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DOCTORAL DISSERTATION:

Energy - An Economic Approach
- Past, Present and Future Prospects -

(Abstract)

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This doctoral dissertation: "**Energy - An Economic Approach, Past, Present and Future Perspective**" aims to make contributions in Economics presenting a topic with a great potential of meanings. By carrying over four chapters, the thesis tries to outline possible answer to be given to two questions that troubles the worldwide economists' minds, as follows:

- **Is the energy just a resource subjected to the constraints?**
- **What is the impact a negative response in economic theory would generate?**

The importance of these answers seems to have a similar role to that of Einstein's Theory of Relativity on Physics as a science, in the early XX Century. It could be a turning point in the approach of economic production processes. Even if, at first glance, an answer to the first question seems not to have an impact on economic theory, in general terms, a negative answer could change the suggested perspective, while the deep influence that it generates could lead to the redefinition of economic concepts with a major impact in the very structure of the economy as a science.

The thesis structure is designed in order to gradually get over the approached subject issue, trying to highlight the implications that some explicit responses could generate, both in terms of practice and theory.

The first chapter, "Energy Resource, from Liberality to the Constraints - Coordinates of Development in Romanian , European and global areas" proposes a review about the concept of the energy and of the five principles that represent the basis of its definition. In this chapter are also established the details of this concept, regarding the humanity's perception on the environment.

The concept of energy resource and its progressive evolution determined by present discoveries and technical progress, highlights the fact that development and economic growth is a direct conditioning relationship with the need for power.

Showing the real dimensions of hydrocarbon's evolution, the greatest actors on the energy market were immediately highlighted. Their presentation was made taking into the account the ownership structure of public and semi-public companies, listed on international stock exchanges and unlisted companies owned by states and organizations.

Strategic control of the energy sources and continuing struggle caused by the armed conflicts and political interests and power, led to the so called seven-induced oil price crisis. The effects of these crises were acutely felt in the world economy. We called them induced crisis

because the factors that led to these barrel oil price crises are not related to the intrinsic nature of the product.

Gradual awareness of the consequences of oil dependence, prompted a coalition of importing countries, especially of the industrialized ones grouped in the OECD, for the purpose of an organized reaction to the situation created. The institutional form of this reaction gave rise to the International Energy Agency (IEA), founded by OECD countries (except France, Finland and Iceland) in November 1974. Member States have implemented policies to reduce oil dependency by increasing energy efficiency and developing alternative energy sources. In this context, a picture of the structure of primary energy consumption in Romania, reveals that 82% of the national energy source is a type of non-renewable, namely coal and oil. The answer to the justified question upon the awareness of the decision makers in Romania about the state of the energy sector can only be negative. This is because in recent years, national interest was not to balance the energy system of Romania. Similarly, there is a negligence on the use of national energy resources, the lack of concern of reducing consumptions by retrofitting technology and investment. Also, since 1990, technical losses have been thrown by the energy industry into the selling prices, and this has continuously contributed to economic inefficiency of most sectors of the national economy.

The energy security has become an essential component of national security and national interest. The competition for the energy resources gives, along with the other areas, a particularly important economic dimension of the international relations. The economic security of a country is measured in the light of its dependence on imported energy resource. Energy is the engine of the economy and any disruption in this area can interfere with dramatic effects throughout the economic life of that country. For this reason, decision makers of various industrialized countries, explore ways forward to ensure energy resources needed to develop their economies. Such analyzes are hardly breaking toward public since their economic impact may have incalculable consequences. Such studies and their information are used in the development of coherent and pragmatic politics in relation to the findings of these studies. Responsible governments of industrialized countries have begun to provide budgets for production capacities of complementary sources of energy.

Civilization today is based essentially on energy, a tremendous amount of energy. The future of hydrocarbons will be influenced by the four factors that will determine the dominant type of energy source: geological, technological, economic and political.

An affirmative answer to the question "Is energy just one resource subjected to the constraints?" could lead to a scenario that anticipates the emergence of a generalized systemic apocalyptic crisis. In coming decades, according to this situation, due to severe decline in production of oil and natural gas, their prices will rise steadily. This will inevitably lead to a crash of the dollar and of global stock exchanges. At the time, restricting consumption and saving resources will become the basic rule in Economics. In order to rationalize the energy reserves and planned production programs implemented by governments, coercion mechanisms will replace the existent ones on the free market.

On the other hand, a negative answer to the same question, opens entirely different perspectives, both on the approach from a theoretical standpoint and in terms of practical effect in the global economy. Creative ability and ingenuity of humans could generate solutions that fit to Godwin's optimistic ideology.

As a concept, alternative economy is a post-oil economy, where oil and gas are no longer indispensable economic resources and therefore no longer considered as strategic resources. Such an economy will use overwhelming renewable energy, characterized as coming from unconventional energy source, meant to free us from the trap of fossil fuels and the dangerous fission atomic reactions whose residues will choke full planet, unless you decide as soon as a fundamental change in the economic vision and scientific approach to energy sector. History of energy usage leads to the conclusion that those who have control of energy sources; the appropriate technology to exploit these sources are those who have power and leadership. This is one of the main reasons why renewable energy (solar and wind) or the alternative (zero point energy, electrostatic energy, nuclear energy produced by cold fusion, gravitational energy) ranks not first instance. Sun, wind and alternative power generation principles can issue important amounts of energy. Characterized by diffusion, this form of energy cannot be controlled completely. Perhaps the most interesting method of its use will be the small and simple plants. This will not lead to centralization and accumulation of power, unlike the situation of non-renewable sources of energy.

Chapter two of the thesis continues to support a negative answer to the justified question on energy capacity if it can be more than a constrained resource through economic arguments. For such a response, I approached from the perspective of economic concept of resource and economic category it belongs, meaning the factor of production. For this reason, I consider the disclosure option of so called "An outlook on production factors" as being warranted.

From classical perspective, the concept of factor of production "includes all the elements involved in the production of goods and services and it represents the economic form of resources, i. e. the premises of the business production"¹. From the economic point of view, the relationship of independence among volume, structure and intensity of the needs on the one hand and among quantity and quality of resources and economic structure on the other hand, there is always a continuity of the existence and evolution of the society. It is characterized by a state of constant tension between limited resources and unlimited needs regarded as an aggregate under specified conditions of time and space, being implemented in the so-called law of scarcity. Even if the level of supply and demand market is currently balanced, studies conducted in this regard demonstrate that the market can not ensure an universal access to resources.

Considering the perspective offered by this dissertation, human society has faced scarcity because of the local perspective to evaluate these resources. In the beginning it was about the scarcity of copper, then iron and gold. Today humanity is facing the scarcity of energy and water. However, we see that human society has always found the resources in order to increasingly satisfy the demanding human needs.

Resource scarcity manifests itself when man always relates to a closed system (local, regional). At the moment, human society has made the leap from local or regional development to the global or the universal one. This new approach is reflected by the awareness of humanity, of the place they occupy at the moment in the universe, by the fact that universally, Terra can be compared to a speck of dust in the vastness of the desert. In support of this theory and developed by Ludwig von Bertalanffy in 1952 that proves that the universe is organized into systems and sets of items located in interplay. The transition from theoretical analysis of closed systems to the open ones, actually represent the great change promulgated by von Bertalanffy.²

This new type of approach opens up completely new perspectives with regard to available resources that man can use in order to satisfy his needs. Thus the notion of "rarity of resources" claimed in the classical approach of economic phenomena loses importance and along with it, the apocalyptic connotations regarding the impossibility of ensuring the necessary resources for the human society development. The existent state of permanent tension between the unlimited needs and available resources in the context of the open systems disappears.

¹ *Manual of Political Economy*, "Lucian Blaga" University, Sibiu.

² Ludwig von Bertalanffy, *General Theory of Systems. Application to Psychology* in the volume *The Social Science: Problems and Orientations*, Paris, UNESCO, 1968.

The most coveted resource is oil, resource with specific property of energy storage and the ability to perform a mechanical work. However, we can say that if the scientific and technical progress will be able to offer people and economic agents, another way to gain access to quantities of stored energy in place of oil, keeping the same parameters of cost or even at lower prices, then the oil will become a thing of the past, the more so since this resource has the disadvantage of being an important pollution factor.

Another consequence of the settlement of energy resources, will have implications for other primary resources substitution. On one hand, I am taking into consideration the resources created by nature, such as renewable natural resources: agricultural area, climate, forests, waters and non-renewable sources such as useful minerals or substances, fossil fuels. On the other hand I refer to resources created by humanity, that have always been subjected to restriction forms of energy that could replace primary resource characteristics. Even if it seems an utopia at first, assuming that through the technical - scientific progress, the access to unlimited energy resources at very low costs is to be ensured, many characteristics of these primary resources could be challenged so that they will lose their role of conditioning factors resources.

Regarded this context (now closely linked to the planet Earth by hydrocarbons rule) the energy resource is the one that can raise the bar of development of human society to universal parameters.

Given this perspective proposed in this paper, I tried to emphasize the difference between the classical approach of production factors and their possible redefinition.

Generally considered, the factors of production are defined through all funds raised, necessary and sufficient, that contribute to the production of material goods required by the growing needs of the human society development. Production factors can be defined as a whole of necessary and sufficient resources attracted, allocated and consumed in the production of economic goods.

Classical economic theory has highlighted three main factors of production, namely:

- **labour** - original primary production factor, active and decisive;
- **nature** - primary production factor, original and passive;
- **capital assets** - derived factor of production and subordinated to the first two factors.

In economic terms it may be noted that only labour is an active and decisive factor. This is due to the limited perception of primary sensory five human senses, characterized by the inclusion of economic phenomena within closed systems.

To be able to detach from this kind of approach, in this paper I proposed, in terms of addressing the concept of economic factor within open systems, inputs that are no longer limited by the perception of primary sensory five human senses and combining reality scientifically proven concept on resources and economic inputs. Also, I used a completely different delimitation of these inputs, an approach that can support new economic conceptions about the environment and of course, about production processes. In this regard, I considered to cover the whole spectrum of production processes, whether manned or not deployed, micro or macro scale, or may not be detected by human senses. In such approach, I considered the adapted concepts that would meet and act as inputs mayors, active and determined, quantifiable and measurable, both in quantity and value, and which fall within the usable resources production processes, to be stored and renewable, capable to comprise (include) other resources within the concept usable in the production processes of goods necessary for the immediate and future satisfaction of needs of the people are:

- **energy** - primary production originating factor, active and decisive;
- **knowledge** - primary production originating factor, active and decisive;
- **capital assets**- derived factor production and subordinated to the first two.

These factors of production must be negotiated on the open market and could set a selling price based on supply and demand.

The proposal that I made herein the paper should not be regarded as a replacement of terms, touching the very structure of matter (nature) as they can describe nowadays scientific research carried out in the exact sciences and the unique ability of man to synthesize knowledge (one of the prime features of human labour). The border between nature and work is not immutable if we relate to structural elements of the two concepts. From this perspective, this new approach goes beyond, making some elements mixing up and also goes to define the concepts in different ways.

Energy directly participates in the production process, both at micro - as structural element found in the composition of matter and at the macro level, as part of the transformation expressed through mechanical work, electricity, heat, etc., to the creation of goods required for the immediate and future satisfaction of people needs.

An adequate energy equation system can be written as follows:

$$\mathbf{Energy = Anergy + Exergy}$$

where:

- **Exergy** - physical size starting from the concept of so called "energy extractable", referring to the free usable energy of the system;
- **Energy** - the zero energy conversion capacity, is the energy that, even under conditions of total reversibility of the processes, cannot be transformed into exergy (the mechanical work), even partially.

Energy on the terms of factors of production should not be confused with the energy resource.

Data, information and knowledge represent characteristics of a growing value chain evolution of the human mental model.³ In terms of information, knowledge exists in latent form and may be considered the primary resource that underpins all the other derived resources.

Information and acquired knowledge are considered in turn as resources derived from the primary resource.

Knowledge participates directly in the production process, the creation of necessary goods for the immediate and future satisfaction of needs of the people.

A proper equation of a knowledge system can be written as follows:

$$\mathbf{Knowledge = Data + Information + Acquired Knowledge}$$

Knowledge seen in terms of production factors should not be confused with the information resource.

A secondary aspect that I has had to bring into debate is about the confusion that exists in academia on how to use the concept of factor of production. In most approaches, the factor of production is confused with the resource. Therefore concepts are confused and unclear. This states that an entrepreneur uses factors of production in order to achieve an efficient production process so that to maximize benefits and reduce costs. In fact, the ability of the entrepreneur combines or substitutes available resources at a given time, referring to the components of factors of production.

In order to remove this confusion, in this paper I have tried to correct this approach, focusing on how entrepreneurs use the components of inputs for achieving the best results in terms of given economic data.

In terms of economic efficiency, obtaining the goods required on the market by merging at least two factors of production represents the technical-economic process of combining specific

³ Donald A. Marchand, Thomas H. Davenport – *Is KM just good information management?*- in *Mastering Information Management* , *Financial Times*, Prentice Hall, Great Britain, 2000 (Summary of National Post Online, 2001, July, 24; http://providersedge.com/docs/km_articles/is_km_just_good_information_management.pdf)

economic factors of production. Combining components factors of primary production (energy, knowledge - as proposed by this work, nature - in the classic version) with elements of the derived factor - the capital, it is depending on the area in which the entrepreneur skilfully operates. The process of combining components of production factors has a dynamic character. It takes place in the context of technical, economic and social conditions of the economy where the combination occurs.

Most of the works that deal with the factors of production substitutability say that this is a feature of inputs, used by entrepreneurs to optimize the production of goods necessary to obtain economic and social satisfaction of needs. The reason for this is done with the premise that under the influence of new techniques and technologies and price trends the entrepreneur is always changing the relationship between inputs and replaces components of a factor of production with components of other factor of production, more productive, cheaper, more actual and modern.

I believe that due to excessive generalization and to the desire of highlighting a phenomenon, the essence of the concept of production factor was lost during the theoretical demonstrations, meaning that a resource must meet certain conditions and criteria in order to be considered a factor of production.

The substitution is defined as the phenomenon of substitution of a quantity of an input through a portion of another factor production. It is not specified yet what kind of factors may be substituted, which shows that the generalization was considered that a contractor may substitute one factor of production with another so as to optimize the production result.

By this omission, I believe that it passed too easily just over primary determinants character respectively in the classical vision, nature and labour. An analysis of this feature reveals that two factors could never be a substitute to each other because of the uniqueness of its characteristic of both of them. I mean to say I believe that never a contractor could use more work of the available staff and thus supplement the lack of raw material (resource that covers the concept of nature) or conversely, have the raw materials in addition to demand for the output and set it to fill the labour shortages (covered by the concept of work).

The examples used in most works, whether scientific or didactic, the substitution can take place between labour and capital factors or between the factor nature and factor capital (a substitution between primary and secondary factors). In order to be very clear and avoid any confusion, we can say that substitution, which would take place between different components of

the same input is possible. It is much used by the contractors, but it might not be conclusive enough so that we can generalize the substitutability on any factor of production for another.

Looking from a theoretical standpoint, I uphold and maintain that substitutions can take place only between components of a derived factor and components of a primary factor or to emphasize more strongly primary characteristics of a production factor, between elements of the primary factors and elements of the same type found in secondary factor.

In the recommended approach, the energy inputs and knowledge are no longer dependent on the five human senses, substituting components of the primary factors can not be achieved only by means of factors derived components. This means that the energy or knowledge stored in capital derived factor are alternatives (within the meaning of complete) energy or knowledge that can be found in the position of the primary factors. As a consequence, a contractor neither can replace energy needs through knowledge nor knowledge through the energy requirement. This is determined by the primary character of the two inputs. At first glance it seems to be a restriction on the action opportunities for an entrepreneur, but in fact it is a theoretical correction of the economic concepts that the contractor uses in the production process.

Chapter three of the paper aims to take account of the new perspective proposed to highlight how could they be defined and what relationship can exist between two basic economic categories, which particularly concerned philosophers, historians, moralists, mathematicians, clergy and then the professionals in Economics, as value and price.

The concept of value has been addressed in time from the perspective of different views that correspond to different schools and trends of economic thought. However three trends can be highlighted (theories) as the main objective theory, subjective theory and also the contemporary theory:

- According to the objective theory of the concept of value, the main value of an asset it is supported by its scarcity and employment expenditures, materialized in the asset implementation;
- According to the subjective theory of the value concept, 'every need reduces its intensity as long as it is satisfied'⁴, the economic optimum is determined by obtaining a degree of satisfaction as high as possible using a limited resource, where only the insufficient

⁴ Nicholas Georgescu-Roegen, *Hermann Heinrich Gossen: His Life and Work in Historical Perspective*. p. LXXX "If an enjoyment is experienced uninterruptedly, the corresponding intensity of pleasure decreases continuously until satiety is ultimately reached, at which point the intensity becomes nil."

assets have value because of its less amount than the needs volume to be satisfied and only as long as needs-goods ratio is maintained in these coordinates;

- According to contemporary theory of value concept, the macroeconomic vision of market economy is the new analysis field of the economic phenomenon (the balance between supply and demand for goods and services, competitive mechanisms of the free market and their role in maintaining economic stability, the use of fiscal and monetary policies to eliminate recessions and control the economic boom).

The perspective of the three different ways of approaching the concept of energy value leads to find definitions of it from different angles; in the present context of so complicated transformation process of energy resources in factor of production, understanding the role that the energy resource owns in production processes, all these will lead to a gradually awareness regarding the energy market atomization, meaning a control taking over by the consumers-producers. The concept of consumer- manufacturer is based on the scenario of autonomy developing of energy source is able to develop itself in both scenario types: rivalry of energy sources, and swirl variant scenario. The continuous scientific and technological development and the holistic understanding of the universe will create conditions to ensure the energy independence both in regional and individual levels.

These are just a few of the premises that provide a step change in the near future, not only of the types of available energy sources or energy price in the market, but also of the energy value concept; this veritable factor of production and its characteristics will serve as primary inputs originating, common to all types of social activities with an active role (dynamic) and determinant in the production process.

Chapter four aims to highlight the linear relationship between energy consumption and the living standard. This will be done based on specific analysis of energy consumption and resource use throughout the history of the human society and it is based on the continued process of decarbonisation of fuels. Thus we can assume that the energy consumption will be continuously growing up, leading to the development of living standards.

Over time, humanity has used two ancestral existing energy sources: energy from the sun and the one generated by the planet on which we live. All forms of energy known until today come from these two ancestral sources. Thus, humanity will have to go to a higher phase of its evolution, regardless of scientific disputes about the origin of hydrocarbons, the existence or not of a peak oil; This will happen as a result of continued growth in living standards. Energy resource may be given

to either one of two ways, or both simultaneously. So far, the most appropriate use of energy is electricity, due to its versatility.

The historical analysis of energy consumption evolution revealed that man used energy resources with increasingly higher capacity as he developed his knowledge level through scientific research or intuition. He was forced to do so in order to cover the energy needs. At the moment, human society uses in particular telluric energy to trigger off the production processes taking place on Earth even if there is the disadvantage of restricted planetary locations.

Migrating production processes towards energy of solar origin will represent a leap on the scale of evolution, when we refer to the type of energy used. Leap will generate, in my view, a change in economic reference system. It will have to make an evolutionary leap in turn while the economic perception could not be considered Newtonian anymore -if I can make this comparison and pass a relativist approach, to keep me on the same lines. The leap made in scientific knowledge should run its course in the economic field also. In this regard, in a relativist approach, Economics has to redefine its notions, so they can describe the economic phenomena on required parameters by new scientific challenges.

Making an analysis of the current trends of the moment in human behaviour and of characteristics in times of transition (evolution) and studying the contemporary protagonists of energy behaviour, actually highlight the factors that could generate the change.

Their evolution may determine the manner of change, the transition period and the trajectory as follows:

- increased energy demand, spurred by competitive prices generated by developing a competitive and steady growth of living standards, is the determining factor of evolution;
- energy efficiency factor acts as a lever in the development of energy resources;
- scientific research determines how the change reacts;
- the factor consumer- producer operates the lever evolution, covering the need of cheap energy in sufficient quantities;
- energy security motivates the consumer decision to act the lever evolution;
- development of energy resources used throughout the history of human society, is the factor that determines the evolutionary trajectory that change will follow, ensuring a development horizon;
- Awareness of the responsibility of mankind to maintain specific ecological parameters on planet Earth in the survival of the human species and other creatures also represent

environmental factor that acts by psychological approach characteristic of human behaviour in times of transition;

- the human factor is the main driver of change, because there is a human need to evolve regardless of the existent vicissitudes and setbacks; in a natural evolving the reason gives a meaning to human life through tracking a higher purpose.

This development will be accompanied by an economic approach, characterized itself by a profound transformation of Economics as a whole, so as to support the theoretical base adapted to scientific challenges, new production processes that will contribute to the development of human society.

The perspective and economic approach adopted in this paper, aimed to achieve an opening of the road that I believe that Economics is indebted to go through in order to provide economic theories for the human society progress. This step made by Economics will contribute to the understanding of economic phenomena that human society generates and goes through in order to progress in the living standards.

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