# LOW ENTROPY: CREATING PHYSICAL BASIS FOR ECONOMIC VALUE BY ENVIRONMENTAL POLICY TOOLS

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**Abstract**
*The economic value is expressed by prices, but their high volatility was a strong reason to consider other elements to be used for measurement. The most appropriate elements for this were established by the theories of value that explain how value is created, enhanced, transferred, and how it influence prices. By revealing the changing economic contexts that forced these theories to adapt and to use different physical basis for value calculation it is prepared a framework model to analyse the current environmental policy. The case study of carbon markets highlighted the limited possibility of restraining access to common goods signalling that a proper addressing of the environmental challenge will necessitate more important changes to be made.*

**Key words:** *environmental policy, low entropy, theories of value, scarcity, carbon market*

**JEL Classification:** *D46, H23, O13*

## I. INTRODUCTION

Contemporary economy is more and more frequently pointed as a system that is not able to deliver social wealth within acceptable limits for the Earth's inhabitants. At least two categories of facts could be mentioned in this respect. Firstly, the world is still divided between few rich people and many more poor people and secondly, the type and comprehension of crisis situation is growing.

Huge gaps between rich and poor nations persisted in the modern history despite the efforts of international organizations that were specially designed to address the challenge from various perspectives. Moreover, the gap is deepening and the number of people affected by poverty, water scarcity, hunger, lack of access to education and sanitation continues to grow. The indicators of the Millennium Development Goals project, one of the most ambitious global initiatives to boost the progress toward sustainable development, are in many cases far behind targets although the due date is very close (Author et al., 2013a).

The environmental crisis depicted in early 1970s is showing more and more symptoms around the world. Continuous increase of carbon dioxide concentration, mirrored more and more consistently by the raise of air and water temperature, high rate of extinction for many species, the great Pacific garbage patch, extreme events with growing impacts, toxic waste deposits, villages depopulated because of mounting e-waste, cities drowned in smog and many other situations are proves of the environmental crisis that challenge the modern society. The environmental crisis threatens not only the wellbeing of humans, but also their survival by undermining the stability of natural systems on that society is still relying despite the ability of modern technology for controlling a growing number of ecological factors (Author, 2014).

The outbreak of the financial crisis in 2008 revealed many weaknesses of the modern economy and banned many nations to economic crisis and recession. The peril of resource exhaustion is yielding its first effects consisting in land grabbing. By this large scale of land procurement from developing countries is made by organizations or individuals from more developed countries. The process was boosted by the world food price crisis of 2007-2008 (Author et al., 2013).

Most of the unacceptable situations mentioned above are approached as managerial issues and engage the knowledge and resources in corrective actions that aim to reduce the so called market failures. These actions are derived from global visions built on both scientific results and experience, while the theoretical foundation of economic interactions is seldom questioned. The currently pursued models like sustainable development or green economy are underpinned by the premise that social wealth cannot be accomplished without economic growth (Author, 2013).

Nevertheless the basic economic concepts are not entirely beyond questioning and there is a growing body of literature that demonstrates how different economic paradigms could allow the design of better development models (Author, 2013; Author, 2011; Author et al., 2011; Author, 2009). For instance, by changing the premise of infinite needs of humans that supports the goal of continuous growth for consumption it is possible to limit at least material and energy consumption that trigger environmental crises. Measurement of happiness and the Happy Planet Index report are economic assessments that provide meaningful reasons to support such a paradigm shift.

The concept of value is a central issue in economics, although it is not a permanent concern. How value is related to price is the part of this debate that earned more focus since the factors that influence prices are of great concern for most economic actors.

The theories of value attempt to explain how value is created, enhanced, transferred from one actor to another, and how it influences prices, since price is the most obvious form of valuation in a world dominated by economic interactions. Differences between the values of similar goods or services at different moments or in different geographic areas are an economic reality that has deep implications for global and regional economies. Improving the understanding on the physical basis of value would allow more consistent explanations for these differences, but also the design of more effective policy tools that better adjust economic exchanges to the social and ecological restrains.

## II. THE IMPACT OF CHANGING ECONOMIC CONTEXTS ON THE PHYSICAL BASIS OF ECONOMIC VALUE

Value is a sensitive expression of human interactions that was addressed by various fields of knowledge, although it resulted in more comprehensive and analytical approaches in philosophy and economics. Axiology and ethics are the branches of philosophy that focus on what divide deeds and persons in good or bad on the basis of morality, while economics seeks to explain value as exchange value for goods and services.

Finding immutable elements that can be used for establishing the value of goods and services is a puzzling issue because price volatility creates serious threats for many businesses. Since the first speculative bubble of tulips in the Netherlands, then some bulbs of tulip were sold for a price that was ten times the annual income of a craftsman, economists acknowledged the complexity of the exchange value and reconsidered the importance of having a physical basis for that. Hence, the theories of value attempted to find at least one core physical reality that can be measured as the landmark for value assessment.

Value theorists had different opinions on the part of physical reality that should be used in this respect, fact that resulted in more theories of value, such as: labour theory of value, utility theory of value (marginal theory), power theory of value, and entropy theory of value. Their opinions mirror the economic contexts that reduced the explanatory power of the current theory and claimed novel approaches that are able to inform better all economic actors. These theories are also divided on the basis of the perception in subjective and objective theories of value.

Each theory of value explains most of the variation of value that is expressed in prices, but in the same time there are situations that cannot be predicted. In other terms, the theories of value have their strengths, but also their drawbacks in providing a proper rational for exchange value and a reliable explanation for its relation with price.

***Labour theory of value.*** According to this theory value is created in the production process and its physical support is the duration of work, known as socially needed time. This time is the time that is necessary for producing use value within the existing production processes that are normal from a social point of view and with a medium degree of social skill and intensity of work (Author, 2009).

The concepts of socially normal conditions and medium degree of social skills and work intensity are theoretical constructs that challenge measurement. The value is produced only by the production process and within this process by the work, which is expressed as units of time.

Human handling makes an intended change of an object. Thus, the process is disappearing in the product that has a use value and represents a substance from nature adapted by the change of its form to human needs. The work was combined with the object and enhanced its value.

In the production process the owner brings the capital that is used to buy two components: i. means of work and objects of work; ii. labour. The process of work produces an intended transformation of these two inputs according to the following rules: i. the value comprised in the means and objects of work is transferred entirely in the value of the product and represents its cost; ii. the work that transforms the object of work by the means of work is added as supplementary value of the product.

The theory emerged at a time then technical endowment was far less developed than today. Meanwhile the challenge was not to discover or create needs, but to cover the needs of a growing population. In addition, most of the products subjected to economic exchanges were products that satisfied needs situated at the bottom of the Maslow pyramid. Most of the machinery was handled by humans, labour scarcity being more frequent than its excess.

The criticism of the theory regards its scope and the so called miracle that enhance value by work. Hence, value has no physical basis within natural processes or systems, despite the fact that the objects of work are procured from nature. Further, the miracle of work was contradicted by the changing economic framework at the

end of the nineteenth century then engine based machinery boosted production and released labour. In such conditions the number of hours used for the production of a good was cancelled by the lack of demand for that product and the calculation of value was deeply affected.

***Utility theory of value (marginal theory of value).*** This theory was developed in the second half of the nineteenth century and attempted to replace the duration of work with a more appropriate physical basis for value assessment.

In this theory the physical basis is considered the marginal utility of a good or service. The marginal utility is the benefit brought by the last consumed unit of a good or service. Fact is the physical basis vanished being replaced by a subjective perception.

Utility means the satisfaction degree at that goods or services are preferred by consumers. The theory brings new elements as contributors for value creation such as:

- The consumer with his/her degree of satisfaction;
- Marginal utility.

The theory was unable to explain some major differences. The water-diamond paradox is illustrative in this respect and forced the emergence of an additional concept, the concept of scarcity. By adding scarcity in the equation the difference between the value of water and the value of diamond could be explained.

Technical capital and labour have similar contributions to value creation. The supplementary value is depending on inputs but also in the equilibrium price established at the point where demand and supply curves are meeting.

The production is limited by the needs of the consumer. When the marginal cost equals the equilibrium price the production should be seized.

The criticism of the theory consists in:

- Too much weight given to the multiplying effect of technical endowment. This led to investments in technique and technology and reduction of labour that resulted in high unemployment. Meanwhile the increased production capacity should be used for processing ever growing amounts of materials obtained on the expense of the exhaustion of natural resources and pollution of air, water, and soil;
- Outbreak of crisis then the circulation of value is blocked. Interventions such as advertisement, consumption credit and monopoly are aiming to correct the faults of the theory.

The utility theory of value is lacking a solid physical basis, since the marginal utility is the result of a subjective perception and its size is function of the amount of goods or service that are consumed.

***Power theory of value.*** This theory was developed in recent years being promoted by the collaborative work of Author (2009). The main premise of the theory is the compulsory nature of the economics-politics relation.

According to its proponents this theory considers as physical basis of value the power gained by a certain actor within society. Thus prices do not express external laws, but the relations that are internal to a certain society. Capitalization is the measure of power and every capitalist is struggling to accumulate greater earnings than its competitors.

Capital is important not only for the production process, but as facilitator of access in higher levels where the subsystems that have impact on a certain enterprise could be influenced. The concept of proactive behaviour coins this action and is already promoted as one important condition for business success.

Fact is production and human costs cannot be further reduced, while inputs such as raw materials, energy, water etc. are available at higher prices. That leaves almost no other option for managers who are forced to improve profitability than to look upward in order to create enabling conditions for their enterprise. In addition, access in higher social levels allows exchange values to rise and push prices higher than it could be derived by the application of both labour and utility theories of value.

Capital is understood as physical capital and money, although it should be complemented by other forms of capital. A growing body of research demonstrates, for instance, the more and more important role to be played by the social capital.

The physical basis of value is more concrete, since almost any form of capital could be transformed in monetary terms, although little is known about how the monetary size of the capital relates with the actual power of its owner.

***Entropy theory of value.*** This theory is making a step forward a more consistent physical basis by exploring elements that are outside the scope of economics and that are studied by other sciences. The hypothesis that underpins the exploration of such a direction is that value is stemming in processes and components of the economic systems, but also in processes and components of natural and social systems. Thus raw materials, energy, water etc. were considered inputs that have no contribution to the value creation. Likewise, utility is a function of the benefit perceived by the consumer for his or her self. The utility of a good or service for the society is not considered here, although the addition of individual utilities will not necessarily result in benefit for the society (Author et al., 2011). Moreover, the perception of the utility is influenced by the social interaction and cultural and historical background of a society.

The major change that triggered such an approach is related to the additional concept that supports the explanatory capacity of the utility theory of value, namely the concept of scarcity. The wide availability of natural resources such as soil, oil, natural gas, various ores, water etc. were interpreted by the utility theory of value in the same way as it was the endless demand by the labour theory of value. After 1972 then the Club of Rome issued the "Limits of growth" report it became clear that the abundance of resources is not a reality and even goods like clear water, unpolluted air, waste disposal sites, along with all other natural resources are fulfilling the conditions of scarcity (Author et al., 2013).

The entropy theory of value claims that value is stemming, on the one hand, far upstream from the manufacturing unit, and on the other hand, it should be discounted by the effects occurring downstream to the economic process. That means a broader range of processes and elements to be considered as physical basis for value creation (Author, 2009).

Entropy is the concept that outlines the availability of materials, energy, and information, which are the basic forms of matter, by expressing the level of their internal order or their degree of organization. Low entropy is the characteristic that allows something to be used, while high entropy excludes this option (Author, 1994). This model was developed taking in account a note of Schrodinger according to that living beings owe their internal order to the fact that they feed on low entropy from their environment. Such interpretation caused the wide adoption of the system approach that allows pursuing the transformation of matter and the measurement of the entropy. According to the law of entropy, high entropy is generated spontaneously, while lowering entropy needs effort.

The physical basis of value is the degree of organization that is expressed as the potential of a natural element or process for an economic transformation. Building on this, Author (2009) claims that the potential is a system's capacity to provide organization. He also differentiates this potential for broad categories of systems, such as natural potential, biological potential, social potential and economic potential. The value results by the activation of these potentials and subtraction of the organization loss due to waste.

The entropy theory of value is still a proposal that is debated mainly by academics. The paradigm shift proposed by this theory is hindered by the relative nature of entropy and by the challenge of measurement. Thus, the same reality is low entropy for a system and high entropy for another system. For example, soil is a form of low entropy for agriculture, while for a transport infrastructure is high entropy. Further the transfer of organization degree in prices is still unclear and is possible that scarcity would represent an important landmark in this respect.

## II. SCARCITY – STEPPINGSTONE BETWEEN LOW ENTROPY AND ECONOMIC VALUE

The value of low entropy becomes apparent then a good or service is scarce enough to allow the competition among its users. Pricing low entropy is possible by creating such conditions. As long as users have free access to natural resources the value of low entropy will not be priced. Meanwhile, the value of high entropy cannot be priced unless there is competition for the means of its reduction. It also should be kept in mind the fact that the possibility to generate high entropy by pollution, waste disposal, ecosystem disturbance etc. could be framed also as a resource that allows discounting of exchange value by the broadening of the scope for low entropy. For instance, the value of a waste disposal space could become an input for the calculation of exchange value based on the scarcity of space available for this purpose.

There are a number of environmental policy tools that were designed in order to limit the access to natural resources that enable competition in order to integrate the value of the resource in the cost. These include cap and trade schemes, payments for ecosystem services, biodiversity credits etc. (Author et al., 2013). The proper design of these levies is hindered by many aspects, among the most important being the effectiveness of the means used for restraining access to resources and sizing scarcity in monetary terms.

In the first case, the uneven application of access restrains allows competition to occur between actors that should pay for access and the ones that could escape from this payment. Thus instead of increasing the demand for low entropy along with the growing of needs, part of these needs are satisfied by relocating production in places were such restrains are not enforced. For example, the demand for carbon permits decreased while the carbon emissions continued to increase (Author, 2012).

In the second case, the lack of scarcity cancelled the economic value of many natural resources that are perceived by consumers as free goods or services. For the monetary expression of their economic value there are employed a number of techniques that attempt to measure various components of the total economic value. Some of these techniques are using market prices as reference, although for other components there is no such input. Despite many decades of application and improvements, the comparability and reliability of the results continue to be quite low. For instance, the lowest estimate for the economic value of a protected area is more than ten times smaller than the highest estimate for the same type of protected area. Such differences undermine the effectiveness of policy tools in restraining access for low entropy sources.

## III. CASE STUDY: CARBON MARKETS

Carbon market is one of the most advanced environmental markets born out from the implementation of the climate change policy. The rational that underlies this policy tool is that limiting the access to air as pool for emissions there are created scarcity conditions that allow pricing the low entropy represented by the capacity of the atmosphere to absorb carbon dioxide.

The carbon market is entirely a policy construct designed to reduce the amount of emissions to a level that is compatible with the capacity of the global ecosystem to absorb carbon dioxide emissions in order to prevent the accumulation of this greenhouse gas.

Kyoto Protocol is the global agreement that enforced this policy tool and its ratification was made within the United Nations Framework Convention on Climate Change (UNFCCC). The overarching goal of the Kyoto Protocol is to keep the concentration of carbon dioxide below the level that corresponds to a 2 Celsius degree increase in global average temperature. The model of the global carbon market and the ambitious goals of the Kyoto Protocol stimulated national and regional initiatives that led to the development of regional and voluntary carbon markets (Author, 2013).

The markets that allow the transaction of carbon dioxide emissions are the followings:

- Kyoto Protocol: mandatory. Carbon is transacted by emission trading, Clean Development Mechanism, and Joint Implementation projects;
- EU Emission Trading Scheme: mandatory. It is a cap-and-trade system in which each source received a number of allowances based on historical data and other parameters;
- New South Wales Greenhouse Gas Emissions Trading Scheme: mandatory. Is a national scheme from Australia that covers electricity retailers and other emitters;
- Chicago Climate Exchange (CCX): voluntary. Is the first carbon market established in North America that allows the interaction between emission sources and offset projects from North America, but also from Brazil.
- Voluntary Over-The-Counter Market (OTC): voluntary. Comprises all carbon transactions that are occurring outside CCX. Because there is no upper limit for emission, there are not established allowances and the transactions are made for the carbon offsets of various projects;
- North American Regional Markets: voluntary. These markets are developed at state level, mainly in the northern part of the US, being established in order to compensate the lack of national regulation regarding carbon emissions. Western Climate Initiative, California AB32, Regional Greenhouse Gas Initiative are the most common carbon markets of this region.

The most important international carbon markets are the Clean Development Mechanism (CDM) and the European Union Emission Trading Scheme (EU ETS). The first one allows the signatory state to procure Certified Emission Reductions that allow the compliance with their Kyoto commitments. In the second case, there are regulated the emissions from power generation and other industries.

Within the CDM, there are registered more than 6000 projects that fall in one of the following categories: solar power projects, biomass plants, industrial projects, wind farms etc. All these projects concentrated investments of 215 billion USD that were made in 81 countries.

Between the supply and demand of carbon emission reductions initially there was a balance. This equilibrium was shaken by the financial crisis from 2008 because many industrial polluters reduced the volume of their production to a level that made unnecessary the acquisition of emission permits. Therefore the demand for carbon emission reductions was significantly lower than the supply causing an abrupt fall of their price. Thus the same permit that was sold in 2008 with 20 USD, in 2012 had a value of only 5 USD. Such difference indicates that scarcity creation is more challenging than it was assumed. The effectiveness of CDM is also hindered by the fact that the two of the largest contributors to the global emissions, USA and China, are not activating on this market.

The price of carbon is depending on how the market is regulated, fact that influences the rules of exchanges and also the ones used for establishing caps and allocations. Due to these interferences, there is little predictability for carbon prices.

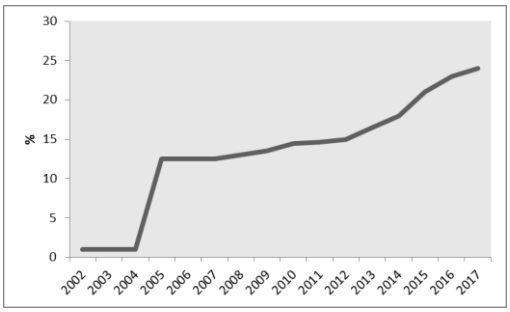


**Figure 1 Carbon dioxide emissions' coverage by carbon pricing schemes**

*Source: authors representation using data from Author, A. (2013) title, http://onclimatechangepolicydotorg.wordpress.com/2013/03/, accessed March 15, 2014.*

The expansion of carbon markets' coverage above more and more emitters should tighten competition that could result in increase of carbon prices. The outlook for the coverage of these markets indicates that less than one quarter of emissions from both energy and industry will be covered by these markets until 2017 (figure 1). Most of the carbon emissions are escaping commercial exchanges, making limited access the main barrier for the action of low entropy as basis for value-price relation.

## IV. CONCLUSION

Predictability continues to challenge our minds in all actions in the quest for a more reliable future and more comprehensive planning. Meanwhile a number of variables are still escaping the ability of normal science to anticipate their evolution and interaction. In a business environment all these uncertainties are mirrored by price volatility and eventually by low or gain in profit.

Having a physical basis for the calculation of economic value as basis for price is still a challenge for economics. The analysis of the theories of value revealed that along with the change of economic conditions the reference for economic value estimation was modified. In fact, value was associated with the ability to overcome the main restrain of economic interaction. Thus, then the main restrain was labour, the physical basis for value was a standard amount of labour. Once this restrain became obsolete, the usefulness of a good or service took its place the etalon being the marginal utility. Currently the limited availability of natural resources pushes value estimations toward low entropy, estimated on the basis of scarcity. The case study for carbon market, which is the most advanced environmental market, revealed that limiting the access to a common good is amongst the most important barriers that prevent the pricing of natural resources although they are holding the low entropy on which both economic performance and human lives are depending on.

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