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Determinants of the EU sustainable development policy effectiveness. DEA approach[1]

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Abstract: In the last decades, sustainable development has become one of the key principles in the European Union policies. Its concept is based three pillars: economic, social and environmental. They are interdependent and mutually reinforcing. Europe 2020 strategy stresses the importance of more sustainable EU development by establishing a long-term approach based on a clear guidance to climate and energy change. The overall aim of the renewed EU Sustainable Development Strategy (SDS) is to identify and develop activity to ensure the EU to achieve continuous improvement of quality of life through the creation of sustainable communities able to manage and use resources efficiently. It should be based mainly on social innovation potential of the EU economy, to form the background for: economic development, social cohesion and environmental protection. The main goal of publication is to estimate the EU sustainable development policy impact on the economies of the EU Member States. Analysis will be based on Data Envelopment Analysis (DEA) approach, which will let determine the efficiency of this policy. It should contribute to better understanding of the ongoing processes of the sustainable development, providing possibility for monitoring, forecasting and estimating the impact of particular factors on the EU economy in terms of economic, social and environmental aspects.

Keywords: sustainable development, effectiveness of the sustainable development policy, DEA approach.

JEL codes: O43, O44.

1. Introduction

Sustainability issues are one of the major challenges currently facing the European and world economy. There is a need to stimulate this development, both in terms of ecological as well as

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social, through appropriate policies sustainable development. These issues are interdependent and mutually reinforcing. Europe 2020 Strategy (EC, 2010) stresses the importance of more sustainable EU development by establishing a long-term approach based on a clear guidance to climate and energy change. In the last decades, sustainable development has become one of the key principles in the European Union policies. Its concept is based on three pillars: economic, social and environmental. The empirical studies conducted so far attempts have been made to determine the impact of climate policy and social balancing socio-economic development of the EU countries, but only a few studies focused on attempting to assess their effectiveness. Furthermore, the impact of climate policy tools and social policies were considered separately.

This paper introduces a new approach and concentrates to investigate relative efficiency of the climate and social policy in 24 EU member states. It provides evidence on the sustainable development policy (climate and social ones) technical efficiency calculated basing on output-oriented DEA model and includes the analysis of the scope of efficient member states to be a benchmark for inefficient ones. Using the concept of actual and target outputs, individual output-oriented sustainable development efficiency indices are computed to suggest more detailed policy recommendations.

The main goals of this paper are:

1) Presenting main issues connected with sustainable development concepts in the previous literature.

2) Presenting main aspects of the EU sustainable development policy implementation.

3) Estimating the EU sustainable development policy impact on the economies of the EU Member States. Analysis will be based on Data Envelopment Analysis (DEA) approach, which will let determine the efficiency of this policy.

Achieving these goals should contribute to better understanding of the ongoing processes of the sustainable development, providing possibility for monitoring, forecasting and estimating the impact of particular factors on the EU economy in terms of economic, social and environmental aspects.

2. Sustainable development concept (SDC) – genesis and evolution

WCED's report "Our common future" (1987) formulated a definition of sustainable development, which states that: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". It is so called the Brundtland sustainable development definition.

There are also many alternative definitions of sustainable development. The most common among them are following:

- definition of Natural Capital Committee (2012) "Economists define development as sustainable when utility from consumption is non-declining through time" (British Government, 2012),
- definition of Dasgupta (2007) who argues that sustainable development means an economy's inclusive (or comprehensive) wealth should not decline over time. In other words, investment in a productive base (its stock of produced human, social and natural capital) should be positive over time, noting possible substitution constraints for some natural capital stocks" (http://www.defra.gov.uk/naturalcapitalcommittee/natural-capital/what-is-sustainability),
- definition formulated by House of Commons Community and Local Government Committee (HCCLGC, 2012): "Sustainable development is development that meets the need of the present without compromising the ability of existing communities and future generations to meet their own needs". The committee also note that economic, environmental and social pillars are addressed positively and equally with respect for environmental limits,
- 2011 UK Government Vision for Sustainable Development: "... Stimulating economic growth and tackling the deficit, maximising wellbeing in society and protecting our environment, without negatively impacting on the ability of future generations to do the same" (DEFRA, 2011),
- 2005, UK Sustainable Development Strategy Securing the Future: "to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life, without compromising the quality of life of future generations" (UKG SDS, 2005),

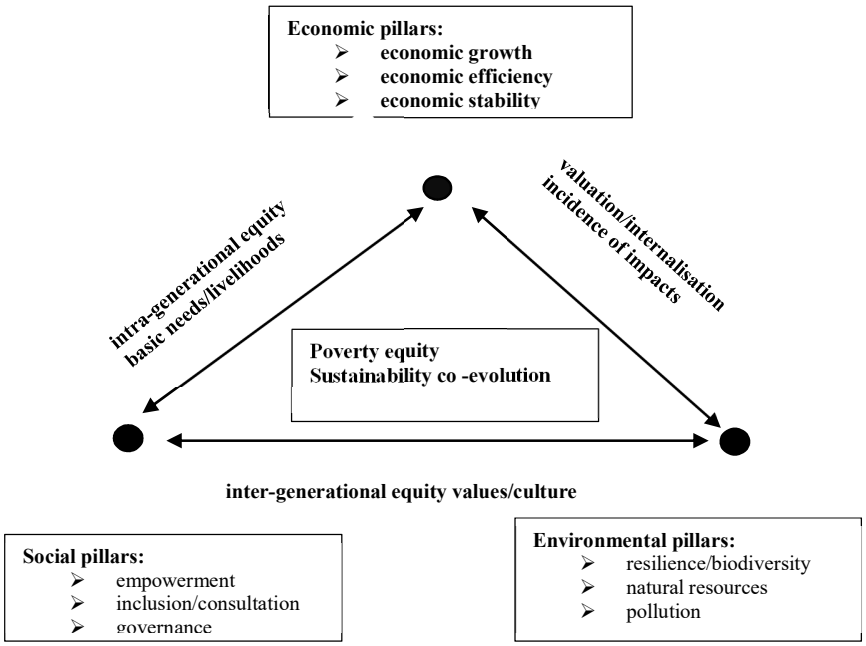
All definitions of sustainable development are focused on the economic aspects and intergenerational solidarity (current use of resources cannot reduce the consumption of future generations). Some of them also stress the importance of social welfare/economic, and quality of life of citizens. Ecological and social aspects are not included in all definitions.

There has been a growing recognition of three principal aspects of the sustainable development concept (Reed, 1997; Harris et al., 2001):

- economic: an economically sustainable system should be able to deliver goods and services on a continuing basis, to maintain manageable levels of government and external debt, and to avoid extreme sectoral imbalances,
- environmental: an environmentally sustainable system ought to maintain a stable resource background, avoiding over-exploitation of renewable resource or environmental sink functions, and depleting non-renewable resources only to the extent that investment is made in adequate substitutes,
- social: a socially sustainable system should achieve fairness in distribution and opportunity, adequate provision of social services including: health, education, gender equity, political accountability and participation (Harris, 2003, p. 1).

The concept of sustainability emerged in the 1960s in response to concern about environmental degradation resulting mainly from poor resource management. Sustainability was adopted as a common political goal. While the concept of sustainable development (SD) generally refers to the achieving a balance among the environmental, economic, and social pillars of sustainable development, the meaning of the social pillar remain vague (Dempsey et al. 2011; Casula Vifell and Soneryd, 2012). It has been presented as the most conceptually elusive pillar in SD discourse (Thin, 2002). Moreover, the social dimensions of sustainability have not received the same treatment as the other two pillars (Cuthill, 2009; Vavik and Keitsch, 2010). There are various interpretations regarding what issues should be addressed (Dixon and Colantonio, 2008). Three main pillars of the sustainable development concept were presented on the figure 1.

Figure 1. Three main pillars of the sustainable development



Source: Munasinghe, 1992; Munasinghe, 1994.

2.1. Economic pillar of sustainable development

Economic sustainability involves creating economic value out of whatever project or decision are undertaken. Economic sustainability means that decisions are made in the most equitable and fiscally sound way considering the other aspects of sustainability. In most cases, projects and decisions must be made with the long term benefits in mind (rather than just the short term benefits). For many people in the business world, economic sustainability or growth their main focal point. On the large scale, this narrow-minded approach to management of a business can lead to unsatisfactory results (see: https://soapboxie.com/social-issues/The-Environmental-Economic-and-Social Components-of-Sustainability).

According to the neo-classical economic theory, sustainability can be defined in terms of the maximization of human welfare over time. Most economists identifying the maximization of welfare with the maximization of utility derived from consumption. This approach includes many important elements of human welfare and it has the analytical advantage of reducing the problem to a measurable single-dimensional indicator.

A formal economic analysis then raises the question of whether sustainability has any validity as an economic concept. According to standard economic theory, efficient resource

allocation should have the effect of maximizing utility from consumption. If the use of time discounting as a method of comparing the economic values of consumption in different time periods is accepted, then sustainability appears to mean nothing more than efficient resource allocation – a concept already well established in economics.

Although the problem is that the use of a discount rate implicitly imposes a specific choice regarding the relative welfare of present and future generations. Howarth and Norgaard have shown that the choice of a discount rate is equivalent to a choice of allocations among generations (Howarth, Norgaard, 1993). Use of a current market discount rate gives undue weight to the preferences of current consumers.

A related issue concerns the concept of natural capital. In the neo-classical view, there is no special reason to conserve natural capital. The "Hartwick rule", a well-known principle derived from work by Hartwick (1977) and Solow (1986), states that consumption may remain constant, or increase, with declining non-renewable resources provided that the rents from these resources are reinvested in reproducible capital. This rule does not require maintenance of any particular stock of natural capital.

The issue may be posed terms of weak and strong sustainability. Even in the neo-classical perspective the principle of weak sustainability is appropriate. In this approach, sustainability requires that the total value of manufactured plus natural capital will be constant over time.

El Serafy has underlined that in order to assess this value, there must be a full accounting for natural capital depletion (El Serafy, 1993, 1997).

A strong sustainability approach is based on the idea that substitutability between natural and manufactured capital is limited. Rather, the two are seen as complements -- factors that must be used together to be productive. In the case of critical natural capital (Pearce, Warford, 1993, p. 53) (for example water supplies) substitutability is close to zero. The strong sustainability approach implies that specific measures distinct from the ordinary market process are necessary for the conservation of natural capital. The economic system cannot grow beyond the limitations set by the regeneration and waste-absorption capacities of the ecosystem.

2.2. The role of ecological component in the sustainable development concept

Common and Perrings (1992) have stated that the economic perspective of „Solow-sustainability" has to be complemented by an ecological approach of „Holling-sustainability", following the work of Holling (1986) on the resilience and stability of ecosystems. Unlike economists, whose models provide no upper bound on economic growth, physical scientists and ecologists are accustomed to the idea of limits. Natural systems must exist subject to the unyielding laws of thermodynamics, and the science of population ecology has explored the implications of these laws for living organisms. Two of the fundamental axioms of ecological and evolutionary biology are that organisms are exuberantly over-productive, and that limits set by time, space, and energy are inevitably encountered" (Holling, 1994). From the ecological point of view sustainability must involve limits on population and consumption levels. These limits apply to all biological systems. While humans may appear to evade them for a time, they must ultimately accept the boundaries of a finite planet.

However, this simple assertion of limits does not fully capture the contribution of ecologists to the discussion of sustainability. What Holling identifies as a third axiom of ecology has even more significant implications. The third axiom „concerns processes that generate variability and novelty" – the generation of genetic diversity and the resultant processes of evolution and change in species and ecosystems (Harris, 2003).

Environmental challenges are increasing the pressure on governments to find ways to limit negative environmental impact while minimising harm to economic growth. Governments have many tools at their disposal, including regulations, information programmes, innovation policies, environmental taxes and environmental subsidies. Environmental taxes are a key part of this toolkit. They have many important advantages, such as for example: environmental effectiveness, economic efficiency, the ability to increase public revenue, and transparency. Environmental taxes have been successfully used to address a wide range of issues including waste disposal, water pollution and air emissions. The design of environmental taxes and political economy considerations in their implementation are principal determinants of their economic effects (Environmental Taxation, 2010).

Governments have a range of environmental policy tools at their disposal: regulatory (or "command-and-control") instruments, market-based instruments (such as taxes (imposed on: energy, pollution, resources and transport) and tradable permits), negotiated agreements, subsidies,

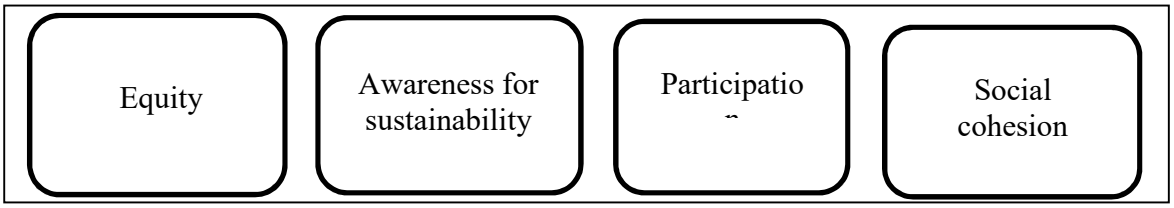
environmental management systems and information campaigns. Although no one instrument can be considered best to address every environmental challenge, there has been a growing movement towards environmentally related taxation (and tradable permits) in the EU economies (Taxation, Innovation and the Environment, 2010).

2.3. The role of social component in the sustainable development concept

While the concept of sustainable development (SD) generally refers to achieving a balance among the environmental, economic, and social pillars of sustainability, the meaning and associated objectives of the social pillar still remain vague (Dempsey et al. 2011; Casula Vifell and Soneryd, 2012). It has been described as the most conceptually elusive pillar in discourse connected with sustainable development issues (Thin, 2002). The social dimensions of sustainability have not been treated in the same way as the other two pillars (Cuthill, 2009; Vavik and Keitsch, 2010) and there were many interpretations according to the importance of the particulated issues (Dixon and Colantonio, 2008). The selection of social measures in sustainable development indicator sets (SDIs) is often a function of power rather than policy coherence, as influential groups are more likely to have their concerns included (Littig and Griessler, 2005). These indicators reflect different sociocultural priorities (Omann and Spangenberg, 2002) and are often picked for political rather than scientific reasons (Fahey, 1995).

A review of literature connected with SD suggests four pre-eminent policy concepts (Figure 2).

Figure 2. Four pre-eminent concepts of the social pillar



Source: Murphy, 2012

SDIs and the social sustainability literature present policy concepts and objectives specifically identified as „social" and represent a significant contribution to how the social pillar is conceived.

The links between the social and environmental pillars are still particularly underdeveloped. It is therefore useful to expand the parameters of the social pillar by connecting it empirically to environmental imperatives. Existing approaches present the social pillar in terms of national welfare objectives for current generations. It would be useful to broaden the understanding of the social by including international and intergenerational dimensions (Murphy, 2012).

The aim of the European Union's social policy is to promote employment, improve living and working conditions, provide an appropriate level of social protection and develop measures combating exclusion.

A number of EU Treaties make reference to social policies. The first significant development in European social policy was in 2000 when the Lisbon Strategy (EC, 2005b) and the EU Social Inclusion Strategy (EU SIS, 2010) agreed the goal "to make a decisive impact on the eradication of poverty" mainly by establishing the Open Method of Coordination.

The last EU Treaty, the Lisbon Treaty (EU, 2008) contains a "social clause" whereby social issues (promotion of a high level of employment, adequate social protection, fight against social exclusion, etc.) must be taken into consideration by defining and implementing all policies.

Social policy is also firmly placed in the most recent Strategy Europe 2020 (EC, 2010) through the headline poverty target. The development and coordination of social policy at EU level is supported by the PROGRESS programme and its sub-programme, the Peer Review in Social Protection and Social Inclusion.

2.4. Linkage between the social and environmental pillars

The literature put the stress on necessity to develop stronger linkage between the social and environmental pillars (Dobson, 2003; Littig and Griessler, 2005; Gough et al. 2008).

The novelty and essential contribution of sustainable development concept implementation and policy approach resides in its requirement to develop interpillar links. According to The Brundtland Report the „deepening interconnections" among the pillars constitutes „the central justification for the establishment of the Commission" (WCED, 1987). Jordan and Lenschow (2008) underline that the report's greatest contribution was highlighting the need for mutual compatibility among the particular pillars. The Aalborg Charter states that policy must „integrate people's basic social needs as well as healthcare, employment and housing programmes with environmental protection" (ESCTC, 1994). The EU Sustainable Development Strategy calls for

the „integration of economic, social and environmental considerations so that they are coherent and mutually reinforce each other" (CEU, 2006). The European Commission argues that the presentation of sustainable development issues without reference to their interpillar relationships may be described as "bundling," "artificial," and "false" (CEC, 2004). Developing all aspects (economic, environmental and social) interconnections via policy may be linked to the concept of environmental policy integration (EPI) and in particular horizontal environmental policy integration (HEPI). The last one refers to including environmental concerns into all sectors of policy, including social policy (Liberatore, 1997; Lafferty, 2002; Lafferty and Hovden, 2003; Jordan and Lenschow, 2008). Liberatore (1997) states: „The relevance of integration for moving towards sustainable development is straightforward: if environmental factors are not taken into consideration in the formulation and implementation of the policies which regulate economic activities and other forms of social organization, a new model of development that can be environmentally and socially sustainable in the long term cannot be achieved".

While disciplines such as environmental economics do link environmental and economic imperatives, sustainable development concept is unique in that it adds social aspects into the interdimensional mix (Dryzek, 2005). However, much of the work done on the social pillar discussed above does not place much focus on environmental links. The work of Littig and Griessler (2005), Chan and Lee (2008), Cuthill (2009), and Dempsey et al. (2011) provide discussions regarding social aspects of sustainable development, but the links between social and environmental goals were not broadly described. Cuthill (2009) and Littig and Griessler (2005) mention that developing such links would strengthen understanding of the social pillar. Key EU SDI documents often cite the importance of developing „interdimensional" relevance among pillars (CEC, 2004; Eurostat, 2007). A review of key international Sustainable Development Initiatives SDIs (e.g., UNCSD, 1996; UNDESA, 2001; 2007; Eurostat, 2005; 2007) reveals that while some linkages are made, these are very weakly developed.

2.5. Other pillars of sustainable development (culture, institutions, governance)

Throughout the past decade, indicators and data on the cultural sector, as well as operational activities have underscored that culture can be an important driver for development. Especially important role has to play the cultural sector's in the scope of its contribution to the economy and poverty alleviation (UNESCO, 2012, p. 3). Culture-led development includes a range of non-

monetized benefits, such as: greater social inclusiveness and rootedness, resilience, innovation, creativity and entrepreneurship for individuals and communities, and the use of local resources, skills, and knowledge. Respecting cultural expressions contribute to strengthening the social capital of a community and fosters trust in public institutions. Cultural factors also influence lifestyles, individual behavior and consumption patterns. Local knowledge systems and environmental management practices provide valuable instruments for tackling ecological challenges, preventing biodiversity loss, reducing land degradation, and mitigating the effects of climate change (UNESCO, 2012, p. 4).

Governance enables the achievement of a range of critical development objectives. The ongoing discussions around a post-2015 development framework are based on a recognition that current development challenges are more complex than they were many years ago. For development to be sustainable, a new approach is needed that addresses the political, as well as the technical, aspects of development solutions. Improved governance across many dimensions is a key part of this new approach. Governance is broader than institutions and includes relations between state and people. It provides the mechanisms through which cooperation can be generated across sectors. It addresses some of the fundamental obstacles to sustainable development including exclusion and inequality (UNDP, 2014, p. 2). In July 2012, UN Member States reaffirmed good governance as a foundation for development: Democracy, good governance and the rule of law at the national and international levels, as well as an enabling environment, are crucial for sustainable development including sustained and inclusive economic growth, social development, environmental protection and the eradication of poverty and hunger (General Assembly Resolution 66/288) (UNDP, 2014, p. 3). Perspectives from many people coming out of surveys, like "My World" and consultations on "The World We Want" (UNDP, 2014, p. 3), show that the quality of governance has a profound effect on sustainable development. A majority of the people consulted voted for 'an honest and responsive government' among their top priorities. Inadequate controls on power and the exercise of authority lie at the core of development challenges, including weak state capacity, social and political violence, conflict over natural resources, stresses on citizen security, and environmental sustainability (UNDP, 2014, p. 3-4). The quality of governance plays a key role in supporting the pillars outlined in "Realizing the Future We Want for All" (UN, 2012), which advocates for an approach to the post-2015 development

framework that is based on (UNDP, 2014, p. 4): (1) inclusive social development; (2) inclusive economic development; (3) environmental sustainability; and (4) peace and security.

Our common future - The Brundtland Commission's Report (1987) serves as an internationally applicable example where culture seems to influence the sustainable development equation. Article 13 of the Convention on the Protection and Promotion of the Diversity of Cultural Expressions (the Cultural Diversity Convention) of 2005 (the text of the Convention can be found at: unesdoc.unesco.org) explicitly requires the UN Member States to "integrate culture in their development policies at all levels for the creation of conditions conducive to sustainable development". The tie between sustainable development and culture issues is also clear from much of the work of the Cultural Sector of UNESCO (UNESCO, 1996). Complementary to these international developments one finds that issues of culture increasingly are emerging also in national case law dealing with legal claims to sustainable development (see for example: Oudekraal Estates and others, 2009). That is why growing number of scholars from are devoting their research to the overlap between culture issues and the traditional sustainable development equation. The question arises as to whether or not the existing way in which authorities look at sustainable development suffices to recognise these links in practice (Du Plessis, Rautenbach, 2010, p. 27-29).

3. Implementation of the sustainable development concept in the EU

The European Council in Göteborg (2001) adopted the first EU Sustainable Development Strategy (SDS) (EC, 2001). This was complemented by an external dimension in 2002 by the European Council in Barcelona in view of the World Summit on Sustainable Development in Johannesburg (2002). Against this background, in conclusion of the review of the EU SDS launched by the EC in 2004 and on the basis of the Commission Communication: "On the review of the Sustainable Development Strategy – A platform for action" (EC, 2005), the European Council has adopted an ambitious and comprehensive renewed SDS for the EU, based on the one adopted in 2001.

The overall aim of the renewed EU SDS is to identify and develop activity to enable the EU to achieve continuous improvement of quality of life for current and future generations, through the creation of sustainable communities, which will be able to manage and use resources efficiently and to tap the ecological and social innovation potential of the economy, ensuring prosperity, environmental protection and social coherence.

The Commission aimed to draw out some key ideas linked to the Brundtland sustainable development definition on which there would be a very wide consensus, and to build an operational strategy on them. They include (EC, 2005):

- a focus on quality of life,
- responsible approach to managing resources,
- coherence in policy making,
- the strategy also identified a limited set of concrete priority areas: two socially unsustainable trends (ageing and poverty eradication) and four environmental priority areas for action: climate change, environment and health, transport and land use, and nature and biodiversity.

The Seventh European Environment Action Programme (EC, 2012) sets out environmental objectives for the years 2014 to 2020 and outlines the action that needs to be taken to achieve them (EU, 2013). The programme focuses on the following priority objectives:

(a) to protect, conserve and enhance the Union's natural capital,

(b) to turn the Union into a resource-efficient, green and competitive low-carbon economy,

(c) to safeguard the Union's citizens from environment-related pressures and risks to health and well-being,

(d) to maximise the benefits of Union environment legislation by improving implementation,

(e) to improve the knowledge and evidence base for Union environment policy,

(f) to secure investment for environment and climate policy and address environmental externalities,

(g) to improve environmental integration and policy coherence,

(h) to enhance the sustainability of the Union's cities,

(i) to increase the Union's effectiveness in addressing international environmental and climate-related challenges.

The parallel Programme for the Environment and Climate Action covering the period from 1 January 2014 to 31 December 2020 (the "LIFE Programme") has the following general objectives (EU, 2013; EU, 2014):

(a) to contribute to the shift towards a resource-efficient, low-carbon and climate- resilient economy, to the protection and improvement of the quality of the environment and to halting and reversing biodiversity loss, including the support of the Natura 2000 network and tackling the degradation of ecosystems,

(b) to improve the development, implementation and enforcement of Union environmental and climate policy and legislation and promote the integration and mainstreaming of environmental and climate objectives into other Union policies and public and private sector practice, including by increasing capacity of these sectors,
(c) to support better environmental and climate governance at all levels (mainly through better involvement of society, NGOs and local actors),
(d) to support the implementation of the 7th Environment Action Programme.

In table 1 main principles and governance challenges of SD strategies were presented.

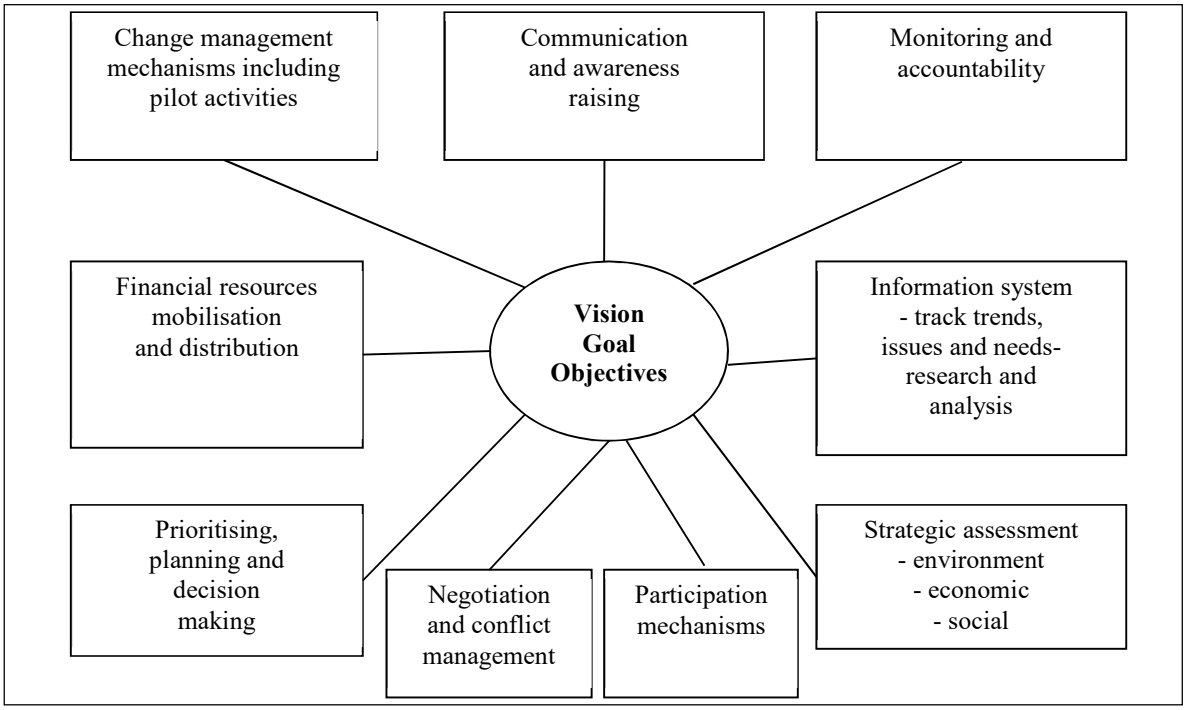
Table 1. Principles and governance challenges of SD strategies

Principle	Governance challenges of SD strategies
(1) Common vision and strategic objectives	- an SD strategy should define a common long-term vision for SD, - the vision of SD should be operationalised with strategic objectives that are SMART, i.e.: - specific (ideally stating a quantified target), - measurable (with SD indicators), - achievable (neither too easy nor too demanding), - realistic (to be achieved with the given resources and political circumstances), - time bound (indicating a start date and target year)
(2) High-level commitment	- an SD strategy should be backed by high-level political commitment (from the entire government, from influential lead institutions)
(3) Horizontal integration	- the integration of economic, environmental and social issues should be taken into account: - in the SD strategy document (e.g. by highlighting links and trade-offs between the three dimensions of SD), - in the governance of the SD strategy (e.g. by establishing inter-ministerial bodies that are responsible for implementing the SDS)
(4) Vertical integration	- an SD strategy should be in line with priorities and implementation activities at other levels of governments (EU, national/federal, regional, local)
(5) Participation	- different stakeholder groups should be involved in the development and implementation of an SD strategy (participatory activities can be informational, consultative or decisional, and they can make use of different tools and mechanisms, such as permanent Councils for SD, ad-hoc stakeholder dialogues, informative/consultative internet actions, etc.)
(6) Implementation mechanisms and capacity-building	- the objectives of an SD strategy should be addressed with: - provisions and mechanisms of implementation (budgeting, annual or bi-annual work/action plans) in which political responsibilities are clearly defined, - adequate institutional and/or personal capacities or capacity building activities that are necessary to achieve the objectives
(7) Monitoring, evaluation and strategy renewal	- the effectiveness of an SD strategy in achieving its objectives should be: - monitored continuously with a set of SD indicators (mostly quantitatively), - reviewed/evaluated in regular intervals (mostly qualitatively), - monitoring and reviewing results/reports should be considered in the continuous adjustment and the cyclical renewal of an SD strategy so that evidence-based policy takes place

Source: internet site of the European Sustainable Development Network (ESDN).

The OECD/UNDP resource book on Sustainable Development Strategies (SDS) (Dalal-Clayton B., Bass S., 2001) underlines that National Sustainable Development Strategies (NSDS) should provide a strategic approach to help achieve a country's long term sustainable development, containing clearly defined long term and intermediate policy objectives, and specific activity and a timetable to achieve them. They should also contain provisions for monitoring and evaluating progress, and for periodic reviews. When developing NSDS, countries therefore have to set up appropriate information, coordination, participation, implementation, and monitoring and evaluation mechanisms as illustrated on figure 3.

Figure 3. Vision, goals and objectives of National Sustainable Development Strategies (NSDS)



Source: Dalal-Clayton, Bass, 2001.

The extent to which NSDS can bring about positive change in unsustainable trends will to a large extent be determined by the quality of the underlying mechanisms for preparation, implementation and evaluation. The OECD and UNDP consider therefore that getting the process right is key to achieving a sustainable growth path (EC, 2004).

4. The essence of the DEA approach

DEA is a non-parametric frontier methodology developed by Charnes et al. (1978). Selection of the most appropriate DEA model is one of the most crucial tasks before carrying out the DEA analysis. There are two basic models of DEA: the Charnes, Cooper and Rhodes and the Banker, Charnes and Cooper (BCC) models. Each Decision Making Unit (DMU) consumes varying amounts of m different inputs to produce s different outputs. Specifically DMU_j consumes x_{ij} of input i and produces amount y_{rj} of output r. Envelopment BCC model (output oriented) can be stated as:

$$Max \quad z + \varepsilon \left[\sum_{i=1}^{m=1} I_i + \sum_{r=1}^{s} O_r \right], (1)$$

subject to:

$$\sum_{j=1}^{N} \alpha_j x_{ij} = x_{ij_0} - I_i \qquad i = 1.....m, \tag{2}$$

$$\sum_{j=1}^{N} \alpha_j y_{rj} = O_r - z y_{rj_0} \qquad r = 1.....s, \tag{3}$$

$$\sum_{j=1}^{N} \alpha_j = 1, \tag{4}$$

$$\alpha_j \geq 0,1...N, I_i \qquad O_r \geq 0 \forall \quad i \quad and \quad r, z \quad free, \tag{5}$$

where

ε - is a non-Archimedean infinitesimal

I_i, O_r - represent additional output augmentations and/or input reductions (slacks)

The optimal value $z^*_{j_0}$ of z is the maximum factor by which the output levels of DMU j_0 can be radially expanded without detriment to its input levels.

Thus by definition is the measure of efficiency of DMU j_0 and a measure of the pure technical output efficiency DMU j_0. Slacks represent the leftover portion of inefficiencies. After a proportional increase in outputs, if a DMU cannot reach the efficient frontier, slacks are needed to push the DMU to the frontier (Kumar and Gulati, 2008).

A measure of scale efficiency (SE) can be obtained by comparing technical efficiency (TE) measures derived under the assumptions of constant returns-to-scale (CRS) and variable returns-to-scale (VRS). The TE measure corresponding to CRS assumption represents overall technical

efficiency (OTE) which measures inefficiencies due to the input/output configuration and as well as the size of operations. The efficiency measure corresponding to VRS assumption represents pure technical efficiency (PTE) which measures inefficiencies due to only managerial underperformance. The relationship SE = OTE/PTE provides a measure of scale efficiency (Kumar, Gulati, 2008, p. 43).

A notion pure is to signal that technical efficiencies are „net" of any scale effect. The impact of scale size on efficiency is measured by scale efficiency. It measures the divergence between the efficiency rating of a DMU under CRS and VRS respectively. The CRS technical efficiency measure is decomposed into "pure" technical efficiency and scale efficiency. Scale output efficiency is defined as follows:

$$\frac{Technical \quad output \quad efficiency \quad of \quad DMU_{j0}}{Pure \quad technical \quad output \quad efficiency \quad of \quad DMU_{j0}} \quad (6)$$

The analysis uses two types of data (from Eurostat database):

Input indicators:

- environmental taxes relative to GDP – indicator of ecological policy,
- ecological government spending per capita – indicator of ecological policy,
- government spending on social protection in purchasing power parity – indicator of social policy.

Output indicators:

- GDP per capita – indicator of economic effects,
- the inverse[2] of carbon dioxide emissions per capita – indicator of ecological effects,
- the inverse of number of inhabitants at risk of poverty (in %) – indicator of social effects.

As concerns the selection of inputs and outputs, it could be accepted only a limited number of them, due to the limitations of DEA resulting from the fact that the number of variables used, must be approximately no less than three times less than the number of test items, the number of which is naturally limited by the number of EU countries. Inclusion to the analysis of a greater number of variables would practically hinder differentiation of efficiency of objects under investigation. Selection of these and other variables stems from of the review of literature, and was also partly motivated by own intuition of researcher. The latter in the case of the DEA approach is often an

[2] In the case of two output indicators their inverse values were was taken into account in the analysis due to the fact that the lower value is preferred.

important factor when selecting variables for analysis.

5. Results of analysis

Values of output oriented coefficients of effectiveness were presented in the Table 2. The relatively large number of countries (16) turned out to be "technologically effective”. These are: Finland, Estonia, Belgium, Sweden, Romania, Slovakia, Poland, Spain, Czechia, Ireland, Bulgaria, Denmark, France, Latvia, Lithuania and the Netherlands. In eight cases Finland was a benchmark for the other countries and thus this country was recognized to be the most effective. Finland probably better serves as a model to follow for the less efficient countries, because its working practices and the environment in which it operates are much more suited to average conditions in which the most inefficient countries operate.

Table 2. Output efficiency scores under Variable Returns of Scale (VRS)(analysed year: 2012 or 2013)

DMU	Score	Benchmark(Lambda)	Times as a benchmark for another DMU
Finland	1.0	Finland(1.000000)	8
Estonia	1.0	Estonia(1.000000)	5
Belgium	1.0	Belgium(1.000000)	4
Sweden	1.0	Sweden(1.000000)	4
Romania	1.0	Romania(1.000000)	3
Slovakia	1.0	Slovakia(1.000000)	3
Poland	1.0	Poland(1.000000)	2
Spain	1.0	Spain(1.000000)	2
Czechia	1.0	Czechia(1.000000)	1
Ireland	1.0	Ireland(1.000000)	1
Bulgaria	1.0	Bulgaria(1.000000)	0
Denmark	1.0	Denmark(1.000000)	0
France	1.0	France(1.000000)	0
Latvia	1.0	Latvia(1.000000)	0
Lithuania	1.0	Lithuania(1.000000)	0
Netherlands	1.0	Netherlands(1.000000)	0
Germany	0.97752	Belgium(0.630080); Finland(0.180595); Slovakia(0.000517); Spain(0.111897); Sweden(0.076911)	0
Austria	0.96245	Belgium(0.423546); Finland(0.191634); Ireland(0.019856); Sweden(0.364964)	0
United Kingdom	0.89854	Belgium(0.261171); Estonia(0.210471); Finland(0.154829); Sweden(0.373528)	0
Slovenia	0.878	Czechia(0.333111); Estonia(0.124342); Finland(0.282017); Poland(0.260530)	0
Greece	0.8614	Estonia(0.522069); Finland(0.264287); Romania(0.191075); Spain(0.022569)	0
Portugal	0.84829	Finland(0.413896); Romania(0.489368); Slovakia(0.096735)	0
Italy	0.77048	Belgium(0.043508); Estonia(0.250610); Finland(0.345220); Sweden(0.360662)	0
Hungary	0.73995	Estonia(0.125693); Finland(0.125400); Poland(0.554906); Romania(0.161176); Slovakia(0.032824)	0

Source: own calculations based on Eurostat data

In the Table 3 was shown the ranking which was drawn up on the basis of average values of ρ coefficient. Finland is a country of reference having the highest average potential growth in all

three examined effects. In this respect the second place is taken by Estonia. Countries, which have reached very low values of the coefficient ρ in terms of the given effect should consider carrying out fundamental changes in their policy. Taking into account economic aspects (expressed by GDP_per capita), three key countries to follow are: Finland, Estonia and Sweden; taking into account environmental aspects (determined by the rate of CO_2 emissions_per capita): Finland, Poland and Estonia can be regarded as patterns; while considering social aspects (based on the ratio: People at risk of poverty), it can be stated that inefficient countries should follow primarily: Finland, Estonia and Sweden. Dominance in the ranking of the Scandinavian countries should be underlined, these countries rank high in international competitiveness indices. Also high positions held by the countries of Central and Eastern Europe, particularly the Visegrad Group (V-4), with the exception of Hungary should not be underestimated. This shows a very strong tendency to balance the socio-economic and ecological factors in the latter countries. It seems that the fundamental reason for this is the adaptation of these countries to the European Union's requirements related to environmental protection and social welfare. These results confirm also the literature findings which justify the need to take into account ecological and social aspects in the policies carried out by the EU Member States or other countries. Table 3 includes only 10 fully effective countries, because the coefficient p shows the number of times a fully effective country was the benchmark for the inefficient countries.

Table 3. Output-specific reference share ρ for efficient DMUs being benchmarks for inefficient DMUs in %

Countries	GDP_per capita	CO_2 emissions_per capita	People at risk of poverty	Average rank by p
Finland	28.56% (1*)	26.91% (1)	26.50% (1)	1.00
Estonia	18.34% (2)	16.66% (3)	24.08% (2)	2.30
Sweden	18.02% (3)	9.12% (5)	17.34% (3)	3.66
Romania	11.63% (4)	14.38% (4)	10.22% (4)	4.00
Poland	9.89% (5)	18.71% (2)	9.72% (5)	4.00
Belgium	9.05% (6)	4.39% (7)	7.76% (6)	6.33
Czechia	3.06% (7)	7.29% (6)	2.91% (7)	6.66
Slovakia	1.91% (8)	2.43% (8)	1.23% (8)	8.00
Spain	0.55% (9)	0.41% (9)	0.62% (9)	9.00
Ireland	0.11% (10)	0.04% (10)	0.05% (10)	10.00

* in brackets was shown the position of the EU country in the ranking, which takes into account the particular analysed factor (e.g. GDP_per capita).

Source: own calculations based on Eurostat data

Table 4 shows the factors defining an efficiency of scale, economies of scale and intensity of the inefficiencies of scale. The effectiveness of scale includes the impact of the scale of activity on the effectiveness of decision-making objects (i.e. countries) under consideration. Constant returns to scale (CRS) mean that the amount of the inputs incurred by the analysed object is optimal (i.e. that the change would deteriorate efficiency). In the case of decreasing returns to scale (DRS) reducing the inputs would be desirable, but in the case of increasing returns to scale (IRS) it is desirable to increase the volume of inputs. The greater the deviation of the evaluation from the effectiveness of the scale, the lower efficiency of scale and the greater negative impact of the size scale on the efficiency of operations. Ten analysed countries were characterized by constant economies of scale, while in the remaining fourteen countries decreasing economies of scale were observed. It suggests a need to reduce the scale of their policies' impact.

Table 4. Scale efficiency, returns to scale and intensity of scale inefficiency (CRS)

DMU	Score	Returns of Scale (RTS)
Austria	0.930403	increasing
Belgium	1.0	constant
Bulgaria	1.0	constant
Czechia	1.0	constant
Denmark	0.91684	increasing
Estonia	1.0	constant
Finland	1.0	constant
France	1.0	constant
Germany	0.972696	increasing
Greece	0.819732	increasing
Hungary	0.733126	increasing
Ireland	0.949361	increasing
Italy	0.752954	increasing
Latvia	1.0	constant
Lithuania	0.89174	increasing
Netherlands	0.771655	increasing
Poland	1.0	constant
Portugal	0.808161	increasing
Romania	0.911545	increasing
Slovakia	1.0	constant
Slovenia	0.832736	increasing
Spain	0.97818	increasing
Sweden	1.0	constant
United Kingdom	0.889284	increasing

Source: own calculations based on Eurostat data

6. Conclusion

On the base of conducted considerations, the following conclusions and recommendations can be drawn:

- on the base of the analyzes it can be stated that the leader of the ranking is Finland, mainly due to the fact that this country has a highly developed economy in economic, ecological and social terms. In addition, Finland has developed the institutional system, which favors the development of eco-innovation,
- high position of Estonia and Central and Eastern Europe countries, especially three Visegrad countries: Poland, Czechia and Slovakia, whose economies are developing very quickly, despite the trend experienced by the crisis have to be underlined. Of course, one has to pay attention to the so-called base effect, stemming from the fact that countries with lower levels of socio-economic development, by definition experience higher growth and development rates,
- among the fully effective countries, which are benchmarks for other states, the lowest p value index was achieved by: Slovakia, Spain and Ireland,
- among the fully effective countries, which are benchmarks for other countries, the lowest index values p were achieved by Slovakia, Spain and Ireland,
- inefficient countries should adjust their policies, in particular to environmental and social standards/recommendations of the EU,
- it is also necessary to adapt institutional and legal framework of economic systems in order to increase the effectiveness of economic policy,
- there is also a strong need to achieve balance in all spheres: economic, ecological and social ones
- implementation of eco-innovation and supporting R & D activity are also very important,
- implementation of the Scandinavian model, taking into account the specifics of national economies, can be very useful for some analysed countries.
- results of the analysis are very promising, but they should be treated with caution, primarily due to the limitations of the DEA method, mainly related to the limited number of variables, which can be used in analysis and as well as to the relatively high sensitivity of this method to the choice of inputs and outputs, Therefore, the results of research should be treated with caution. The necessity of this method's usage is justified by research and data, which are

used in the analysis. Due to the limited availability of data, this method is the "second best solution".

- there is a strong need to take into account different methods and approaches in future research.

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Determinanty efektywności polityki zrównoważonego rozwoju UE

Streszczenie

W ostatnich dekadach, zrównoważony rozwój stał się jedną z najważniejszych zasad w polityce Unii Europejskiej. Jego koncepcja opiera się na trzech filarach: ekonomicznym, społecznym i środowiskowym. Są one współzależne i wzajemnie się uzupełniają. Strategia Europa 2020 podkreśla znaczenie bardziej zrównoważonego rozwoju UE poprzez ustanowienie długoterminowego podejścia opartego na jasnych wytycznych odnośnie do zmian klimatycznych oraz w zakresie energii. Ogólnym celem odnowionej strategii UE dotyczącej trwałego rozwoju (ang. *SDS – Sustainable Development Strategy*) jest identyfikacja i rozwój działalności, mających zapewnić Unii Europejskiej osiągnięcie stałej poprawy jakości życia poprzez tworzenie zrównoważonych społeczności będących w stanie zarządzać i efektywnie wykorzystywać zasoby. Podejście to powinno opierać się przede wszystkim na społecznym potencjale innowacyjnym gospodarki UE, tworząc podstawę dla: rozwoju gospodarczego, spójności społecznej i ochrony środowiska. Głównym celem publikacji jest oszacowanie wpływu polityki UE w zakresie zrównoważonego rozwoju na gospodarki państw członkowskich UE. Analiza będzie opierać się na podejściu wykorzystującym metodę obwiedni danych (ang. *DEA - Data Envelopment Analysis*), która pozwoli określić skuteczność tej polityki. Powinno to przyczynić się do lepszego zrozumienia zachodzących procesów zrównoważonego rozwoju, zapewniając możliwość monitorowania, prognozowania i szacowania wpływu poszczególnych czynników na gospodarkę UE w aspekcie ekonomicznym, społecznym i środowiskowym.

***Słowa kluczowe**:* zrównoważony rozwój, efektywność polityki zrównoważonego rozwoju UE, podejście DEA.