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The connection between efficiency and sustainability - a theoretical approach

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Abstract

The present paper is the result of the approach and research from a common perspective of two issues regarding economic development, with different time lengths: *economic sustainability* – one of the newest and most modern theories related to the meaning and context of economic development and *economic efficiency* – an old theory which has been the focus of many generations of specialists. This simultaneous, common approach claiming to reunite various ideas aims to identify a way of putting together the different purposes of the modern economic world, characterized by numerous fluctuations and a spectacular evolution in order to be sustainable and efficient. The study of the literature has fostered one of the solutions of harmoniously combining efficiency and sustainability: the orientation towards eco-efficiency. This solution, tackled in the present paper, is based on two of the newest theories of economic scientific research, although little known and dealt with in the national economic research area: the theory of *Factor 4* and the theory of *Factor 10*, both approaching the sustainable development under the conditions of meeting economic efficiency. The main goal of the paper is to identify and analyse the main benchmarks allowing the clarification of the relation between the concepts of sustainability and efficiency, given that there are some difficulties when attempting to apply the obvious theories about sustainability into practical activities. Thus, the conclusions will show that it is necessary to identify and accept the rules of setting the sustainability condition of an economy, so that the eco-efficiency concept might be approached in a pragmatic manner.

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1. Introduction

The present economic environment is subject to major changes, especially as regards economic growth that is not considered any longer a top priority, given the turbulences affecting the rhythm of a balanced development: economic crises, environmental crises, rapid-pace growth of population, increase in the pollution level, numerous ecologic disasters, climatic changes, degradation of natural resources, social frictions etc. - which, in a nutshell, are the support of economic development.

For all these problems having unfavourable consequences on the evolution of the human society, feasible and relevant solutions are sought after, both at theoretical level and at the level of the implementation of these solutions. One of the variants of solving the previously named problems affecting the present economic environment is the orientation towards a so-called sustainable development and for which, for the time being, there are no clear and precise units of measure.

According to Brooks (1992) and Solow (1991), cited by Curzio and Zoboli (1995) sustainability is a socio-technological feature of a development strategy or rather something such as a feasible/real society rather than a desirable society, respectively a dynamic and evolutionary concept or the steady-state or the zero growth solution. According to some researchers (Giovanetti, 2011) the definition of sustainable development in compliance with the Bruntland Report is wrong from the start, because we cannot possibly know now what the future generations want. In brief, when we speak of economic development which is based, alongside economic factors, on social and environmental factors (natural resources), we implicitly speak of sustainable development.

The importance of sustainable development for the human society is provided by the present and future management of the natural, energy, raw and informational resources, in relation to the goals of economic growth and the insurance of a better life quality and environment (Zaman&Gherasim, 2007). "The sustainable development is also seen as a fundamental aspect in the efficient management of business, so that the aspiration towards economic growth and promotion of a healthy environment should be indissolubly connected" (Albu, 2003). Therefore, the issue of rational management towards effective measures of using the resources (regardless of their nature) is encompassed by the theme of sustainable development, taking into account that the resources of each generation are influenced by the consumption of the previous generations (Georgescu-Roegen, 1926, in Tiezzi and Marchettini, 1999).

From the perspective of the relation set between sustainability and efficiency, we start from the hypothesis that this is an indestructible one, a sine-qua-non condition when tackling the sustainability concept from a general perspective. "The sustainable development of the society implies, in the context of the ecosystem-eco-efficiency dualism, the mankind's concern for the present and future situation of its natural, energy, material and informational resources.

Alongside the responsible approach for the next generations, the efficient use of natural, energetic, material and informational resources also involves the highlight of the functioning of a sustainable economy in order to meet the present needs of the human society" (Zaman& Gherasim, 2007).

Taking into account these considerations, we proceeded to research and approached some theoretical elements, intended to identify a common path between the principles and objectives of economic sustainability and those of maintaining or increasing economic efficiency both at micro and macroeconomic level. Thus, the most relevant theories identified which should meet the requirement are: the theory of Factor 4, the theory of Factor 10 and eco-efficiency.

The theory of Factor 4 supposes the increasing by four times of the resource productivity, aiming to significantly reduce the costs which are non-sustainable or which are supported for non-sustainable actions (wars, politics, and over-exploitation of natural resources). The cost reduction in fields of activity which proved to be non-sustainable would allow the creation of considerable economies for the public resources of a country.

The theory of Factor 10 completes the previous theory; it is based on the principles of sustainability and

implies the analysis of the input-output balance related to the production processes, by taking into consideration a 10 order factor for the reduction of resource consumption.

The efficiency term has been more and more encountered in the economic theory of the XXth century while the traditional theory has little research of this kind. The analysis of efficiency holds a special place in the economic theory and consists in fact of the management ways of resources since, in essence, efficiency is the most appropriate form of expressing the extent to which the available production factors of a nation are capitalized.

In compliance with the future requirements and in order to insure a sustainable development and the simultaneous increase in the level of population's life standard, a revolution of production efficiency will be needed, while the economies of the world countries could know a new re-launch by spreading the best practices, stimulating innovation, establishing new methods of organisation and efficient management of resources.

The economic efficiency implies the relation of the effect with the effort and the results obtained to those known during a period of comparison or the reference to the best international performances, while for the insurance of a sustainable development, the economic process, the increase of the welfare level and life quality, a "revolution of production efficiency" will be needed (Carley&Spapens, 1999).

Under these conditions resuming the insurance of economic sustainability and a higher level of life standard of the ever-growing population as well as a more efficient use of resources, the thesis of decoupling seems functional because it shows that economic growth may continue while the resource consumption and their irrational exploitation decrease (Jackson, 2009).

2. Literature review related to common new theories on sustainability and efficiency

In the last 20 years, numerous, extremely interesting and useful debates have taken place, supported by theoretical and methodological arguments about the possibilities to use as rationally as possible the Earth's resources, taking into account that the rate of real consumption exceeds the rate of consumption needs. There are great discrepancies between the development levels of the world countries while the commercial interests and those specific to the growth of a developed country do not coincide (Talmaciu, 2012). The present, modern literature intended for the promotion of a sustainable economy highlights that people can have a better life only in a better society and prosperity should be conceived as a condition for the duties and responsibility towards the environment (Sardar, 2007). The approaches of the theories regarding sustainability have led to the identification of new and modern theoretical concepts, real cornerstones for the evolution of the future economic world.

Regarding the efficiency theory which has a longer temporal evolution than the sustainability one, we can remark that William Petty and Adam Smith are the theoreticians of the classical economy who tackled the problem of results maximization, without making reference to the consumption reduction. One of the economists who manifested deep interest with major contributions in the definition of the concept *economic efficiency* is Vilfredo Pareto, who analysed the resource distribution. The new concepts concerning the determination of areas specific to efficiency are (Pellegrini, 1996):

- *Informative efficiency*: highlights the ability of prices to reflect the information in the system;
- *Functional efficiency*: refers to the services the financial industry performs for the use of economy in its complexity as well as the capacity to transmit impulses to the economic policies;
- *Technical and productive or operational efficiency* (X efficiency) reflects the capacity to minimize the costs related to the unitary input data;
- *Allocative efficiency*: has the role to reflect the sellable goods and the price corresponding to the marginal production cost.

The best known and used indicators to express efficiency (understood as a criterion to reflect performance) are the synthesis indicators: *capital productivity*, *work productivity*, *allocation and consumption of natural resources*, *return rate*, *profit rate*, etc. It is certain that the unilateral analysis of economic efficiency indicators is not representative, since it only creates a partial and/or distorted image of the phenomenon under analysis (Mardiros, 2011).

The preoccupations for the insurance of sustainability of world countries' economies have led to conclusions having in view the strategic approach of the consumer behaviour at macroeconomic, enterprise or individual level. Thus, we identified the notion of efficiency strategy which aims to "drastically reduce the consumption through the reorientation of technical progress" (European Project implemented in Romanian rural area, 2012). This strategy focuses on increasing the resource productivity by order 4 and on a long term, even by order 10, according to the arguments presented by the authors Ernst Ulrich von Weizsäcker, Amory and Hunter Lovins (1998), a perspective seen as a desirable challenge for the present economic world.

In 1997, one of the reference volumes of the present economic theory was published: *Factor Four: Doubling Wealth - Halving Resource Use: A Report to the Club of Rome*, where the authors Amory and Hunter Lovins (from Rocky Mountains Institute, USA) together with Ernst Ulrich von Weizsäcker (from Wuppertal Institut Germany), presented with appropriate arguments, the possibility and necessity to double the resource productivity taking into account that the resource consumption halved. If this goal, of increasing two times the resource productivity, is reached, then the doubling of mankind's wellbeing would be possible by halving the consumption of natural resources. Obviously, the notion of wellbeing deserves special attention so that the material wellbeing should be accompanied by a set of boundaries. The basic idea, mathematically treated, of the concept of factor 4 is to make two times more with two times less. The term *more* refers to wellbeing, while the term *less* refers to resource consumption. Therefore, the factor 4 is a feasible progress factor and accounts for sustainable development.

The theory of factor 4, which is based on the theories of economic growth, is little known in the European economic world and very little or at all applied at macroeconomic level. Some specialists agree that this theory is adequate for the orientations specific to ecologic, public and private politics. For these reasons, the classification of the specialists' opinions who dealt with the analysis of the Factor 4 theory in two groups is perfectly justified: those who represent the economic world and consider that this theory cannot be put into practice and those who are eco-economists and believe in the practical success of this theory. The authors' arguments on the importance and pragmatism of this theory rely on an essential element: there are countries where, even if the GDP/per capita has decreased from one year to the other, the level of life quality has increased (for example Switzerland in comparison with France, Italy, Germany, Austria). The explanation resides in the fact that a twice reduced amount of produced wealth determines a 4 times higher efficiency rate: therefore the consumption of natural resources has been reduced by an 8 order factor.

Likewise, the researchers from the Wuppertal Institut identified and launched on the economic market, for knowledge, acquisition and application purposes, the principles of the strategy "better - different - less", which translates into: the drive of human preferences towards a better life standard in relation to a wealthier life (with more needs), the approach of urban spaces as living environments (not artificial ones), the drive towards ecologic agriculture, the large-scale approach of permanent recycling, etc. (European Project implemented in Romanian rural area, 2012).

3. Methodology research

The present paper is based on the fundamental research of the specialty literature being a conceptual-methodological and empirical research. We start from the hypothesis that the assessment of sustainability of an economy is performed according to the performances registered within the microeconomic systems and the appreciation of performance is based on the efficiency analysis, completing the approach from the standpoint of

the impact of economic activities on the environment. Subsequently, we proceeded to a comparative analysis of the theories about efficiency and sustainability and by means of the empirical research of a synthetic-comparative nature, we identified the common paths of interest of these two theories, starting from the goal of highlighting the importance of correlating the objectives to reach an optimum level of efficiency with those creating the conditions for a sustainable development on a large scale, respectively of obtaining feasible variants of transferring these theories to practice.

One of the main hypotheses of the present research to which we adhered, according to the literature studied, is that "30-40% of all the environmental issues have at their basis prevalent consumption models" (Study on sustainable consumption, Berlin, 1997). It must be remind that the environmental impact is the multiplication result by human population, quantity of goods consumed and need for raw materials/unit of goods produced.

Due to considerations relating to the increase in human needs which in their turn determined the increase in the resource consumption, over time proposals have been formulated and actions to raise the level of resource consumption efficiency have been supported, namely the need for raw materials/unit of goods produced. Thus, the orientation towards eco-efficiency proved to be the focus of more and more specialists belonging to the economic research area as well as of representatives of the "active" economic world. In essence, eco-efficiency is perceived as a mechanism aiming to reduce the negative impact of human actions on environment while the natural capitalism has the capacity to account for the resources and underline the natural efficiency in order to produce more with less (Hawken & Lovins, 1999). The need to increase productivity is specific for numerous reference environments and it is much obvious as it is more correlated with efficiency. Recent studies prove the existence of the compatibility between wealth creation and mitigation of environmental pressure. In this context, we identify the birth of the concept which ties together the notions of efficiency and sustainability: eco-efficiency that can be also seen as a strategy allowing the balanced and at a reduced scale exploitation of environmental factors. In fact, the orientation towards eco-efficiency must support the economic activities and not limit them in any way.

From the literature we synthesized the basic idea, subsequently developed in the paper, that: according to the theory of Factor 4, in order to get a sustainable development a reduction of 75% (or of $\frac{1}{4}$) should be performed from the energetic intensity and from the quantity of materials usable in the production processes, respectively, while, according to the theory of Factor 10 (Schmidt-Bleek, 1996), to obtain a long-term sustainable development, the input should be reduced by 90% (that is $\frac{1}{10}$).

4. The results of the research

We have drawn the following basic idea from the literature on the sustainability concept, namely the need to redirect the economy towards a sustainable development and the application methods of the concept into the daily activities of companies: even if sustainability proves to be a rather theoretical concept, there is the possibility that, through the correlation with other related theories, it should be more clearly perceived how an economy should perform in order to become sustainable. Basically, the problem is about the management of resources which, regardless of the type of economy for which they are used, should be managed as efficiently as possible, without registering greater resource consumption than the real needs of production in accordance with the population's consumption needs. The economic evolution of the last 20-30 years indicates that a reorientation of the economic development is more than necessary so that resource waste should not become a real problem. The paths to follow are associated with the economic efficiency of the production processes and with the efficiency of resource use.

When synthesizing the main common notions of the concepts of efficiency and sustainability, we notice that the theoretical notions regarding sustainability, factor 4, factor 10 and eco-efficiency have a common denominator. Thus, by means of the Factor 4 theory we understand that the wellbeing may double by halving the resource consumption, insuring the economy's sustainability; this theory certainly promotes the more

efficient use of resources, as regards the regulation of exploitation and production costs and not the reduction of profit. The reductions of resource consumption, gradually but systematically applied in a well-defined time lapse, would free some of the useful resources and would allow their redirection towards other goals associated with sustainability (pre-launch or re-launch of the *green* business environment, the increase in the occupation level of the population or the reduction of the disoccupation rate, etc.)

If we advance in studying the real ways to insure the efficiency of resource consumption, we notice that the theory of Factor 10 starts from the need to obtain socio-economic results in terms of welfare, goal which can be achieved through balanced and proportional resource consumption by means of order 10 computations. Based on sustainable principles, Factor 10 focuses on the balance between materials and inputs in economy. Factor 10 was assumed as a strategic objective by World Business Council on Sustainable Development (WBCSD) and by the United Nations Environment Program (UNEP). A short history shows that ever since 1995 Austria proposed the meeting of the specific goals of factor 10, in 1997 Switzerland proposed the meeting of the same goals for the following 50 years while in 1996 the Netherlands assumed the objectives of Factor 4.

Therefore, both theories oriented towards a balanced consumption in accordance with the goals and principles of a sustainable development, prove to be directly correlated with the evolutionary needs of the economies of world countries. In this context, a special importance is awarded to the efficient management of resources, namely the performance of the highest production by input unit resource provided by environment. The evaluation of how this wish will be performed implies the approach of the term efficiency in the new context of sustainable development. Starting from the simplest definition of the term efficiency - the output amount generated by the production process/the input unit - we identify the adequate concept for making the connection between sustainability and efficiency, that of *eco-efficiency*.

The theoretization of the eco-efficiency concept was conducted by World Business Council for Sustainable Development (WBCSD), which in 1992 defined for the first time this term aiming to include the impact, the environmental costs and the negative externalities in the calculus of economic efficiency. In a practical way, WBCSD defines eco-efficiency as “the development of goods and services at a competitive price so that they could meet the human needs, lead to a progressive improvement of life quality and at the same time, reduce the impact on environment and the irrational exploitation of resources throughout the entire life cycle of the product, until a minimum level”.

The principles proposed by WBCSD for the insurance of a sustainable development stipulate: the dematerialization of productive processes, the extension and closing of productive cycles (by means of the recycling process) and multi-functionality; all these are considered synonyms of eco-efficiency. In fact, these principles are translated in the optimization of productive processes, the extended-scale recycling (by means of the 7R approach) and eco-innovation. In order to transfer these principles into the daily activity of companies, these must reduce the resource inputs allocated to the productive processes and identify new paths to increase the capacity of goods to be sustainable, recyclable and eco-innovative on a long-term. According to Lovins & von Weizsäcker, a reduction of only 25% (¼) of the resources necessary in the production processes would be sufficient to obtain a minimum level of sustainable development.

In a nutshell, eco-efficiency aims to identify the products and services which satisfy the human needs and the ongoing increase in life quality, reducing at the same time the impact on environment and the resource consumption intensity during the entire life cycles of the product; we consider that it should comprise two other stages, such as upstream and downstream of the real production process; one stage refers to the setting of the supply source of resources taking into account the need to protect the environment; the second stage describes the recycling connected to the post-consumption of the products obtained. We also conclude that eco-efficiency refers to the generation of mutual advantages of the use of economic and environmental resources, with the aim to obtain a significant financial return, a favourable image and the meeting of all legal regulations.

If theoretically the issue of eco-efficiency is well-shaped, we would like to raise the problem of how the need to be eco-efficient is translated at macroeconomic level. We believe that the solution to this problem

resides in the use of eco-efficiency indicators, which express the ratio between the outcomes of the economic process and the environmental inputs, thus reflecting the nature's productivity. Thus, in order to determine the nature's productivity some restrictive factors will be taken into account such as work and capital and it shall be completed with the material intensity of the economy, meaning the ratio between environment inputs and economic outputs (The National Commission for Forecast - NCF, 2009).

The most known and used indicators to express efficiency (understood as a reflection criterion of performance) are the synthesis indicators: capital productivity, work productivity, allocation and consumption of natural resources, return rate, profit rate, etc. The indicators have the role to measure the results and performances of an enterprise or an economy. Certainly, the one-sided analysis of economic efficiency indicators is not representative since it only creates a partial and/or distorted image of the phenomenon under analysis (in the case of the present paper, the connection with sustainability). The indicators considered representative for the approach of the theories allowing the connection between the concepts of efficiency and sustainability (Factor 4, Factor 10, eco-efficiency) are (NCF, 2009):

- *The material efficiency* which is expressed as a ratio between the GDP and the direct inputs of materials in economy (GDP/DIM). According to the data provided by the National Commission for Forecast in Romania, at national level this indicator registered an ascending evolution from 1994 until 2000, respectively from 0.22 lei/ton of materials entered in economy to 0.38 lei/ton, after which it came back to a descending trend (0.24 lei/ton in 2007). These values prove the drop in the efficiency level of the use of natural resources.
- *The material intensity* is expressed as a ratio between the domestic consumption of materials and GDP (DCM/GDP). At national level, the value of this indicator dropped from 4.31 lei/tons in 1994 to 2.38 lei/tons in 2000, followed by an increase of up to 3.92 lei/tons in 2007, an inferior level to that registered in the first year of the comparison period.
- *The material productivity* represents the inverse of material intensity and is calculated as a ratio between GDP and the domestic consumption of materials (GDP/DCM). This indicator had an increasingly constant evolution during the period 1994-2000, respectively from 0.23 lei/ton to 0.42 lei/ton, after which the trend reversed so that in 2007 it reached the value of 0.26 lei/ton in the context of a more accentuated increase of consumed natural resources in relation to the GDP increase.

It can be noticed that eco-efficiency does not only represent an abstract, theoretical concept but it can be also expressed in a numerical form. In this regard, it is necessary to evaluate and objectively customize the eco-innovative tools that could condition the ratio between the enterprise and environment. The mathematical result of eco-efficiency is given by the ratio between the product or service value and the environmental impact. From this ratio we can observe that at the numerator the values used are those specific to the value added (the difference between the production cost of a good or service and its sale price) and at the denominator the effects or consequences of the socio-economic activities on environment, synthesized in a calculus of the impact on environment.

As a consequence, we propose as a solution of transferring the theoretical elements specific to eco-efficiency into the daily activity of enterprises, the implementation in the first stage, of an orientation strategy towards an eco-efficient production system, on the following levels:

- The level of basic components (Use of materials with reduced environmental impact, Reduction of use of raw materials);
- Structure level (optimization of production techniques, optimization of the supply chain, reduction of the impact on environment);
- System level (optimization of economic life, optimization of life duration of the products performed, development of new products which should prove to be eco-innovative).

For each of these levels, the enterprise interested in a sustainable development, apart from insuring a high level of economic efficiency, may approach one or several orientations in its current activities so that it

launches the applicability of the concept eco-efficiency at microeconomic level:

- reduction of the raw materials for the production of goods and services;
- reduction of energy consumption allocated to the production of goods and services;
- reduction of the toxicity level of materials;
- increase in the rhythm of recycling reusable materials;
- extension of useful life of products and the intensification of their use;
- increase in the technical and economic performance of products;
- optimization of production processes by means of new managerial orientations;
- recycling the waste and eco-innovation.

The general advantages recurring from the large-scale implementation of such a strategy could be: the use of more reduced amounts of raw materials for the production processes, the allocation of resources at minimal costs, generation of more reduced amounts of waste, improvement of products quality, increase in the level of value added, compliance with the environmental rules, facilitation of repairing, recycling and reusing of products. In fact, the previously mentioned strategic approaches determine the enterprises to be efficient.

5. Conclusions

The evolution of scientific research towards the increase in the productivity of resource use is influenced by the appearance of specific theories that outrun the classical approaches of efficiency of productive sectors. Thus, from the 1990 approach of the sustainability concept, the year 2000 saw the occurrence of the theory of factors 4 and 10, respectively the theoretical and applicative approach of eco-efficiency. All these new, modern theories encompass the need for acceleration of the consumption reduction and increase in resource productivity, especially in the developed countries. The applicative goal of these new theories is associated with the goal of insuring a sustainable development. In the present paper we attempted to get together the theoretical, new and modern, aspects regarding the shaping of a stable relation between efficiency and sustainability, starting from the premise that the economy of the future may certainly rely on the holistic approach of traditional and modern theories. Despite this, the paper has certain limitations coming from causes such as: the specialized literature, especially the domestic one, does not tackle minutely enough these types of relations; the lack of an applicative orientation decreases the intensity of theoretical confirmations; the lack of a methodological framework which may allow the performance of applications based on indicators. Out of these considerations, the paper has a strong theoretical aspect; even if the usefulness of the theory is extremely relevant in the economic research, we believe that the relationship efficiency-sustainability, namely the theories of factors 4 and 10, need to be dealt with also from an applicative perspective, understanding thus the utility of such an approach for all the economic agents.

Given that the figures from the statistical reports for various world countries show that the economic evolution in the last 20-25 years has not followed the trend of the sustainable development, we believe that this continuous rhythm of economic development, based on hyper-consumption and production exceeding the real consumption needs of the population presents major risks for the insurance of a balanced economic development of the future generations as well as of the present one. The excessive and irrational consumption of resources has direct negative consequences on the state of the natural capital, which will not be able to fulfil its role as a main provider of economic resources as well as on the economic and social development and welfare state of the population. Due to these reasons, we conclude that a fundamental orientation, enabling the avoidance of an economic, ecologic or social collapse, should first of all focus on the eco-efficient management of resource consumption and promotion of production and consumption models allowing the increase in the efficiency of resource use and a long-term, global, sustainable economic growth.

As a conclusion, we consider that the new economy, often called eco-economy, should be based as much as possible on the production and trade of dematerialized services and less on the material products. This

could be thought of as the new model of the service economy, while in a future research we propose to prove this based on a set of indicators appropriate to this aim.

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