal way.

Another important factor is the technological change related to natural resources. A change in technology can reduce dependency and hence the demand for a particular resource. For example, let us compare solar energy with fossil fuels energy. A rapid technological development in capturing and storing solar energy can result in substantial demand decrease for fossil fuels.

This type of uncertainty is always in the attention of resource owners when they set the depletion plan for their deposits. Alongside the fundamental economic principle, resource owners are also guided by the rule which says: "Sell reserve stocks at the moment when the demand exists for them." When depletion time ("T" in our analysis) is high, it is necessary to develop a technological breakthrough.

Last but not least, an important issue is the time factor – that is, impatience - which can exert a strong influence on depletion time for natural resources deposits. For various reasons, a resource owner can be strongly determined to have money in cash, which may be obtained either by selling their property rights over resources, or by speeding up the extraction regardless the fundamental economic principle rules. When fields are owned by the state, selling property rights may not be politically possible in most cases, and the government remains with only one alternative: fast depletion to obtain immediate cash resources. This happens quite often nowadays.

The mining economic literature shows that the prices of natural resources as raw materials for the manufacturing industry have been declining for a long period of time [1; 2; 10; 12]. There were some exceptions, such as timber which presented an upward trend, or the oil price that has rapidly increased during 1973-1982, although after 1982 and until 1988 was in decline.

On the other hand, the economic fundamental principle shows very clearly that, ceteris paribus, the price of mined ore and fossil fuel should increase linearly with the market rate of return. This raises the question whether or not a contradiction between the economic theory of natural resources and the situation observed in the real world is manifested. Therefore, we may introduce a model to test the basic economic principle applied to the mining industry.

Once again we emphasize that in Hotelling model [5] we considered the net increase of reserves of fossil fuels and mining products in time - that is, the market price less extraction costs - all expressed in real terms. However, it is known that, with the exception of short time periods, the

real rate of return has been positive in many countries over time. In this case, there was a sustained reduction in extraction costs that can explain the current trend of prices within the meaning of Hotelling's rule. This has been tested by Slade [11] who tried to reconcile the theoretical predictions of actual price increases in natural resources and raw materials for manufacturing industry with the above-mentioned empirical findings of lowering prices.

Slade's model assumes exogenous technological improvements and endogenous changes in state deposits, parameters that are used to predict price trends for all metal mining products and fossil fuels in the U.S. If equation (1) is slightly amended in that it allows the extraction cost to change in time, then:

$$P(t) = C(t) + \lambda(1+r)^t \tag{2}$$

Slade allowed a reduction in price stating that, although $\lambda(1+r)^t$, which is the resource rent, is normally growing, if technological progressions are substantial, then C(t) that is the extraction cost may decrease substantially and may induce a trend in resource price decline. In the early stages of research, a decline in cost may offset the increase in rent, but later its intensity decreases the likelihood to obtain a U-shaped price trend.

However, Slade notes that his model is simple and naive, because it neglects the important issues facing mining industry as environmental regulations, tax policy, price controls, natural resources market and market structure; models related to the latest issues will be further discussed in the next paper.

4. Conclusions

Economic literature has often promoted the idea that resource reserves depletion is significantly affected by the extent of economic and demographic development. Economic and population growth lead to increasing consumption of natural resources. Given that natural resources are limited, their stock volume must be known in order to determine the duration of their use until complete exhaustion, for non-renewable resources, or their decrease level of stocks per capita, beyond subsistence level assurance, for renewable resources. It is therefore important to identify the sources of inefficiency and, as far as possible, to see which are the most important.

In this paper, as related to natural resources management, in fact we had identified **three potential sources of inefficiency in natural resources use**, not all acting in the same direction. These are:

1) *externalities:* neglect of over-failure costs of resource use. This allows us to tend towards *too high* current rates for the use of natural resources.

2) *monopoly:* restrictions on production due to profit. This makes the current rates *too low* for use of natural resources.

3) *government intervention:* the use of subsidies and tax laws. This leads to *excessive* current rates of natural resources use only if they occur to correct inefficiencies of type (1).

In fact, with this analysis we have made a perfect analogy to the pollution situation [3]. But these issues will be largely addressed in our next paper.

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