EDUCATION PRINCIPLES IN A MODEL OF STRONG SUSTAINABILITY

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Abstract

In the past decades, in all the world schools and faculties of economics, it was taught that the main objective of economic policy is to ensure continuous economic growth. However, for reasons of limited absorption capacity of the environment and increasing reduction of the original ecosystems, models of economic growth are in opposition to the basic ecological principles. This is primarily the consequence of learning and applying the conventional economic paradigm which disregards the relationship between economy and environment. Therefore, the authors of this paper, proceeding from the correlation between economy and environment from the aspect of fundamental natural laws, analysed the basic determinants of the strong sustainability paradigm which implies that natural capital resources should be maintained in the constant flow of time. The research also includes analysis of the correlation between specific economic and ecological challenges of sustainable development in global regions. The authors concluded that sustainable economy may exist only in the sustainable symbiosis with the natural system. Taking into account the complex relationship between nature, society, technology and economy, the authors concluded the paper with the proposition of concrete guidelines for a reform of economic education, in accordance with the concept of strong sustainability.
Key words: *economy, education, environment, strong sustainability, weak sustainability.*

Introduction

Past development of modern industrial society determined anthropocentric world view, which perceives nature exclusively as a tool whose function is to satisfy human needs. Positioning a person in the centre of life on Earth manifested through the emancipation of society from nature and implementation of the concept of infinite economic growth. It was believed that inexhaustible natural resources will enable production of unlimited quantity of products, and that waste created in the production processes and consummation of these products will never exceed the absorption capacity of the environment. Because of unreasonable exploitation of natural capital [1] in the past few decades, people have caused unseen changes in the ecological system of the Earth. These changes provided dignified, healthy and safe life for billions of people, but at the same time weakened the fundamental ability of global ecosystem to regulate itself and maintain life on Earth.

The concept of development which was based on infinite economic growth did not only disturb the relationship between man and nature, but also caused socioeconomic imbalance within the society itself. Growing demand for food, drinkable water and energy sources started numerous antisocial activities, such as wars, for controlling someone else's natural resources, or frequent violations of fundamental human rights. It is for these reasons that all great global challenges which include nature, society, and economy are, in fact, closely related to the question how to manage natural resources rationally.

Contemporary ecological problems indicate that the development paradigm based on unlimited exploitation of natural resources becomes a limiting factor for future development of society. Since education represents a basic tool for changing the unsustainable patterns of human behavior, it is necessary to review the basic assumptions conventional educational programmes are based on, in the sense of their ability to develop a transdisciplinary concept of the impact of economic activities on natural environment. In this context, the basic purpose of the analysis was to identify wrong studies, i.e. paradigms of conventional economic theories in the interrelation between economy and environment. In the framework of methodological approach, the authors analyse the selected, neoclassical forms of economic growth and ecological sustainability (the Kuznets Curve, the Cobb-Douglas production function, the Solow-Stiglitz model of aggregate production function). They are opposed to theoretical and empirical findings of advocates of ecological economics and strong sustainability paradigm (Constanza, Daly, Georgescu-Roegn, etc.). Since this is a theoretical research, the used method was the comparative method of analysis of neoclassical and ecological economics, and the analogue induction method. The conclusions of the analysis are that the existing educational principles in economics are unsustainable and that a new study should be designed on the relationship between economy and environment in the framework of strong sustainability concept

Economy and Environment Interaction

Each economy is connected with the natural environment in two ways. Firstly, environment is a source of resources for economic processes. Secondly, the absorption capacity of the environment is a container for waste material and harmful emissions which are a by-product of economic processes (Figure 1.). Degradation of the environment refers to overexploitation of natural resources, and pollution of the environment represents the excessive use of its absorption capacity. Since natural resources and environmental containers represent a factor provided by nature for processes of human production and consumption, degradation and environmental pollution are two sides of the same process, excessive exploitation of natural environment with the purpose of economic growth (Goodstein, 2003, p. 81).

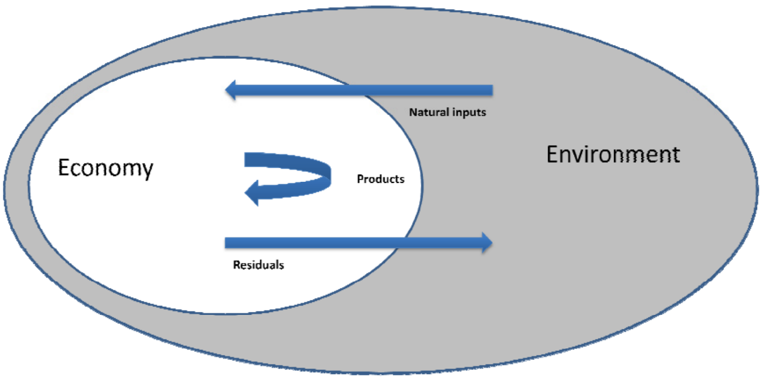

Figure 1: Economy and environment interaction, adapted from UN (2012). Revision of the system of environmental - economic accounting, Background document, United Nations Statistical Commission, p. 20.

In all world economies, growth of economic activities without a proportional increase in substance and energy consumption from the environment is utterly impossible and yet unrecorded in history (i.e. Gehrecke, 2004). In order to increase material welfare, production growth requires an increasing flow of energy through the economic system and more intensive exploitation of the potentials of planet Earth. All the energy and material flows between economy and environment are determined by unchangeable laws of thermodynamics which represent a key for deeper understanding of ecological limits of economic growth (e.g. Smith and Smith, 1996). The first law of thermodynamics refers to the phenomenon of residual flows of economic activity and is directly connected with the environmental pollution issue. The second law of thermodynamics, the law of entropy, is connected with the problem of scarcity of resources.

The first law of thermodynamics reads that total energy and substance in space are unchangeable. Energy cannot be created or destroyed, but can only transfer from one form into the other. This means that, when material resources enter into a production process, their total mass remains unchanged after the production process. The total mass of production inputs equals the sum of the mass of the finished product and the mass of all forms of waste, including gas emissions (Bryant, 2011, p. 1). If Earth is viewed as a system governed by the laws of thermodynamics, pollution of the environment is, in fact, a consequence of non-efficient conversion of natural resources into finished products. Thus, environmental pollution is not only a consequence of thoughtless and irresponsible human behaviour, but also inevitably follows economic activity.

From the material flow perspective, the global economy is a one-way linear economy (Stahel, 2011). A linearly structured economic system functions in the manner to receive the inflow of natural resources which, in processing, manufacturing and consumption processes, is transformed into waste and harmful emissions which are not biodegradable and economically useful (Figure 2.).

Waste
↑
Resources→ Processing →Materials→ Manufacturing →Products→ Distribution →Consumption
→Waste
↓ ↓
Waste Waste

Figure 2: The linear pattern of global economy.

Global economic growth, which was based on linear economy from the beginning of the industrial revolution, has led modern civilisation to the edge of ecological crisis (i.e. Malaval, 2008). Because of ecological externalities of social reproduction, the world is currently facing critical challenges such as climate changes, threats to biodiversity, rapid depletion of natural resources, frequent ecological disasters, uncontrolled spread of infectious diseases, etc. (e.g. European Commission, 2011).

The second law of thermodynamics reads that total entropy in isolated systems keeps increasing, i.e. useful energy constantly turns into non-useful. This process represents the law, so there is no possibility for its inversion. The higher the level of organisation of substance and energy, the greater their utility (low entropy), and vice versa, the lower the level of organisation of substance and energy, the lower the utility (high entropy). According to this law, free and unbound energy needed for some operation is irretrievably lost when its potential is used up (e.g. Asafu-Adjaye, 2005, Chapter 2.). For example, in the process of oil burning, highly organised substance-energy form releases heat and residual emissions in the same quantity that is contained in oil, in which some of the oil reserves transform into low entropy states which are no longer useful in terms of energy.

The entropy law applies to all natural and social systems (ecosystems, social communities, companies, etc.). In order to reduce entropy in a system, it is necessary to continuously invest in new energy. Reduction of entropy in a system may only be achieved through increasing total entropy in its environment. Because of constant transformation of substance into energy, and useful energy into non-useful, there is less and less useful energy on Earth. It is a fact that some parts of residual flows of energy and substance may, through recycling, change again into a low entropy state; however, such a process also requires additional energy. In order to release additional energy, the entropy level increases in another physical or chemical process, which indicates that recycling possibilities are fundamentally limited. In the opinion of J. Rifkin (1980), recycling effects equal only 30%.

Since the past growth of world economies was based on conventional economic models which completely disregarded interrelation between economy and environment, the first and the second law of thermodynamics are undoubtedly significant for future economic growth. Because of limited absorption capacity of the environment and increasing reduction of the original ecosystems, the term economy growth became disastrous for environmental protection. In the long run, sustainable economy may exist only in a sustainable symbiosis with the natural system, upholding natural laws and respecting natural limits of economic growth. It is the only option which ensures long-term survival of human civilisation on Earth. From the aspect of economic activities, as well as current educational principles, this implies abandoning the dominant paradigm of weak sustainability, and acceptance and implementation of the strong sustainability concept.

Strong Sustainability Paradigm

Ecological externalities of economic growth encouraged the international community to initiate numerous activities for prevention of further destruction of the biosphere After the *Conference on Environment and Development*, held under the auspices of the UN in Rio de Janeiro in 1992, relevant international institutions realised that sustainable development is the answer, which tries to fulfil the needs of modern generations without endangering developmental possibilities of future generations. Although many have accepted sustainable development as a moral obligation, it remained unclear how to economically interpret sustainable development. Presently, two basic sustainable development schools are renowned in economic circles. The concept which is based on the insights of neoclassical economics is called weak sustainability, while the strong sustainability concept is derived from the insights of ecological economics.

The weak sustainability concept developed through the works of Solow and Stiglitz, written as a critique of the bestseller *The Limits to Growth* from 1972. In the book *The Limits to Growth*, a group of scientists from the MIT formulated a system dynamics model which, on the basis of data available at the time, predicted catastrophic consequences of economic growth for the future of life on Earth. Computer simulation of demographic trends interaction, industrial growth, production of food and the boundaries of the Earth's ecosystem showed that growth limits on Earth will be reached in less than a 100 years, if the exponential trend of growth of all the above-mentioned factors continues (Meadows et al., 1972). Such predictions shocked the public; however, they at the same time caused severe reactions of economists like Stiglitz, Solow and Hartwick.

Stiglitz's work G*rowth with Exhaustible Natural Resources: Efficient and Optimal Growth Paths* and Solow's work *Intergenerational Equity and Exhaustible Resources* from 1974 analyse economic growth characteristics in cases when non-renewable natural resources and produced capital [2] are significant inputs in aggregate production. In line with basic assumptions that natural resources are limited, non-renewable, and necessary for production, the authors believe that produced capital can fully substitute natural resources in the *Cobb-Douglas production function* (Petith, 1999). According to the *Hartwick rule*, the entire rent from exhausting non-renewable resources should be invested in the produced capital so that inputs of natural resources could be replaced. In order to keep consumption constant in the conditions of non-renewable resources, unlimited substitution rate is necessary among various kinds of capital (Ryuzo and Youngduk, 2002). The Solow-Stiglitz variant of the aggregate production function reads (Daly, 2008, p. 127):

$$Q = K^{a1} R^{a2} L^{a3}$$

Q = output
L = labour force
K= produced capital
R = natural resources
a1 + a2 + a3 = 1

From the Solow-Stiglitz aggregate production, it is concluded that, with adequate accumulation of produced capital, annual output can be kept constant, despite of reduction of inputs from natural resources. According to economists from the neo-classical school, the so-called “technological optimists”, unlimited substitution is allowed between natural and produced capital because technological development will provide the adequate substitutes when natural capital becomes scarce. It is necessary to maintain current capital levels for future generations, in the process of which the relationship between the natural and the produced is irrelevant. Economy is sustainable even in the case when natural capital is degraded, under the condition that society creates enough produced capital which will supplement the loss of the natural value (i.e. Ayres, Gowdy and Bergh, 1998). Neoclassicists believe that the need for produced substitutes will launch new scientific research, open new workplaces and stimulate new forms of consumption, which will, ultimately, initiate economic growth (Kordej-De Villa, 1999).

However, in reality, an increase in produced capital causes additional spending of natural resources. If unlimited substitution between natural and produced capital were allowed, natural resources would eventually be exhausted because of creation of produced capital. Labour and capital are merely the factors of transformation of natural resources and are not physically integrated in the final output; thus, in the production process, only various forms of labour and capital, or various natural resources, may be substituted, while interrelation between production factors and natural resources is fundamentally complementary (i.e. Georgescu-Roegen, 1979). For example, when building a house, a brick may substitute wood or vice versa. This is possible because both inputs represent raw materials which are processed into a finished product, which is a house. Also, there can be less workers working on the house and more machines; or, more workers and less machine power involved in house-building. However, a house cannot be built without bricks or wood, i.e. a smaller quantity of material for house-building cannot be substituted by increasing the number of workers or machines.

Complementarity of natural capital with other production factors questions the interpretation of marginal product in the generally accepted theory of production. According to the definition, a marginal product of a certain production factor is a spinoff product created by increasing inputs by one unit assuming *ceteris paribus*. If natural resources are constant, a spinoff product unit may not be produced through increase in labour or capital, because there is no additional physical substance and energy which will be transformed into a product. This means that a marginal product of labour or capital might be created out of nothing. Technological progress or change in methods may only increase productivity in the production of goods to a certain point, and reduce the quantity of the created waste, but neither labour nor capital, as production factors, can create substance and energy which is transformed into finished products.

For reasons stated above, representatives of ecological economics, the so-called “technological pessimists”, think that natural and produced capital are complements in the manufacturing process. Ecological economists allow a certain degree of substitution, but point out that segments of environment necessary for ecosystem regulation must not be substituted by produced capital. The basic rule of strong sustainability stipulates that natural capital stocks must be maintained constant over time. The purpose is to minimise the accumulation of harmful waste and ensure availability of stable inputs for future manufacturing processes.

Mainstream economists have not yet taken into consideration the relationship between invaluable natural ecosystem service and material goods obtained by destroying the ecosystem. In 1997, Costanza and associates calculated that the annual money value of ecological services of the ecosystem (for example, pollination, soil creation, regulation of climate, etc.) amounts 33,3 trillion dollars, which is almost two times more than the world GDP, which amounted 18 trillion dollars at the time (Costanza et al., 1997). If capital is an economic value invested in material or non-material assets with the basic purpose to create value added, unlimited substitution between natural and produced capital is, in fact, uneconomical. Costanza's assessment of money value of ecological services should be viewed as damage cost, not substitution cost of natural ecosystem services, because ecosystem services are irretrievable. Neoclassicists do not understand that natural capital is a product of a complex interaction among natural cycles and all plant and animal species on Earth. This is why human technologies will never be able to replace the loss of natural capital, nor do what nature does for free. The problem is that school subjects and study courses in formal educational institutions still rely on the weak sustainability ideology. According to this concept, environmental issues in certain regions of the world should be solved automatically, by achieving economic growth. However, this does not happen.

Ecological Problems in Global Regions Cannot be Automatically Solved by Economic Growth

In the 1970's, development planning of leading world economies was set in the framework of economic growth and analysed only through the possibility of increasing GDP. This is the period in which the neoclassical paradigm of economic growth became dominant. Its representatives advocate the point of view that social development and environmental protection are a necessary consequence of economic growth. In order to substantiate such point of view, scientists have conducted numerous research on the correlation between the growth of national income per capita and other thematic indicators on the state of environment and social development.

An example of such research is attempting to prove the hypothesis of the Kuznets Curve applied on the environment (Environmental Kuznets Curve – EKC), which first appeared in the document *World Development Report* (1992). The basic EKC hypothesis is that the state of environment with growth of incomed per capita deteriorates first, and then, after a certain level of income per capita is reached, the state of environment improves. Advocates of the EKC hypothesis see economic growth as a tool for improvement of the state of environment, and not as a threat, and claim the following:

At lower levels of economic development, economic activity effects are limited only on the natural basis and the existence of certain quantities of biodegradable waste. With economic development, exploitation rates of natural resources are higher than their renewal rates, and the quantity of waste and its toxicity is increasing. On higher development levels, structural changes in economy are accompanied by heightened ecological awareness, enforcement of regulations, more acceptable technology and higher expenditure for environment, and they result in gradual reduction of degradation and improvement of environment quality.

In the first empirical research of the EKC concept, this hypothesis was verified. Grossman and Krueger (1995), with their works, group among the greatest advocates of the EKC hypothesis. They estimated the EKC for 14 different indicators of air and water quality for 42 countries and reached the conclusion that growth of income per capita reflects increased demand for preservation of environment on higher income levels. In their opinion, the correlation between income growth and reduction of pollution are politics and civic pressure. The more developed the countries, population demands devoting greater attention to non-economic aspects of living.

The initial studies were followed by numerous empirical research which analysed the EKC effect for various pollutants. Analysis of individual or group indicators for air and water pollution, deforestation and waste quantity, led the scientists to different results. Turning points, i.e. points in which improvement of environment quality begins, appear on different levels of income per capita, depending on the indicator (e.g. Dasgupta, 2002). The general conclusion which is derived from literature is that the EKC relation offers very few recommendations for leading economic policy; thus, application of the EKC concept is limited solely on the role of descriptive statistics for individual measures of environmental protection.

Critics of the EKC concept point out that the possibility of substitution among various pollutants might undo the positive effects of reduction of exploitation of a certain energy source or raw materials. Reduction of the harmful emissions level per product, because of the application of technological innovations and use of alternative resources, is usually accompanied by an increase in different forms of waste and pollutants. Therefore, total waste per capita in developed countries is continuously rising.

For a wide range of indicators on the state of the environment has indicated very different relations between environment and economic growth, one should be careful in the interpretation of results of former empirical research. Past empirical research were mostly oriented on analysing the correlation between the selected group of pollutants and economic growth, which also represents their greatest failure. Taking into account environmental functions, it is a completely wrong hypothesis that quality of the environment can be measured by measuring the concentration of individual pollutants in water, air or ground. Such approach only analyses the relationship between economic growth and pollution of environment, while it completely disregards the impact of economic growth on degradation of environment.

In the analysis of the relationship between economic growth and quality of environment, it is necessary to use comprehensive indicators of environmental load such as ecological footprint. The ecological footprint is the necessary soil and water for maintaining material standards of a certain population while using the dominant technology. It is measured in global hectares which society needs to satisfy its needs through the use of natural resources, production, consumption and waste management. According to the World Wildlife Fund Living Planet Report 2012, mankind has been consuming the Earth by 50% more than it can offer. The World Wildlife Fund calls such state “ecological debt”, because people live above the carrying capacity of nature. Ecological footprint on the planet per capita is 2, 7 ha, while the current allowed carrying capacity amounts 1, 8 ha (WWF, 2012, p. 38). However, it is important to point out that not all have the same share in the creation of the “ecological debt”. From the conference in Rio to the one in Johannesburg, ecological footprint in the 27 richest countries in the world has grown by 8% per capita, and, at the same time, it was reduced in the rest of the world by 8% (Šimleša and Motik, 2007, p. 9).

The USA and the EU have the greatest ecological footprints on the planet. The USA is on the first place with as much as 7, 19 ha, Western Europe has 4,72 ha per capita, while South American countries have 2,7 ha, and African 1,45 ha per capita (WWF, 2012, p. 140-145). In order to fulfill all his needs, a US citizen needs almost three times more hectares than a South American citizen. Rich industrial countries, in fact, achieve their development on the import of carrying capacity from poor countries and developing countries. The USA managed to reduce energy intensity of its production through an increase in energy intensity of import. This means that it is impossible for developing countries to become as rich as the Western countries because, if everyone lived like an average inhabitant of the USA, it would be necessary to have

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the carrying capacity of four planets Earth. For example, an average American has a footprint like 66,5 inhabitants of India, and India has three times more inhabitants than the USA (i.e. Merkel, 2003).

Industry, as an anthropogenic factor, is mostly responsible for global pollution and degradation of the environment. However, mere change in the economic structure of a country will not have any impact on global improvement of environment quality. Orientation on service-based economy usually results in transferring environmentally polluting activities to other countries, and this is the reason why the EKC hypothesis was verified in some empirical research. Changes in economic activities cannot lead to improvement of global environment quality if they are not accompanied by changes in the manufacturing modes in all parts of the world.

Conclusion

Economic growth issues obviously have many causes. The crisis which modern world is facing warns of the unsustainability of the past postulates of economics as a science and economic policy as a practical activity. The present crisis requires a completely different view of the relationship between economy and environment, in the framework of the strong sustainability model. Without rapid changes in the education of economists, but also in numerous other professions and scientific disciplines, we cannot expect to find a solution to the problem based on the past postulates of weak sustainability. If educators want to stimulate new living habits which will contribute to sustainable coexistence of man and nature, they must, in the planning of their curriculum, take into consideration the requirements of various professions and the significance of preservation of the environment in their field of work. Until now, educational process tried to be modified through the introduction of new subjects and courses based on sustainability and environmental protection topics. However, because of the traditional division of science and focus on individual subjects, pupils and students acquire only partial knowledge, and do not have an insight into the whole and the interrelation between causes and effects of economic, social and ecological events. Because there is a lack of the economic basis in natural science and technical curricula, and insufficient representation of natural-science in economics, young people are unable to think in a holistic manner. The sustainable development concept should create preconditions for the transformation of the existing educational system towards of creating a sustainable society. Instead, it is partly assimilated in the educational system, without a greater influence on people's awareness of the necessity for changes in man's relationship towards the environment.

All school subjects need an integrative approach, should be supplemented by elements from other thematic fields, and linked with natural, ecological, cultural, technological, social, and political needs of contemporary society. Designing of comprehensive educational programmes is a multidisciplinary process which requires co-operation between scientists and experts from various sectors. It is necessary to create a network of schools, faculties, educational institutions, and other organizations on local, national and international level in a single holistic system, which will represent a platform for detailed monitoring and analysis of economic and ecological processes. Professional co-operation of researchers at the university with entrepreneurs and other experts from the public sector will generate the necessary knowledge and competence for creation of quality study programmes. In this way, a new generation of experts will emerge, which will be capable to accept and implement the sustainable development principles in everyday life and work.

Notes

[1] Natural capital consists of all the processes, resources and benefits produced by the ecosystem, which are essential for maintaining life on Earth and survival of human and economic activities (for example, natural resources, biodiversity, landscapes, ground, habitats, climate regulation, erosion control, renewable and non-renewable energy sources, etc. (i.e. UN, 2003, p. 5).

[2] Produced capital comprises material assets, i.e. capital assets, which contribute to the manufacturing process (for example, buildings, machines, equipment, infrastructure, technology, etc.) (Črnjar and Črnjar, 2009, p. 87).

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