Methodological Notes for Cost and Benefit Analysis of Drilling in Eastern Mediterranean

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Abstract. The Mediterranean Action Plan of the United Nations is legally the only set of binding policies to address common issues and challenges of environmental degradation and the protection of marine and coastal ecosystems in the Mediterranean. The oil and gas industry is at the heart of the global economy and crucial for many national economies, including developing and emerging countries, being a driving force for economic growth. Cost Benefit Analysis (CBA), known also as Social Cost Benefit Analysis, is a method of evaluating investment plans and their impact with a view to socioeconomic well-being and the environment. In order to be able to answer the question whether or not research and subsequent mining of hydrocarbons should be done in the Eastern Mediterranean, one should consider all of the above, affecting political answers, especially as climate change is more visible than ever and the potential costs of these activities are difficult to assess

1. Introduction

The Mediterranean Action Plan of the United Nations is legally the only set of binding policies to address common issues and challenges of environmental degradation and the protection of marine and coastal ecosystems in the Mediterranean [1]. As the first regional seas program under the auspices of the U.N. for the environment, this inter-governmental institutional framework brings together the 21 coastal states and the European Union as contracting parties to the Convention for the Protection of the Marine Environment and the Coastal Area of the Mediterranean in accordance with the Barcelona Convention. After four decades of environmental cooperation, the Mediterranean Action Plan continues to be ambitious and relevant towards a peaceful, prosperous and sustainable Mediterranean region, where societies will enjoy a high quality of life within healthy marine and coastal ecosystems [2].

The Sustainable Development Goals of the 2030 Agenda emphasize that economic growth must be accompanied by social justice and environmental sustainability. For this reason, the UN Development Program (United Nations Development Programme), the International Finance Corporation and the International Petroleum Industry Environmental Conservation Association (IPIECA) collaborated to create an Atlas on the contribution of the industry of oil to the Sustainable Development Goals [3].

Given the vigorous relevant discussion worldwide, as we anticipate the importance of the question to drill or not to and the difficulties in answering it, the present paper provides a methodological discussion on the aspects that need to be considered when evaluating possible costs and benefits, especially in in Eastern Mediterranean. In the following section we proceed with a short overview of recent experiences from drilling activities and relevant policy documents. The third part provides the main analysis, where, after discussing shorty the main framework of Cost Benefit Analysis (CBA), we proceed with specific methodological notes that need to be considered when applying it in the specific issue we are dealing with, in general and also especially in the case of the Eastern Mediterranean.

2. Recent Experience from Drilling Activities

Among the policies promoted by the Mediterranean Action Plan it is also the Mediterranean Strategy for Sustainable Development 2016-2025, which was approved in February 2016 and constitutes a comprehensive political and strategic direction framework for all interested partners. Oil addressed by Goal 1 which refers to ensuring sustainable development in marine and coastal areas and Goal 5 which refers to the transition to a green and blue economy [4].

The oil and gas industry is at the heart of the global economy and many national economies, including developing and emerging countries being a crucial driving force for economic growth. However, in our time, from their reckless use, in addition to the positive effects, there are also negative effects. This industry faces climate change as a key challenge, along with the

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concerns resulting for the "Dutch disease" scenario. That is, while oil and natural gas enabled industrialization and human development, their use contributed to the increase of carbon dioxide in the atmosphere, which in turn contributed to global warming [5].

Although there is no single path to a future with net-zero GHG emissions, the Atlas presents a series of actions that could contribute to the stabilization of atmospheric pollutant concentrations and global temperatures, in line with the *Paris Agreement* on climate change. The *Paris Agreement* is the 1st universal, global, legally binding climate agreement, which was signed on 22 April 2016 and ratified by the European Union on 5 October 2016. Its long-term goal is to increase the global average temperature to 1 .5 degrees Celsius above pre-industrial levels [6].

Essentially, the *Atlas* encourages the oil and gas industries to incorporate into their operations techniques that will be in line with the Sustainable Development Goals. Collectively, Atlas aims for the following three results [7]:

1. Strengthening the understanding between the relationship of Sustainable Development Goals and the oil industry,
2. Raising awareness about the opportunities and challenges posed by Sustainable Development Goals and ways the oil industry could address them,
3. Dialogue and cooperation of all interested parties to achieve the above two.

The primary responsibility for the implementation of the Sustainable Development Goals country governments have. At the same time for each Sustainable Development Goal, the *Atlas* provides a subset of targets that are deemed to be of particular importance to the oil and gas industry. For this reason businesses should appreciate the importance of each objective, prioritize them and try to integrate them into their activities. The achievement of Sustainable Development Goals will also benefit the oil industries themselves. However, the relevance of each Sustainable Development Goal varies from company to company and depends on a number of variables such as location, size, duration of the project and more. Some Sustainable Development Goals they may apply to an enterprise globally, while others relate only to the project life cycle. A company also faces different challenges in its different activities [8-9].

The 14th goal concerning oil seeks to promote the sustainable management and protection of the seas, coastal ecosystems and biodiversity. In our time over a third of the oil and natural gas extracted comes from offshore areas. Offshore drilling often faces greater technical challenges and more difficult conditions. They also create the risk of harming or disrupting the marine ecosystem and migration routes through pollution, noise or leaks. At the same time, many coastal operations are carried out in areas that are little explored. Therefore, the cooperation of the companies is required to improve the techniques [10].

The *Atlas* for the 14th Sustainable Development Goal focuses on the following areas:

- Incorporating environmental considerations into action plans: The offshore oil and gas industry operates in a variety of environments, including coastal waters, deep waters and estuaries. All are made up of unique ecosystems and biodiversity. Mitigation of potential impacts requires the creation of environmental management plans that can be implemented throughout an operation, incorporating any marine ecosystem that may be affected.
- Minimizing and addressing ocean acidification: The oceans absorb about 30% of the carbon dioxide produced by the consumption of fossil fuels, resulting in their acidification. Since the start of the industrial revolution there has been a 26% increase in acidification, with impacts on fisheries, aquaculture and tourism. To reduce this rate, governments should adopt a lower gas emission energy system in their businesses. One such example is the Blue Carbon Initiative. It is a global program focused on mitigating climate change through the conservation and restoration of coastal and marine ecosystems.
- Accident prevention, preparedness and response: The primary goal of companies should be prevention and continuous improvement of facilities where oil is extracted, transported or stored. But beyond prevention, industries must be able to deal with any incident should occur by implementing a well-prepared oil spill response plan. Projects such as the Global Initiative created by the International Petroleum Industry Association on Environmental and Social Issues (IPIECA) and the International Maritime Organization19 bring together governments and industries to help countries develop national oil spill preparedness and response structures [11-12].
- Transfer and sharing of marine technology: Oil and gas companies need to collaborate both with each other and with academic scientists to develop technologies and conduct studies to improve the protection and understanding of the marine environment. A typical example is the response program to an oil spill in the Arctic [13-14]
- Coordination of biodiversity research: Protecting marine and coastal areas is knowledge of the environment and the changes that can occur. This requires extensive, continuous research and collaboration of scientific bodies. Given the sheer volume of research, a central repository can be useful for coordination, management, and information sharing and opportunity exploitation. Atlas proposes the harmonization of the oil industry with the Sustainable Development Goals in a theoretical framework. However, in the continuation of the chapter, the situation in the Greek area is presented [15-16].

3. With respect to Cost and Benefit Analysis

In general, natural resources bring risks. One is that too many people become locked in low skill intensive natural – resource – based industries, including

agriculture and thus fail through no fault of their own to advance their own or their children's education and earning power. Another risk is that the authorities and other inhabitants of resource – rich countries become overconfident and therefore tend to underrate or overlook the need for good economic policies as well as for good education and good investments [16].

Cost Benefit Analysis (CBA) is a method of evaluating investment plans and their impact with a view to economic and social well-being. In other words, it is a socio-economic approach, since it assesses the costs and benefits of a project taking into account the social dimension. Nowadays, this method is widely used by many governments and organizations to evaluate public works and policies with the ultimate goal of developing both the economic and social well-being of citizens. But beyond this dimension, the CBA used in the private sector to evaluate and decide between investment scenarios.

It is very important to mention that CBA It is not a specific method, but an analysis approach, since in the literature it appears in various forms and several models. The choice of the appropriate model of analysis differs in each case and depends on the preferences of the analyst, the constraints on the collection of analytical data and the level of development of each country or organization.

Although there are several variations of the analysis, there are some key commonalities. The social interest and not the direct interest of the investor are used as a benchmark for measuring the impact of public spending. This is done with various quantitative criteria in order to evaluate a comparison: whether or not to do the project / investment / policy. In this but the point of analysis, introduces the subjectivity of each author and is one of its most difficult points. At the same time, if the market prices do not represent the real cost and benefit, then the shadow prices are used. Also, since the formulation of a policy at the moment and that its effects will be seen later at a different time, their discount is required so that the costs and benefits can be compared. The identification / investigation of the parameters can be performed within a hierarchical ontology of functions.

The model estimation methodology in the case of the eastern Mediterranean can be carried out in laboratories of various types and forms: legal and epistemological independent laboratories, laboratories integrated in research centers or universities, laboratories legally independent, but with cognitive dependence or interaction, have emerged as techno blasts (spin offs), laboratories connected with professional bodies, with institutionalization from within, i.e. the state body, laboratories connected with professional bodies, who have established and operate them (bottom up).

In the case of the eastern Mediterranean, the adaptation of the model requires the multi-criteria choice of an organizational scheme, which includes criteria such as: the operation of independent companies with private capital base, research centers, and units connected to research centers. The selection criteria include the following: average operating costs, flexibility (i.e. low dead-end point), reliability, feedback - and use of results to further promote applied research, job creation in the wider field of activity.

The methodology adopted is heavily based on the marginal analysis, where total cost consists of two conflict variables C_1 and C_2 and total benefit consists of two conflict variables B_1 and B_2. The partial cost C1 is an increasing function of NR with an increasing rate (i.e., $dC_1/d\,(NR)>0$, $d^2C_1/d\,(NR)^2 > 0$). On the other hand, the partial cost C_2 is a decreasing function of NR (i.e., $dC_2/d\,(NR) < 0$ and if the respective rate is algebraically increasing (i.e., $d^2 C_2 / d\,(NR)^2 > 0$ or absolutely decreasing (implying convexity of the corresponding curve, then there exists an optimal value NR* as equilibrium.

The cost-benefit analysis is done in the form of two scenarios, the optimistic and the pessimistic and leads to the possibility of making intermediate estimates in the area defined between two poles, the optimistic and the pessimistic version (best / worst case reasoning).

The cost of extracting a natural resource is a function of the level of extraction. This cost consists of two sub – costs, the cost of mining and the cost of the 'no – mining'. According to classic economic theory, the optimal level of extraction is determined by the minimization of the total extraction cost, which corresponds to the point of intersection of the two conflicting marginal quantities (marginal economic analysis).

So, where C_1 is the partial cost of mining the natural recourse including the cost of 'Dutch Disease' phenomenon
C_2 is the partial cost of the 'no – mining' and

$MC_1 = dC_1/d\,(NR) > 0$, the marginal cost of the mining (C_1)

$MC_2 = dC_2/d\,(NR) < 0$, the marginal cost of 'no mining' (C_2)

The total cost is a function of the quantity of the natural recourse (NR),

$C = f\,(NR)$

$C\,(NR) = C_1\,(NR) + C_2\,(NR)$

C (NR) must be a min C (NR)

$d\,C/d\,(NR) = 0$ or

$d\,(C_1+C_2) / d\,(NR) = 0$ or

$d\,C_1/ d\,(NR) + d\,C_2 / d(NR) = 0$ or

$dC_1 / d\,(NR) = -\,d\,C_2 / d\,(NR)$ or

$|d\,C_1/d\,(NR)| = |d\,C_2/d\,(NR)|$ or

$|MC_1| = |MC_2|$

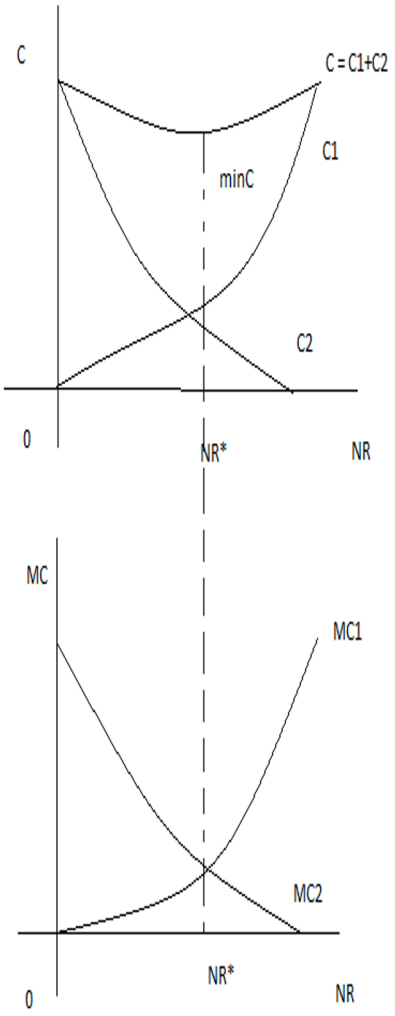

Fig. 1. Dependence of partial costs C_1 and C_2 on Natural Resource (NR) and shifting of its optimal value NR*

Where, B is the total benefit of the mining of the natural recourse, B_1 is the partial benefit of the natural resource and B_2 is the partial benefit which is lost due to 'Dutch Disease' effect from the de – industrialization, respectively. Where, MB_1 is the marginal benefit of B_1 and MB_2 is the marginal benefit of B_2.

$MB_1 = dB_1 / d(NR) < 0$ and

$d^2 B_1 / d(NR)^2 > 0$, due to the 'Law of Diminishing Returns'

$MB_2 = d/B^2 / d(NR) < 0$ and

$d^2 B_2 / d(NR)^2 > 0$, due to the scale of economies effect

The total benefit is a function of the quantity of the natural resource (NR).

So, $B = f(NR)$

$B(NR) = B_1(NR) + B_2(NR)$

B (NR) must be a max B (NR)

$d B / d(NR) = 0$ or

$d(B_1+B_2) / d(NR) = 0$ or

$d B_1 / d(NR) + d B_2 / d(NR) = 0$ or

$dB_1 / d(NR) = - d B_2 / d(NR)$ or

$|d B_1/d(NR)| = |d B_2/d(NR)|$ or

$|MB_1| = |MB_2|$

Where, B_2 (NT) is the lost social benefit causes by the output effects of the de – industrialization. De – industrialization will be grater but the adverse effects of the boom on profitability in the lagging sector will be less because of the capital outflow. In the area of East Mediterranean Sea and especially in Greece, where the industrial sector is lower than in the North Europe, B_2 (NR) tends to be $B_2' < B_2$.

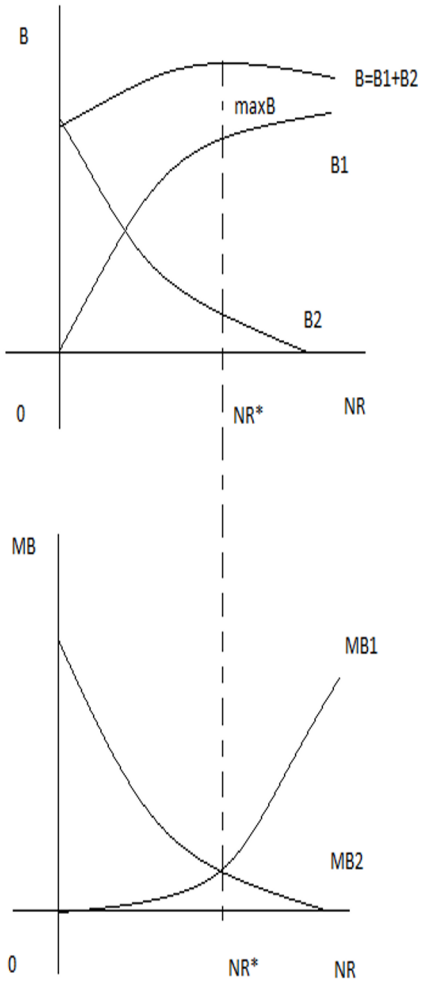

Fig. 2. Dependence of partial benefits B1 and B2 on Natural Resource (NR) and shifting of its optimal value NR*

Where, B' is the total benefit of the mining of the natural recourse in the area of Mediterranean Sea, B_1 is the partial benefit of the natural resource and B'_2 is the

new partial benefit which is lower due to 'Dutch Disease' effect from the de – industrialization, respectively. Where, MB_1 is the marginal benefit of B_1 and MB'_2 is the new marginal benefit of B'_2.

$MB_1 = dB_1 / d(NR) < 0$ and

$d^2 B_1 / d(NR)^2 > 0$, due to the 'Law of Diminishing Returns'

$MB'_2 = d/B'_2 / d(NR) < 0$ and

$d^2 B'_2 / d(NR)^2 > 0$, due to the scale of economies effect

The total benefit is a function of the quantity of the natural resource (NR).

So, $B' = f(NR)$

$B'(NR) = B_1(NR) + B'_2(NR)$

$B'(NR)$ must be a max $B'(NR)$

$dB'/d(NR) = 0$ or

$d(B_1+B'_2) / d(NR) = 0$ or

$dB_1/d(NR) + dB'_2/d(NR) = 0$ or

$dB_1 / d(NR) = - dB'_2 / d(NR)$ or

$|dB_1/d(NR)| = |dB'_2/d(NR)|$ or

$|MB_1| = |MB'_2|$

The application of CBA aims to highlight that the project is financially desirable and in line with EU objectives and at the same time to prove whether or not the viability of the project requires the contribution of the funds. In other words, it is a tool for assessing the financial benefits of the project and thus evaluates all the consequences, i.e. the financial, environmental, social, etc. The purpose is to translate all these consequences into monetary units so that the costs and benefits of the project can be properly determined. The level of analysis is related to deciding what costs and benefits will be considered and depends on the size of the project. For this reason, the local, regional, national and community impact of the project is taken into account. For a project to be considered "large", its total cost must exceed 25 million euros in the case of the environment and 50 million in other sectors.

To become a complete CBA need to be able to identify potential profits from mining activities. Without them the analysis is incomplete and no scenario can be chosen safely. But beyond the profits there is a need to include in the costs all the areas of interaction. More specifically, in the case of Greece, the costs arising from the environmental burden are divided into both direct and indirect. Immediate is what arises from the influence of hydrocarbons on marine biodiversity as well as the cost of purifying water from a possible oil spill. Indirect are the opportunity costs arising from the impact on other sectors, such as fisheries and tourism. Along with environmental costs, there is a need to include as an opportunity cost the costs that come from the negative effects of the outbreak of the Dutch Disease, such as the closure of industries. Finally, it would be an omission to exclude the indirect costs arising from the geopolitical developments in the wider region (as detailed in the previous chapter on Dutch disease in the Mediterranean).

4. Discussion

The policy developed in this work includes both drilling cost and dialing cost. Introductory remarks are made on the cost and benefit of such an investment. The connection is also made with the Dutch Disease Model. The net benefit resulting from the comparison of the total cost and the total benefit is determined as a range of values within which the optimal value that determines the optimal degree of extraction with economic criteria and following the methodology of marginal analysis.

5. Concluding Remarks

In closing, in order to be able to answer the question whether or not research should be done and subsequent mining of hydrocarbons in the Eastern Mediterranean, one should consider all of the above. Many times it is possible to lead to political answers. But as Climate Change is more visible than ever, the potential costs of these activities are difficult to assess, the European Commission is proposing that Europe become climate neutral by 2050, and perhaps the above answer may be easier. If the dialogue succeeds and the Green Agreement is signed, at least European countries will be forced by law to switch to alternative energy sources and stop extracting hydrocarbons. Therefore, Greece was slow to turn to mining activities and probably better for it as a country, as it is located in a politically sensitive and fragile area, while at the same time it is on the verge of lithospheric plates that are already quite seismically active.

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