

# Determining the Sustainability Zone for Sustainable Development Indices

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**Abstract:** There are needs for dynamic-analysis on the process of sustainable development in economy of the countries in transition. In this paper, a new concept, “sustainability zone”, is proposed, which defines the levels of sustainability in those countries. In order to demonstrate the effectiveness of this methodological approach, capabilities of exporting high-technology products of Ukraine were examined, and then previously developed indices of sustainable development and of economic development of the world were analysed. As a result, the methodological approach for shaping and defining the sustainability zone was determined upon the dynamic-analysis on the development of socio-economic system. A procedure of shaping the zone of the targeted sustainability should be further investigated by the experts of optimizing the resource allocations.

**Index Terms:** sustainability zone, sustainable development, dynamic analysis, index of economic dimension

**JEL:** Q01

## I. INTRODUCTION

Conceptual foundations of sustainable development imply rational use of the limited resources of the Earth. Restraining the consumption level enables humankind to preserve resources of the Earth for generations to come. It is of particular importance for the developed countries. Employing the foundations of the given concept contributes to establishing the balance within the social, ecological and economic domains. Systematic unification of these domains allows a deeper study of the development of particular states.

Methodology and results of these studies were supported during the UN summits with the participation of more than 180 countries and international organizations in Rio de Janeiro (1992) and Johannesburg (2002). In 2012, during the Rio+20 (20th anniversary since the last summit in Rio de Janeiro), the Resolution 66/288 was adopted – “The Future We Want” (The UN General Assembly) (UN General Assembly, 2012).

In Ukraine, Zgurovsky (Zgurovsky, 2006) developed the systems and techniques for analyzing and evaluating the levels of sustainable development in the regions.

Thus, Ukrainian research teams have elaborated several methods. Under the guidance of Makogon (Makogon, 2011), the method for analyzing the transformation processes of trans-nationalization within the increasing uncertainty in environment was developed.

Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine (Paton, 2012) has suggested its own scientific developments. Research of the Institute for economics and forecasting (Heyets, 2010) presented the similar methods. Institute of Industrial Economics of National Academy of Science of Ukraine (Novikova, Amosha, & Antoniuk, 2012) has made its research activities in the area of regional industrial development. There are also developments (Atkinson, 2012).

In general, the concept of sustainable development is illustrated by a set of indices and indicators, which are defined by their static and dynamic characteristics. Zgurovsky (Zgurovsky, 2006) proposes integrations of those indicators and indices, aiming at analyzing the process of socio-economic development. Essential part of this research is the analysis of economic systems in their static and dynamic conditions on the state and regional levels. The data used in the research is provided by the World Data Center for Geoinformatics and Sustainable Development (World Data Center, 2017).

## II. MODEL AND METHODOLOGY

In this research, the “sustainability” is measured by a change of a value of certain index in time. According to the concept of the sustainable development, a claim for the sustainability of a certain system is to be approved when the magnitude of the change in parameters in each subsequent period of time takes a value that corresponds to the conditions, which are defined by certain restrictions. Fig. 1 shows the model of sustainability zone.

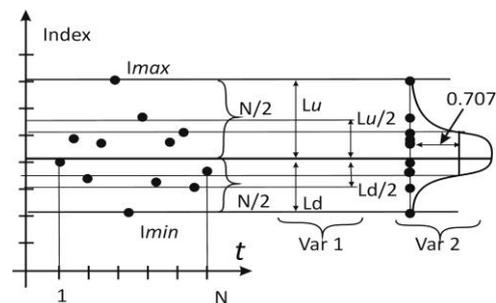


Fig. 1. Models of defining the “sustainability zone”

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Notes:  $I_{max}/I_{min}$ : the maximum/minimum value of the index data,  $N/2$ : half the range of values,  $Lu$ : the upper range,  $Ld$ : the lower range,  $Var 1$ : Variation 1,  $Var 2$ : Variation 2

Variation 1 shows a wider sustainability zone. The deviation of the values of the index from the central value is significantly wide. For variation 2 the given zone is narrower, and the distributions of the values of the index are observed closer to the central value. Generalizing the two cases shown above, it is worth mentioning that selecting the sustainability zone entitles one to employ certain logical conclusions. Thus, the sustainability zone can be defined as a zone which comprises of some portion of the observed values. In this research, applicability of the following two criteria is examined:

Criteria 1 (the variation 1 of Fig 1): The maximal and the minimal values are chosen as the boundaries. Then, the sustainability zone is determined as a set of values within the range of  $Ld/2$  and  $Lu/2$  of Fig. 1.

Criteria 2 (the variation 2 of Fig 1): The normal distribution is assumed as the basis of this option. The sustainability zone is defined as the zone where the values of the index fall under the interval from  $-\sigma$  to  $+\sigma$ . I.e. 68.26 % of the cumulative value of the normal distribution.

Thereby, by defining the sustainability level one gets a certain distribution of the values within the sustainability zone and beyond.

In order to demonstrate the usefulness of the model shown above, the following procedure was taken:

- 1) Examine the capabilities of exporting high-technology products of Ukraine.
- 2) Analyze the indices of sustainable development and of economic development of the world.

### III. RESULT

Fig. 2 presents the results of the analysis.

The result of the analysis on the observed values that are distributed in the “ $1/2$  zone”, the variation 1 modeled in Fig 1, and in the “ $-\sigma \dots +\sigma$  zone”, the variation 2 modeled in Fig 1, leads to the following conclusions. Out of 15 observed values, 7 values are distributed in the “ $1/2$  zone”, whereas 4 values are distributed in the “ $-\sigma \dots +\sigma$  zone”. This result indicates that more than a half of the observed values of the index of high-technology export of Ukraine are out of the sustainability zone in both cases of variation 1 and variation 2 during the period between 1996 and 2010, therefore upon this model it is concluded that the high-technology export was unstable and not sustainable during the period.

The next step is to analyze the indices (World Bank, 2017) of sustainable development,  $I_{sd}$ , and of economic development,  $I_{ec}$ , of the world. For the analysis, the data were selected from the period between 2005 and 2012, and modifications were made so that the data can hold the consistency of the ranking between the countries. For the modification, the relative values of each country's indices were calculated, and then 1.0 was given to the country with the highest value of each index. For example, the  $I_{sd}$  value of 1.0 is given to Sweden. Fig.3 shows the relation between  $I_{sd}$  and  $I_{ec}$  of 28 member states of the European Union.

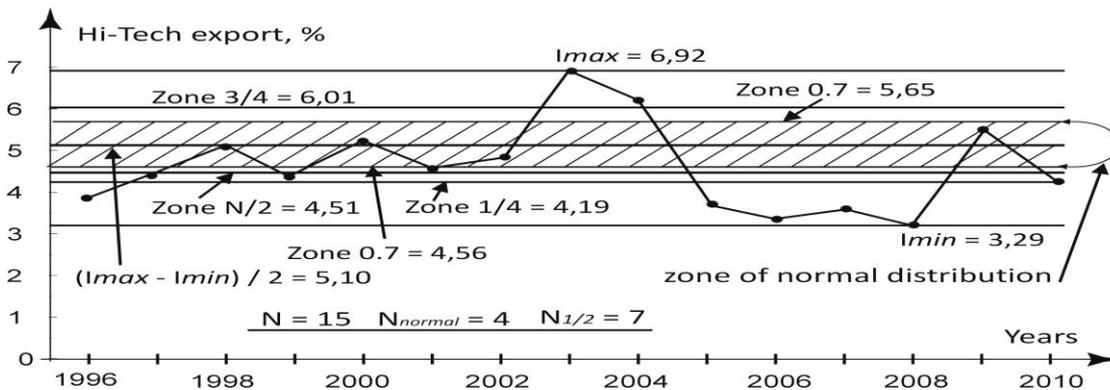


Fig. 2. Dynamics of the values of the high technology exports of Ukraine and sustainability zones of the given index (World Bank, 2017)

Trajectories are shown in Fig. 3, which present the changes of the index values over 7 years from 2005 of Italy, Spain, Greece and Ukraine.

Upon the observation of Fig 3, the following conclusions were drawn: 1) each state has similar loop-like trajectory of the index value; 2) for the last few years, the most dynamic trajectory is that of Greece; Italy bears less substantial changes during the last 3 years; 3) Ukraine and Spain keep higher sustainability level during the period between 2010 and 2012, which indicates the stable economy at the given time period.

When applying the criteria of the “½ zone”, the following results were obtained. Sustainable development in Greece is observed during the period from 2010 to 2011; in Italy, from 2005 to 2006; in Spain, in 2005, 2011 and 2012; in Ukraine, from 2006 to 2010. According to the findings it is concluded that: in all countries who suffered substantial hardships due to the global economic crisis the analyzed values of indices for the period between 2007 and 2009 were beyond the sustainability zone; and there is a distinct division between a pre-crisis and post-crisis conditions, which are revealed by these trajectories.

Those values should be investigated by the experts for the optimization of resource allocations in regard to sustainable resource management. On the grounds of the methods mentioned above, it is also recommended to further investigate the ways of determining the limits of the acceptable deviations of the index values.

#### IV. CONCLUSION

After evaluating the trajectories of the values of the indices from 2005 to 2012, it was found that the minimum interval of one year is necessary for analyzing the processes of sustainable development, which should be associated with the optimal use of limited resources of humankind and concordant unification of economic, social, ecological and institutional domains.

The methodical approach described in this paper enables determining the sustainability zone upon the dynamics of a couple of indices, and analyzing the processes of socio-economic development of the countries and the regions. Elaborating the measures that would allow maintaining the level of the index within the sustainable zone for a period

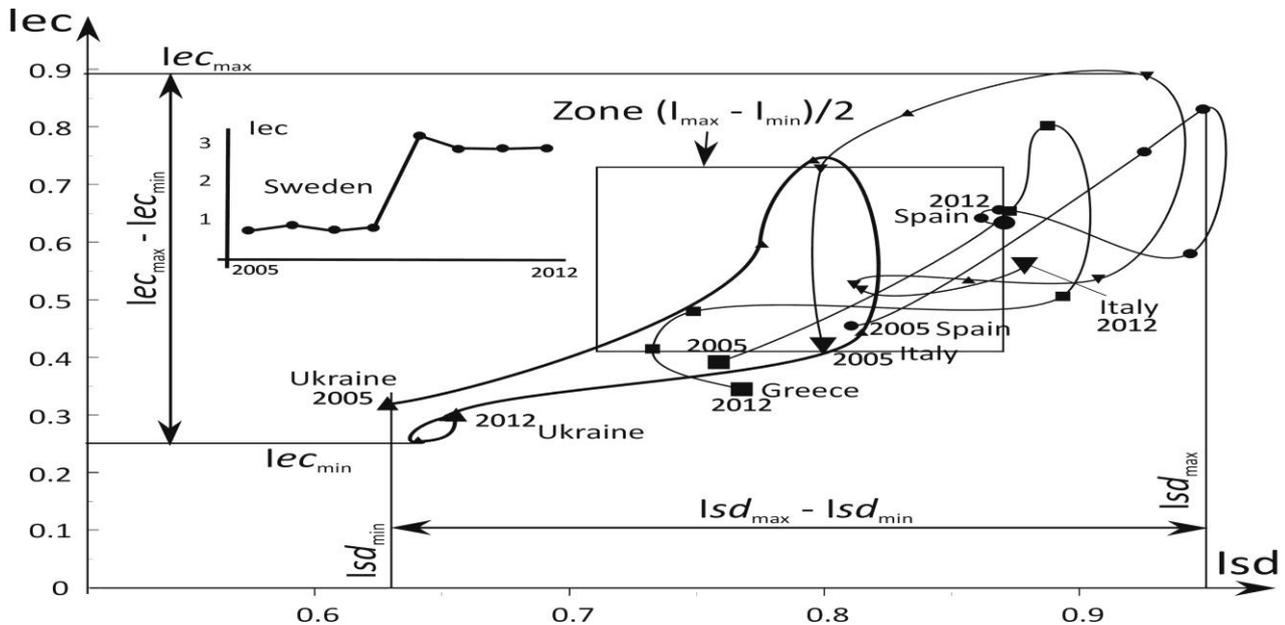


Fig 3 Includes the period of global economic crisis in 2008

Based on the above findings, it is recommended to determine the zones of targeted sustainability with various indices.

To carry out further investigations, a certain trend should be selected so that the optimal indicator of sustainable development can be found. For example, the above analysis shown in Fig 3 includes the period of global economic crisis in 2008 so that a contrast can be made between the countries who have more involvement in the world economic system such as most of the EU member states and who have less such as Ukraine.

of time shall ensure the execution of the analysis of sustainable development on a long-term basis.

A form of methodological approach was developed to determine the sustainability zone for assessing the values of the indices for a significant time interval. A certain time period is necessary for dynamic modeling of individual indicators.

Further scientific research is required for justifying the proposed methodical approach upon the data set of various indices, regions and time periods

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