Sustainable development and the need to manage taxes on pollution

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Abstract: The extractive industry is unanimously acknowledged as being a vital sector of any country which owns workable natural resources. The experts claim that this industry is a source of foreign income, of direct foreign investments and it is also the main and sometimes the only energy provider of a country. The activities carried out within the extractive industry of any country provide employment to population and contribute to the public budget by taxes and dues, while the incomes resulted from these activities can be directed towards charity; however, at the same time, there is a certain environmental risk related to each initiative that is being carried out in this industry.Given that ecological research has begun to study environmental phenomena and interpret data and information on economic and social relations taking into account environmental restrictions, as to draw conclusions about the effects that such restrictions have on economic and social life, this paper intends to determine the extent to which costs provide maximum benefits for quality of life in general and human in particular.

Key-words: environment, extractive industry, impact, marginal cost and benefit, models, taxes on pollution, non-renewable resources, sustainable energetic development

1 Introduction

The extractive industry activities are widely recognized as having a significant impact upon the population, both from the financial and from the social, cultural and environmental point of view.

More and more it has been emphasised the need for minimising negative impacts and promoting positive elements that could control the external threats while also developing the competences of those involved in the process of minimising the unwanted impact.

Ecological research, lately intensified, highlighted the systemic nature of planetary lifetime, the close interdependence between environment and human activities and the causes underlying the emergence of imbalances in the whole system, with negative effects for life in general and human in particular.

Moreover, economic research has begun to study environmental phenomena and interpret data and information on economic and social relations taking into account environmental restrictions, to draw conclusions about the effects that such restrictions have on economic and social life, including quality of life, and human effects on improving environmental conditions.

A number of theorists and practitioners of environmental movement from different developed countries stresses that safeguarding nature has two objectives: to preserve the fundamental resources - air, water and soil - in the form and proportions necessary for human welfare; and to preserve the elements necessary for human development throughout the aesthetic, educational or scientific approach.

Progress made by Romanian researchers in this area is reflected in crystallizing the idea that environmental quality is a defining component of life quality. Implications of environmental quality on quality of life have intensified the economic problems of environmental costs versus the benefits obtained. Natural resource allocation may not only maximize the environmental effect, as most often say eologists. Allocation of resources should consider finding an optimal level effect in the interest of all human society.

Following observations and empirical studies, it was found that there are relations of dependence between the degree of reduction of pollutant residues, on one hand, and cost and the benefits to be achieved by total control and actions to reduce pollution, on the other hand. It has been demonstrated, for example, that the cost of pollution abatement in total activity describes the degree of pollution as an exponential curve.

The first steps to reduce the concentration of waste without polluting brings the most important effects; then additional measures to reduce waste with the same beneficial effects on life quality, requires spending more. Also it has been found that the evolution of positive effects on life quality for achieving different levels of pollution describes, roughly, logarithmic or semi-logarithmic curve form.Therefore, the problem requires continuously determining the extent to which costs provide maximum benefits for quality of life.

2 Debate upon sustainable development

Behind the sustainable development theory stands the opinion that the environment is a critical natural asset, essential both for consumption, e.g. breathing a clean air, as for maintaining the production to go on. Therefore, harming the environment may be seen as capital erosion that reduces both quality and quantity of its repeated services.

Due to these facts, breathing contaminated air or drinking polluted waters lead to decreasing the human welfare; contaminated soils reduces agricultural productions; fish stocks depletion leads to unemployment and diminishes fishery revenues etc. Economists and other researchers have been seeking for a while to identify the degree of environment's use compatible with natural capital preservation.

Economists, as Smith, say that sustainable development is a new theory that originates in the 1980's Global Conservation Strategy of the International Union for Conservation of Natural Resources. In this study the authors stand that sustainable development is a strategic concept implying a sustainable use of natural resources, genetic diversity preservation and ecosystems maintenance. Three years latter the UN established the Global Commission for Environment and Development for setting out a global changing agenda. Under the leadership of former Norwegian Prime-Minister Harlem Brundtland, in 1987 the Commission published its final report known as "Our Common Future". This document stated that sustainable development is the kind of development that satisfies its present needs without compromising future generation's possibilities of satisfying their own needs.

Pearce and others described the way that Brundtland Report determined that sustainable development to be a concept such popular among other disciplines and opened searching for other more definitions. Even though sustainable development became a usual statement only recently, the concept itself is not a new one.

For example, in forestry industry the concept of sustainable management is well familiar for biologist, engineers and forest-relate-economists from Martin Faustman's researches of 1849. In fishery management, sustainability is well known since Gordon, Scott and Scheafer, while in agriculture, writings about sustainable farms date since 18-th century as according to Eliot and Young.

Moreover, existentialist economists formulated different approaches upon sustainability. Hick showed that we must define the maximum income that a person can spent during a week having no lacking. With this theory Hicks clearly defined the sustainable consumption in opposition to irrational actions, as selling family's silver-ware in order to meet weekly consumption.

According to Winpenny, a more complete definition for sustainable development became a "sacred spring" for environment economy as Pezzey suggested 60 definitions and Pearce suggested only 30 definitions. Anyhow most of the definitions are similar to that suggested by Hicks.

Probably the most appropriate definition for sustainable development is the one that status the interregional integration aspects, as suggested in Brundtland Report; other good definitions were formulated by Tietenberg, Winpenny, Repetto, O'Riordan and others. All these definitions draw the interest due to their getting back to economic science of ethical and moral judgements.

The economic analysis based on classical utilitarianism denies that present generation to have any moral obligation for the future generations, as Turner said; in utilitarianism a rule is considered as necessary only if it maximize the total utility even where there are losses in the processes.

When interregional environmental decisions are made, e.g. planting a new forest, stopping the burning of a tropical forest, expanding the use of nuclear energy that lead to radioactive wastes for long terms, a cost-benefit analysis (CBA) is required in order to measure the benefits that such project may bring to the society.

Some economists are not very severe when considering the moral duties at this stage because they consider CBA as an alternative. Pearce says, "As a procedure for aggregating our preferential sets of individuals, in the beginning we shall establish a thing of major importance: CBA does not pretend to produce right moral decisions. That CBA really produces and is moral correct may coincide only if we shall adopt a new rule: only some of the aggregates are the moral way for adopting the decisions".

In other works, Pearce and others define sustainable development as a vector of desirable social objectives, as increasing per capita real income, improving population's health and nutrition, educational achievements, nondiscriminatory access to resources etc. Then he says, "the elements to be included in this vector are subject to an opened ethical debate". In other words, sustainable development is opened to ethical debates, while CBA, in which actual decisions are made at micro-economic level, the ethical problems are not taken into consideration. Thus, Turner demonstrated that CBA is an integrated part of sustainable management of resources; but there are contradictions and confusions.

Probably that with the aid of opened and rational discussions will be eliminated most of the contradictions related to sustainable development. But not everyone is optimist regarding the future prospecting. Brown showed that sustainable development begins to become a transcendental term. Others, as Shearman, said that instead of concentrating on a precise definition, it would be much helpful to be more concentrated upon the implications in any context in which sustainability may be applied. The concept is used as a modifying factor in development and growing of ecosystems, and is much important to understand its meaning in the context it is used in.

Most of the economists relate economic growth to the improvement of nation's welfare, this may causing sufferance for the majority (Daly; Douthwaite). According to Smith, more than anything, the economic growth may cost more than it worth. Particularly, the actual resources' distribution patterns in a developing economy may lead to major shortcomings for the population by accelerating the environment's degradation process.

In his works, Frank showed that "the development of undeveloped" is a rule today and consists of a process directed to affect specially the future generations. According to Clark, humanity enters a new era of serious and complex environmental issues.

As regarding the environmental issues, they are characterized by profound scientific ignorance, enormous mistakes in taking decisions and market and institutional failures (Bulearca *et. al.*, 2010/1). Some of these problems, as the ones regarding acid rains, greenhouse effect, ozone layer depletion, acidification of tropical forests and nuclear contamination are irreversible.

Moreover, many of these problems are related one to another, the ad-hoc individual solving of the problems being insufficient, as Smith said, because they depend of social and political factors that offers inadequate technical solutions.

And these are the reasons why the following parts of this paper will deal with the ways in which the extractive industry takes into account the above mentioned principles of sustainable development.

3 The extractive industry vs. non-renewable resources

Practice indicates the fact that some conflicts of interest frequently occur between the companies that benefit from the extractive industry end products and the environment regulations that attempt to minimise the negative external elements that result from the activity of this industry.

On one hand, Fiorino (2006) and Press (2007) discuss about the controversial impact that regulations have upon the performance of companies. On the other hand, as an answer to the shareholders' pressure, companies have begun to increasingly integrate the concept of corporate social responsibility, while more and more impact studies are subjected to the opinion and judgement of the public (Brake, 2007).

Some references to Porter's work (1991) come to support the idea that well-structured regulations can reduce the negative impact upon the environment and can relaunch the activities which are specific to the extractive industry based on some new, innovative components that should generate both profit and environmental protection. Porter's approach of "win-win" type represents the object of a great number of studies and articles but, unfortunately, some quantitative approaches (Jafe *et. al.*, 2002, Smith & Walsh, 2002) based on econometric methods practically invalidate the hypothesis.

Once accepted the fact that the majority of the most serious environmental problems are related to the use of non-renewable natural resources in the production process, we can admit the necessity to discuss some aspects that include (Grimaud & Rouge, 2008): which economic policies allow optimal implementation, what is their impact upon the economy and, in particular, what is their contribution to the technical progress?

In the specialty literature, these aspects have already been discussed and there are two periods that we could consider to be relevant in the evolution of the research.

Throughout the 1990s, most authors tackled partial-balance patterns. Preoccupied with optimal trajectories, Withagen (1994) showed the way in which the current resource consumption should be less if pollution is taken into consideration. Therefore, extraction/ exploitation should be postponed.

Sinclair (1992) demonstrates that an optimal tax on added value in the use of non-renewable resources should be decreasing. This point of view is criticised by Ulph and Ulph (1994) who considers that this result is not thoroughly accurate, especially regarding the environmental regeneration expenses and the extraction costs. Other authors, such as Hoel and Kverndokk (1996) or Tahvonen (1997) take into consideration the possibility to use top non-polluting technologies (*Best Available Technologies - BAT*).

More recently, in the 2000s, the problems caused by the use of non-renewable polluting resources have been placed in the context of general-balance patterns with endogenous increase. Schou (2000, 2002) studies two types of patterns – one based on human resources and the other on research and development, in which pollution caused by the use of non-renewable resources negatively affects both production (2000) and the user/beneficiary (2002). In both cases, he demonstrates that an environmental policy for the implementation of the optimal solutions would not be necessary.

Grimaud and Rouge (2005) discuss about a similar pattern, in which the good performance of the economic and social entities is affected by the level of pollution, without entering the details of the effects of pollution according to the type of activity. Similar to the results obtained by Sinclair (1992), the alterations at the tax level result only in a rent transfer (Bulearca *et. al.*, 2010/2). In this case it is demonstrated the necessity of an environmental policy, in the sense that the optimal tax (ad valorem) must be altered according to the impact, in time, of evolution at the level of pollution.

The main differences between the above-mentioned literature and the work of Grimaud and Rouge (2008) results from the fact that the authors put the question in the context of two different sectors. Actually, they take into consideration an economy in which two inputs are simultaneously used to produce output: a non-renewable and polluting resource on the one hand, such as fossil fuel, and a second, non-polluting, input, materialized under the form of work investment (for a similar type of input, see the work of Smulders and Nooij (2003)). In this case, non-polluting technologies will be considered for reducing carbon emissions, such as, for instance, solar energy technologies, the authors referring to this type of input as being a work resource.

There are three objectives the authors put forward, namely: to compare the trajectory that a decentralised, "laissez faire" type economy might have in reaching the optimum; to study the impact of economic policies (more precisely the elements related to research/development and the political climate) upon the specific balance variables (specifically the route of forest lumbering) and, ultimately, to establish the optimal values of the economic policy instruments.

Last but not least, the specialty literature takes into consideration the way in which a society perceives pollution. In recent times, economists have started to pay increasing attention to the aspects that deal with the degradation of the environment from one generation to another.

The problem related to the modality in which a society not only externalises costs but also transfers them into the future is getting more and more complicated if we take into consideration the effects of such a transfer, materialized in the decrease of the individual future welfare. This injustice that is transferred from one generation to the other is studied from the point of view of the conditions in which it occurs and of the effects that are recorded in case of asymmetrical information, more precisely in the situation in which a generation perceives the level of pollution as being different from the actual level (Schumacher, Zou, 2008).

Starting from the correct identification and from the realist highlighting of these aspects, each primary energetic resource has some particularities that individualises its problems, as follows:

a. Coal. Coal is perceived as being an energetic resource with positive, but also negative, valences:

- positive is its contribution to guaranteeing safety of supply and it being part of the diversification of energy sources;
- negative is the impact upon the environment. If the local environmental impact can and will be reduced by means of technological measures and measures to reduce the affected

areas, the global impact of the use of coal upon the greenhouse gas emissions still triggers significant concern.

The clean coal processing technologies are increasingly developed in Europe and therefore the efficiency of coal-based power stations has already reached 47% and tends to increase up to 50%. The technologies which trap carbon dioxide from thermal power plants emissions will be widely available in the following 10 years. However, clean coal costs will still be high in terms of economic efficiency, but they will be compensated by the contribution to the safety of the supply and to the economic stability in case of large price fluctuations on the energetic resource market.

The directives regarding the air quality are those that have an important impact upon the use of coal:

- The directive regarding the integrated prevention and control of pollution; it is the Directive on which the licensing of large power plants in Europe is carried out, as per the environment protection aspect;
- The Directive of large combustion power plants;
- The frame directive regarding the air quality, with its sisters for sulphur dioxide, nitrites, slurries, lead, carbon dioxide, ozone and benzene, as well as other directives under development regarding the limitation of the heavy metal content (nickel, arsenic, cadmium) in the air;
- The Directive regarding the national emission ceilings (NEC), which limits the values of sulphur dioxide, nitrates, hydrogen sulphide and volatile organic components;
- The Directive regarding the ozone layer.

The environmental issues of the coal industry, which are not strictly related to energy, are covered by the directives relating to water treatment plants and water protection.

Although the control of air pollution and the policy of coal usage do not naturally follow the same direction, being even contradictory, a compromise should be reached, compromise that should also take into consideration other objectives of the energy policy, especially those referring to the contribution of coal to guaranteeing resources and competitiveness. There are hopes that the new technologies will be able to reduce, up to one third, the emissions resulted from the use of coal.

b. Oil. The environmental problems that result from the oil industry and from its use for energetic and transportation purposes are related to air quality, water quality, climate changes and fuel quality. Regarding the use of refined products, there are still great differences between the refining level required by the S/M market and that in the Central and Eastern European countries. In the countries that are in the process of adhesion to the EU or that are candidates to the EU, the demand for oil products that have a lower polluting potential is much lower as compared to the EU.

The demand for oil products is and will continue to be increasing. In the EU, forecasts indicate a share of 40% from the total consumption of the oil energetic resources in 2020. Under these conditions, the changes imposed by the environmental protection will determine a clear orientation towards clean oil products. This will require the development in two directions: a complex of inter-relations between the energy policy and the environmental protection and a comprehensive approach that should take into account, on the one hand, the scientifically-established integrated evaluations and, on the other hand, the targets established for the environmental protection in the durable development context.

For instance, the reduction of the polluting potential of transport fuels might result in an increase in carbon dioxide emissions produced by refineries. That is why a closer collaboration between all the involved factors seems to be the most appropriate way to treat the complexity of the problem.

c. Natural gas. From the environmental point of view, natural gas is considered to be “the gate towards durable development”. The impact upon the environment generated by the use of natural gas has a local dimension (particles, smoke), a regional one (acid rains) and a global dimension (greenhouse gases).

The negative impact at all dimensions could be reduced through the use of clean gas, with a low level of sulphur and carbon, through the use of energetic-efficient technologies and through the reduction in energy demand (thermo-insulating technologies in constructions, adapted life styles). Gas technologies match very well those for the development of renewable resources.

Gas fuel is appropriate for technologies which increase energy efficiency, for instance in condensing boilers.

Gas burning in power plants has the potential to reduce the carbon dioxide emissions. The use of gas in co-generation will double the power production produced based on gas in the European Union. However, this situation will also determine derangements and breakdowns in the competition domain, between the old, low-efficient power plants and the new, efficient ones.

4 Models for determining taxes pollution

From the economic point of view, the environmental protection expenditure maximum level that can be made to is the point where total cost equals the total positive effects. But careful analysis reveals that a zero difference between the benefits and costs would be reached in the foreseeable future, unless they would remain the same or industrial technologies would grow slower than the pace of deterioration in the environment.

Reality demonstrates that the progress on improving or introducing new technologies in the last three decades are more pronounced towards the elimination of pollution, clean recovery of new resources or substitution of polluting resources with other clean or cleaner resources.

The unsatisfactory situation reached regarding the advanced status of pollution in some countries and regions is due not to the lack of technological solutions, but especially to the long time neglect of such important issues as a result of either ignorance of their scale phenomena or negative failure consequences, or insufficient economic mechanisms put in the service of immediate interests, without taking into account the perspective of life quality of individuals and entire communities.

In order to have a better management of natural resources, on one hand, and to reduce environmental pollution, on the other hand, the use of instruments for this destination is detailed below.

In the beginning we have to understand the various costs involved in pollution control. Regardless of the original way for financing this remediation action, the population has to bear a burden on the following four ways:

1) as tax payers, when bearing high taxes because there are grants awarded to companies that install pollution control installations and equipments;

2) through increased products prices, because as long as subsidies cover only a fraction of the remediation equipment cost, the other part having to be supported by companies that have installed them, operators “passes” some of this burden to the public;

3) through additional payments in the future, because at the companies’ already paid level for pollution control equipments and lower investment in other equipments, increase in productivity and production is reduced.

4) through loss of jobs, due to the fact that pollution control standards determine closing plants, and although the highest costs public occur, even those who live near large pollution prefer pollutants than job loss.

Thus, in one way or another cost control pollution affects us all.

Because is so expensive to control pollution the cheapest methods have been chosen (see figure 1). First we must understand why government intervention is essential. Why government facilitates private market? Why we can not count on the "invisible hand" of Adam Smith in limiting pollution?

Good’s marginal cost to society, pointed by the long arrow MC_S, includes both internal marginal cost of producing company (filled arrow), and the marginal external cost of producing company (shaded arrow).

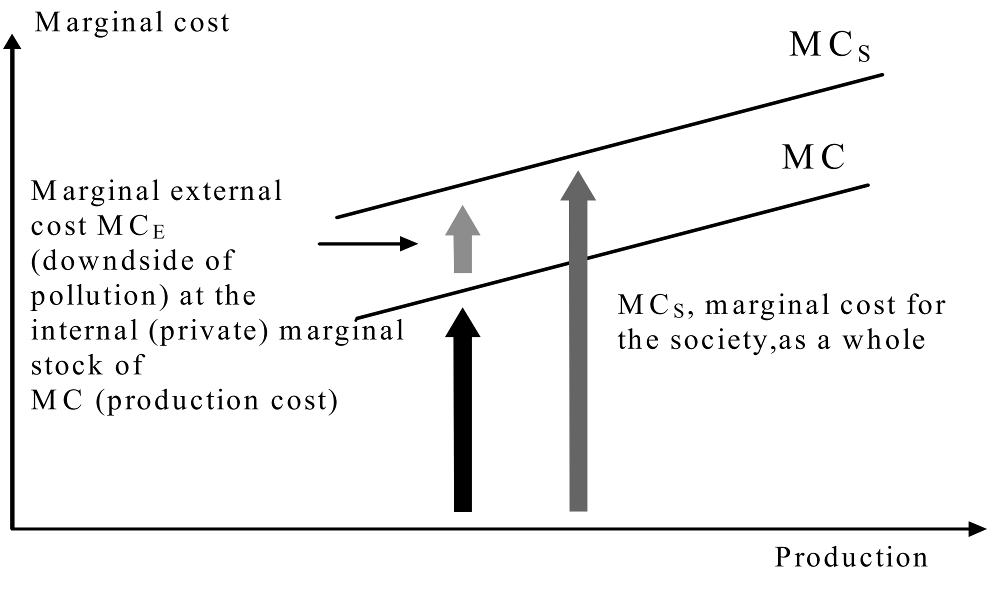

Fig. 1. With pollution, private and social costs differ

Pollution: an external cost. When there is pollution, private and social costs differ. To understand why, let's consider a pulp and paper mill located on a river. Paper cost for the society includes not only company's private or internal production cost, but the cost of downstream companies that have to face water discharges made by upstram companies. While the factory has to pay for the cost of domestic production, any downstream cost is external to such operations, since the cost must be borne by the others.

Internal or private costs are costs incurred by those who actually produce or consume the good.

External costs, also known as neighbor costs or spillover costs are costs incurred by the others. Pollution is such an example.

Let's consider a simple case. Suppose that each unit is treated with a quantity of fluid which is then released as waste in the water. Assume also that each unit of this fluid causes constant damage downstream. As such, each unit of output produced requires a constant external pollution cost, shown in figure 1 by the short shaded arrow. When is added to internal cost borne by the producers (filled arrow MC), the result is the long arrow MC_S, which is the marginal cost to the society of this good. MC_S is constantly higher than MC because of the assumption on constant external cost per unit of output produced.

Pollution control: the simple case. When we have such an external cost, even in a perfectly competitive market economy it results a poor allocation of resources as seen in figure 2.

Before applying antipollution tax, industry supply is S_1, which reflects only the private internal costs of producers facing the sellers. This supply equals the demand in point E_1 through an output Q_1. This production is inefficient because the marginal social cost exceeds the benefit for all productions between Q_2 and Q_1.

For example, last unit Q_1 does not deserve to be produced; its benefit, as shown by the shaded arrow below the demand curve is less than the costs to society (also the shaded arrow plus the filled arrow below curve MC_S). Loss of efficiency is the sum of these filled arrows that is the shaded triangle.

After apllying tax r, producers are forced to face both internal cost and external one, so their supply curve shifts upward from S_1 to S_2. D and S_2 now have a balance in t_2, through the output Q_2. This is efficient because the marginal cost and benefit are equal. Efficiency gained by reducing output from Q_1 to Q_2 is the elimination of shaded triangle.

In figure 2, MC and MC_S are reproduced from figure 1, and the demand D is the marginal benefit of this both private and social good. S_1 shows that firms are willing to offer. This curve measures the internal private costs – the only costs firms face in their decision to offer. With the demand D and supply S_1, perfectly competitive equilibrium is reached in E_1.

For society, E_1 is not an efficient income because it only equalizes the marginal benefit and marginal private cost. An effective solution requires that the marginal benefit equals to the marginal social cost MC_S. This happens in E_2, at a lower production Q_2. We conclude that in a free market, competitive firms produce too much of a pollutant good Q as compared to effectively quantity Q_2. Is in the interest of society to decrease the production of these goods and use resources to produce something else.

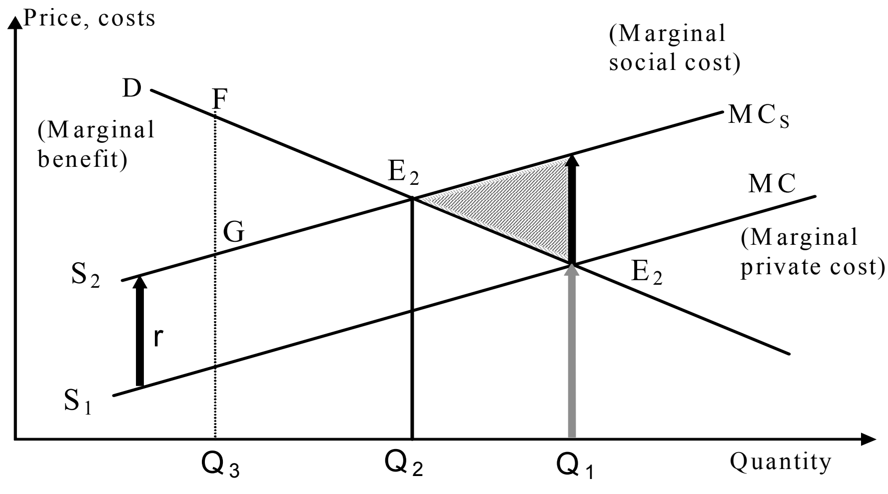

Fig. 2. Loss of free market efficiency when there is an external cost

To confirm that Q_1 is an inefficient production, worth noting that the benefit of the last unit produced is shown by the shaded arrow below the demand curve. However, its cost is even higher, since they include both private costs (the same shaded arrow) and its external costs (indicated by the filled arrow). So, this filled arrow represents the net loss in producing the last product unit Q_1. As long as there is a similar loss in producing of each unit "in excess" between Q_2 and Q_1, the total loss of efficiency is measured by the shaded triangle.

In this case, there is one possible way to solve the situation: the manufacturer imposing a uniform tax equal to marginal external cost shown by the filled arrow. Thus, the tax "internalize" the externality: the manufacturer is forced to face both external costs and internal cost. As a result of this tax, supply curve shifts upward from S_2 to S_1: for confirmation, we have to remember that the offer reflects the marginal cost, and he stood by the size of the tax to be paid. The new equilibrium is in E_2, where the demand and new supply S_2 intersect. This new production Q_2 is efficient because marginal benefit equalizes the social marginal cost. Finally, the gain in efficiency of this taxation policy is the shaded triangle, the loss of efficiency at the beginning, which has now been removed. In short, as a result of this tax, the company receives a benefit that otherwise the market would not offer: pure water.

There have been suggested several ways to reduce pollution. One is setting a limit on the production of polluting companies; another is the introduction of property rights.

Such a limit may or may not solve the problem; in fact, is better than to do nothing. For example, suppose that production is limited to Q_3. Considering the situation shown in figure 1, one can demonstrate that producing too little, a loss for society will occur, that is triangle FE_2G.

As long as the loss will exceed the initial loss, in this case the improvement will be worse than in the original case.

It may be noted also that a greater restriction of production will lead to a higher loss in efficiency. Thus, an arbitrary limit of production may be an ineffective policy. A better approach - if pollution costs can be estimated - is to impose taxes on these amounts. Then, the correct degree of pressure will be applied on the market to push back from production from the initial Q_1 to efficient production Q_2.

Pollution control: the complex case. In practice, policy makers must deal with situations more complicated than those shown so far. First, pollution is not from one polluting industry. Second, pollution and production are not only linked to a situation similar to that already presented, in which each additional unit of production generate an equal amount of pollutants; in most cases the latter varies.

A good can be produced with large amounts of pollutants that are discharged without any restrictions in water or air. However, if the waste is treated, or when using pollutant fuels, this situation will result in a lower amount of pollutants.

Consider a company that treats its waste, and use cleaner fuel but more expensive. This company reduce pollution, but at a certain cost. This cost to reduce pollution for all companies in an area shown in figure 3 as curve MCR (where R is to reduce pollution).

Q_1 is the amount of pollutants that might occur in the absence of control measures. By shifting us back to the left of MCR, we notice the cost of reducing pollution for an additional unit - for example, by installing pollution control equipment. So, if pollution was restricted on the way back to Q_4, any greater reduction would involve very expensive antipollution measures, implying a cost showed by the high filled arrow.

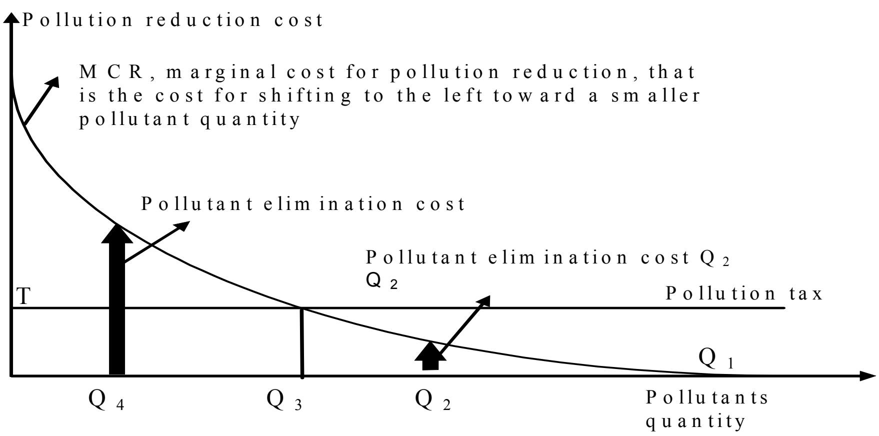

Fig. 3. The cost of reducing pollution and the effect of a tax

If a pollution tax T is applied, companies voluntarily reduce their pollution, shifting from Q_1 to Q_3. As long as they are still at the right side of Q_3, they will continue to reduce pollution because its cost (e.g., short filled arrow) is less than the cost to pay the tax. However, they will not shift to the left of Q_3. In this side, it costs more to reduce pollution (high filled arrow) rather than continuing to pollute and pay the tax T.

Through Q_1, has been designated the amount of pollutants that occur when no restriction is imposed. As it reduces pollution, firms shift to the left on curve MCR. At first, remediation costs are lower. For example, the quantity Q_2 of pollutants can be removed at a lower cost pointed by the short filled arrow. However, further reducing pollution, the lower curve becomes higher as companies shift to the left.

5 Taxes on pollution – a major goal for environmental purposes

Until a few decades ago there were few restrictions on pollution. Therefore, companies preferred to discharge pollutants instead of treating them. The result was the amount of pollutants Q_1.

To prevent this situation, the government wants to dramatically reduce pollution. Suppose they want to reduce by half, from Q_3 to Q_1. Policies are as follows:

Option 1: Pollution tax. Suppose the government imposes a tax on emission – ie, a tax on each unit of pollutant discharged in the environment. Specifically, in figure 3 suppose that T is the tax payable per unit of pollutant. Then, businesses eliminate pollution in the right side of curve MCR, where costs are lower to curb pollution (e.g. small filled arrow), rather than continuing to pollute and pay the tax T. However, pollution is reduced simply to the Q_3 where curve MCR intersects the line of tax. Left to this point, the cost of reducing pollution is high, as illustrated by the large filled arrow. Indeed, the cost is higher than the tax T. So in this area, companies can be encouraged to pay taxes and continue to pollute.

Although “taxes on emissions" have been much supported by economists, still they are not often used. However, in a similar approach, there are some cases in which comanies are required to pay pollution - even if payment is not directly related to each unit of pollutant. For example, EPA (US Environmental Protection Agency) Superfund, a multibillion dollars program for random chemical waste cleanup, was initially financed by imposing taxes on companies that pollute heavily.

Option 2: A physical limit imposed on the pollution level of each company. A question may arise: Why to have so many problems with setting a tax on pollution, as in figure 3, as long as the pollution can be reduced by the same amount through a simple and direct control, ie by asking each company to reduce pollution by half? The answer is that, even if this approach would lead to the same abatement level of pollution, this situation would involve higher costs of remediation (cleaning), as will be further explained.

Not all companies face the same pollution abatement costs by applying a tax, pollution is reduced by companies that can achieve this at *the lowest cost,* ie firms at the right of Q_3. Companies from the left of Q_3 will continue to pollute. However, if all companies would be required to reduce pollution by half, companies from the left of Q_3 should in this case, to participate, even at the cost indicated by the filled long arrow.

As such, the advantage of a tax is that "it lets the market to go". For companies that respond at applying the tax, pollution is reduced by those companies that will do this in the cheapest possible way. Thus, the company devotes fewer resources for cleaning. Gains can be substantial. Wallace Oates of the University of Maryland assumed that the pollution tax would cost the company 75-80% less than a policy of demand (taxation) of all companies to reduce pollution by the same percentage.

Which of these two policies have been adopted by governments? The answer is surprising: rather than let the market work by the existence of several taxes on pollution, governments have relied primarily on regulatory controls. Physical limits imposed by the pollution were introduced for certain companies - a policy, as shown, involving undue additional costs.

There are recent encouraging signs that governments are moving towards a third solution, a compromise that allows individuals to set limits on pollution, but at the same time, to let the market work and, as such, to avoid undue additional costs.

Option 3: Physical limits imposed on the contracting of the pollution permits on pollution emissions. The third option is that the authorities set a specific limit on the amount of pollutants allowed to each company. For example, each company is allowed to pollute only half the level of pollution in its past. So far, the situation is similar to that of Option 2. At this time intervenes the turning to let the market work: companies are allowed to buy and sell "pollution" permits.

It can be shown that in a perfectly competitive market, permits will be sold at the right price T. Companies at the right of Q_3 gain by selling their permits at the price T and by remediation actions at a lower cost shown by the short filled arrow. For the companies at to the left of Q_3 is cheaper to buy permits at price T to continue to pollute than to spend more on remediation, costs represented by the large filled arrow. Thus, pollution is lower only for the companies at the right of $Q_{3,}$ which may realize it at the lowest costs. So, in Option 3 as it can (easy) sell permits on the market, pollution can be reduced at the same low cost as in Option 1 that involves a pollution tax.

Therefore, the effects of Option 1 and 3 are higher than those of Option 2. Only in Option 2 – where all companies are required to reduce pollution with a fixed unit - the high cost of remediation is taken only by the companies at the left of $Q_{3.}$

In these circumstances, the general principle is: ***Pollution can be reduced to lower costs if the government gives way to market forces.*** He can change the incentives by imposing a tax or applying permits sold on the market and then allowing businesses to operate and respond to the new conditions created. Companies are the only one the most aware of their cost levels and thus are best able to choose the path that will minimize these costs.

Basic conclusion is: as Option 2 does not use market principles, is more expensive than Option 1 or 3. But comparing Option 1 to 3, which is preferable?

A comparison between Option 1 and 3. These two choices differ by an important issue. In Option 1 companies are penalized. If they cease to pollute, they have to pay the cost of remediation. In any case they are inversely affected by the applying of pollution tax.

However, in Option 3, through the permits sold on the market, companies do not neccessarely have to lose. Indeed, those with lower costs for remediation actually gain. They can sell pollution rights for a price T that is greater than the total cost for remediation. While companies with high costs for remediation are affected in the opposite direction, they do not lose as much as they would lose by imposing a tax like the one in Option 1. Why? In Option 1, they have to pay tax T for all pollutant emissions. In Option 3, they do not bear a cost for some of their pollution – that is the pollution which is covered by free permits which they were secured.

The fact that polluting companies prefer applying Option 3 makes the application a much more attractive option for the government. Productive activity does not influence too much on it and can assimilate easily into the legal framework. Thus, pollution can be controlled without interminable delays.

However, even Option 3 poses a problem. Why even activities that have polluted in the past are entitled to permits and some may even sell them? In other words, some companies may benefit from pollution done in the past? This suggests that, on an equal basis, Option 1 is preferable because it penalizes the old pollution instead of rewarding it.

Therefore, it was assumed that the government has set as a goal to reduce pollution by half, to $Q_{3.}$ Why not by third or three quarters or other percentage? Below is shown how objectives can be prefixed.

How much pollution can be reduced? In figure 4, MCR is reproduced from figure 3. Moreover, we have here MCP, which is the ecological cost of additional units of pollutants. The best goal is to restrict pollution to $Q_{3,}$ where MCR equals MCP.

The two curves, MCR and MCP should not be confused. MCR is the cost of *reducing* pollution - for example, the cost of pollution control equipment. On the other hand, MCR is the cost of *allowing* pollution. As long as there is only a small amount of pollutants - $Q_{4,}$ say - the marginal cost to allow pollution (MCP height) is small. First wastes that are discharged in a flow are generally absorbed by the environment. As pollution increases, emissions increase and become more dangerous; that means we move to the right, and the MCP curve increases.

With these two curves, the best goal is to reduce pollution by $Q_{3,}$ where MCP equals MCR. Any other quantity is not desired, as can be illustrated by the case in which pollution is left completely open and eventually reaches $Q_{1.}$

For all quantities of pollutants at the right of $Q_{3,}$ MCP is higher than MCR, so it's a mistake to allow pollution any further. To assess the social cost of this mistake we may consider such a quantity, say $Q_{2.}$ The cost of eliminating this quantity of pollutants is the height of curve MCR, shown by the empty arrow. This is less than the cost of allowing further pollution (the height of curve MCR that is both arrows). Therefore, the net cost of allowing such pollution is the filled arrow. If we sum up the costs of all quantities that are similar between Q_3 and $Q_{1,}$ the result is the shaded triangle that is the loss to society by allowing pollution to exist further to unchecked Q_1 instead of limiting it to $Q_{3.}$

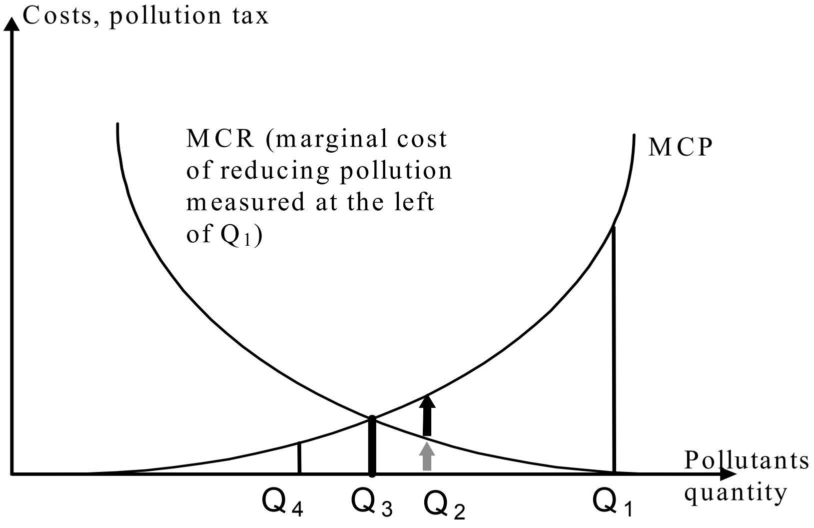

Fig. 4. Loss of efficiency by allowing pollution uncontrolled

On the other hand, a policy to reduce pollution at the left of Q_3 causes a loss also. For example, if pollution is reduced to Q_4, the cost of the last quantity is the height of curve MCP above of Q_4. However, this last unit of pollution exceeds the cost of disposal (the height of curve MCR). Removal is a mistake.

In conclusion, it seems that the best objective, Q_3, can be found only by taking into account both the cost of allowing pollution, MCP, and the cost of removing it, MCR.

Unfortunately, in practice is not so easy to estimate the objective Q_3 due to the difficulties in estimating MCP and MCR. For example, in an attempt to estimate the marginal cost of pollution MCP, we do not know precisely how dangerous pollutants are actually. Moreover, there are many pollutants and the damage it produces each may depend on the presence of the others.

6 Conclusions

On the background of the general characteristics and of the content of the dimensions of durable development at global, regional and national level in the extractive and energetic industry, this development acquires specific connotations stemming especially from the depletion and the non-regeneration of mineral resources that ensure the basis-of-existence for the two industries.

The attempt to decipher these particularities and to highlight the economic implications upon the respective industries allowed shaping of the following relevant aspects:

1. The depletion of some of the natural resources imposes their rational exploitation, at a pace that should guarantee their preservation for as long a period as possible.
2. The pressure upon natural resources could be reduced significantly through a superior valuation of the national capital of such resources.

From the sustainable development perspective, although the extraction of the mineral resources has significant polluting effects upon the environment in the extractive unit areas, they can nevertheless be significantly reduced by the appropriate organisation of activity and extra-care granted to the environment.

A requirement in understanding sustainable development is that the future generations should be compensated for the damages that our present activities produce. According to Pearce and others such a thing is successfully achieved if we let to future generations a capital stock as important as the one we have today at our disposal, a stock that allows them to achieve a welfare similar to ours.

The stock capital includes both artificial capital and natural capital. If a part of the natural capital, as tropical forests, is cut down for agricultural purposes, then the incomes arising from this activity should be reinvested to form other capital forms, as according to Pearce. As long as a few types of natural resources are nonrenewable ones, as deposits of fossil combustibles or tropical forests, any positive use rate of the present generations may reduce the stock available for the future generations. At the time when exhaustion of these capitals is accompanied by other forms of capital creation, we may talk about maintaining a “constant total stock”.

Yet, this is not a convincing way of thinking. Firstly, is doubtful if expansion of agricultural fields might be an acceptable compensation for the losses of tropical forests and extinction of species. Secondly, even if capital stock would include technological know-how for maintaining/increasing the actual production rates, the extinction of species may undermine the creation process itself. Thirdly, the supporters of the rule of the capital's constant maintaining assert that the issue to be discussed is stock's value and not its volume. To assess stock's value, environmental stocks should be assessed similar to human stocks. Anyhow is very difficult, if not impossible, to assess the whole stock of environmental attributes at national level, globally considered.

Above all this, it is sure that on the conditions of population's growth, on one side, and the exhaustion of natural resources, on the other side, the future generations will record worse per-capita indicators. It's true that due to scarcity, prices of the natural resources will be greater in the future and thus their value would be maintained; but this fact should not stand as an advantage for their survival. Another aspect is that as long as the future generations are not here with us, we can not know which will be their values and preferences when considering interregional decisions. This is a pessimistic argument, if not an unfair one, to justify any foolish activity.

Instead of unconventional figures for the net domestic product (NDP), the use of other forms for welfare indices, as measurement of economic welfare (MEW) suggested by Nordhaus and Tobin, or its substitute proposed by Daly and Cobb, should of great interest during the sustainable development debates. Indeed, conventional national income statistics do not deal with the adverse effects caused by pollution, noise and urban agglomerations upon human welfare.

Moreover, the economic growth measured through gross domestic product (GDP) can not demonstrate natural capital's depletion (as compared to the exhaustion of the conventional capital, like buildings, machinery, tools etc.). If national fish stock, deposits of fossil combustible, natural forests, farm's soil fertility etc. are constantly decreasing while the economy "grows up", then the figures for NDP would give completely wrong signals to decision makers. One nation can not sustain its own economic expansion level under while exhausting its own natural capital. When such situation happen then resulting figures regarding economic development may appear very different as compared to the conventional figures.

Recently, natural resource related economists, as Repetto and others, modified national income statistics of selected countries by allowing the depletion of their natural capital for certain resources, e.g. oil deposits or forest stocks. It is obvious that there was a practical reason for such kind of approaching the assessment of national income, but first of all it should be considered some other fundamental issues: the actual national accounting system should be maintained or completed only?; the selling of metal and fossil combustibles deposits should be considered as an income or as a capital selling?; finally, where should be drawn the line between defense expenditures and other kind of expenditures? Anyhow, all these questions and others are subject for further discussions and will be considered in one of our future papers.

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