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DECOUPLING EFFICIENCY INDEX IN SUSTAINABLE ECONOMIC DEVELOPMENT

*M.R.Babayev *, N.V. Aliyeva*

Baku State University, Baku, Azerbaijan
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Abstract

For the first time, the article analyzes the trends of sustainable economic development in the Republic of Azerbaijan through the “Decoupling Efficiency” Index, and identifies the interrelationship of all three processes in the balance of equality “economic development = use of natural resources = degree of anthropogenic impact on the environment”.

For this purpose, the "Decoupling Efficiency" index was calculated based on the dynamics of GDP and water changes from natural sources in the country between 2015 and 2020. The analysis shows that even though GDP and water from natural sources decreased by 9.1% and 9.8%, respectively, the "Decoupling Factor" (-) 0.0781 was formed.

The final result of DF is less than “0” (-) indicator that economic resource development in the republic has growth dynamics of anthropogenic impact on the environment, as well as “Decoupling Efficiency” is not observed in economic development, it does not meet the OESD-sustainability index.

***Keywords*:** economic development, sustainable development, OESD, decoupling efficiency, decoupling factor, declining index, resource capacity, GDP, anthropogenic impact, sustainability index.

*Corresponding author.

E-mail address: magsudbabayev52@gmail.com (M.Babayev)

Main

Sustainable economic development is considered a priority for all countries, including the Republic of Azerbaijan. The Decoupling Efficiency Index is widely used as one of the key indicators of sustainable economic development. It provides a clearer picture of the relationship between all three processes in the balance of “economic growth = use of natural resources = anthropogenic impact on the environment.”

A comprehensive analysis of the "Decoupling Efficiency" in the economic development of the Republic of Azerbaijan allows us to determine the deeper consequences of the effectiveness of eco-economic interaction. The novelty of the study is that for the first time in terms of sustainability of the economic development process of the republic, the analysis and identification of shortcomings was carried out based on the methodological approach provided by the OECD (Organization for Economic

Development and Cooperation). All economic indicators used in the article for analysis are taken from the Statistical Collection "Environment in Azerbaijan" of the State Statistics Committee of the Republic of Azerbaijan (Baku 2017, 2020.).

2. Structure

The Concept of Sustainable Economic Development at the beginning of the 21st Century is widely interpreted by several foreign and local researchers as a factor in reducing environmental risks, transitioning strategy to a "green economy" [(5)], and improving living standards [(3)]. It should be noted that to date, the characteristic analysis of sustainable economic development has not been carried out in the Republic of Azerbaijan by the Decoupling method recommended by OSED *(Organization for Economic Development and Cooperation)*. Analysis by the decoupling method allows to determine the dynamics of growth in economic development in terms of sustainability of its quality parameters, rather than quantitative aspects. Therefore, research was conducted using "resource decoupling" and "impact decoupling" during the analysis. "Resource decapitation" determines the dynamics of reduction of natural resources used in economic development, and "impact decapitation" determines the nature of the anthropogenic impact of economic development on the environment, or rather the eco-intensity nature of economic development in the country.

Taking into account the qualitative advantages of the methodology, the main goal of the article is to identify trends in resource consumption and environmental impact by analyzing the efficiency of decapitation in the process of economic development in the country. Although a number of achievements have been made in the field of sustainable economic development in the country, shortcomings remain in the context of high GDP resource capacity, resource losses in production processes, as well as aspects of environmental impact.

As we know, until the 1970s and 1980s, little attention was paid to the use of natural resources, the problems of the quality of the natural environment, and they were practically underestimated in terms of economic development. This is a characteristic feature of the Frontal Economy. that is, until global environmental changes took place in the biosphere. However, the changes created by the development of productive forces in the qualitative elements of the environment in recent years have created the need to take into account the environmental factor in economic development.

As a result, the "Concept of Environmental Protection" was formed, which forced all countries to adopt a strategy to take into account the environmental factor in economic development. The dynamics of environmental threat has been recognized as a vital problem in more than 100 countries, including the Republic of Azerbaijan, and practical measures have been taken in this direction. Among them, the "National Program for Environmentally Sustainable Socio-Economic Development in the Republic of Azerbaijan" by the order of the President of the Republic dated February 19, 2003 has a special place. Azerbaijan has also joined the Sustainable Development Goals for 2016-2030, approved by the UN Sustainable Development Summit on September 25-27, 2015. Taking into account that the implementation of these Development Goals requires a comprehensive approach from an institutional and political point of view, the "National Coordinating Council for Sustainable Development" was established on October 6, 2016 in the Republic of Azerbaijan. Everyone understood that environmental degradation was a threat to human existence and a deterrent to economic development.

3. Equations

Taking into account the emerging environmental threat, the UN-supported Commission on the Environment and Development was established and adopted in its report the concept of "making changes in the use, technology and management of natural resources through economic development" as a final result. Being a concept of sustainable economic development, it remains a highly developed and researched problem in recent times. Several methodological approaches have been used in the regional analysis of sustainable economic development, among which the analysis based on the *Decoupling Efficiency* Index has a special place.[6]

The analysis of economic development using the *"Decoupling Efficiency"* method is currently accepted as the main direction provided by the *Organization for Economic Co-operation and Development* (OECD) and recommended to the countries of the world. The concept of *"decoupling efficiency"* is one of the methods widely used by the authors in recent years in the analysis of resource capacity of the economy, regional diagnostics of sustainable development, as well as research on the efficient use of natural resources. Being an English term, "decoupling" combines the meanings of "breaking ties", "separating" and "restricting" between two processes. As a final result, we must accept it in the present study as the independent development of two processes, which are dependent on each other, in opposite directions, and independent of each other. Although some authors consider it as an analogy of resource capacity, an in-depth analysis shows that *"Decoupling Efficiency"* is more macro-specific and allows for deeper analysis in the diagnostics of sustainable development.

The following mathematical dependencies are currently widely used by researchers to analyze the *"Decoupling Efficiency"* used as an indicator of green economy and sustainable economic development: (6)

$$\checkmark \quad \textbf{Decouplinq Index)} = \frac{\left(\frac{ER}{DF}\right)ending}{\left(\frac{ER}{DF}\right)begining} \qquad (1)$$

$$\checkmark \quad \textbf{Decouplinq Factor)} = 1 - \frac{\left(\frac{ER}{DF}\right)ending}{\left(\frac{ER}{DF}\right)brgining} \qquad (2)$$

Here:

ER- *strength or level of anthropogenic impact on the environment;*

DF - *growth dynamics of economic development;*

Ending: *condition of the indicator in the current year of analysis;*

Beginning*: status of the indicator in the year of basic analysis;*

Decoupling Index and Decoupling Factor - include changes in the dynamics of natural resource use or environmental impact in the dynamics of 1% growth in production over time. As a result, the analysis identifies two main regularities:

• *If the value obtained is greater than "0", ie:* ***Decoupling Factor> 0*** *and its dynamic increase is observed, then "Decoupling Efficiency" is observed;*

• *If the value obtained is less than "0", or rather if the* ***Decoupling Factor <0*** *and its dynamic decrease is observed, then there is no "Decoupling Efficiency" or the dynamics of economic development is accompanied by increased environmental impact and resource consumption;*

results are obtained.

To analyze the sustainability of economic development in the Republic of Azerbaijan, we conducted an analysis based on the dynamics of change in GDP and water taken from natural sources during the period from 2015 to 2020. Analysis of economic indicators based on statistical information sources shows that in 2019, the value of GDP in the country at market prices will be 81896.2 million. The volume of water taken from natural sources is 13227.0 mln. m^3, and in 2020 these indicators changed between 74432.2 million manat and 12961.0 million m3, respectively.1; 2; Then, the change in "*Decoupling Efficiency"* during the mentioned period is given in the table below (Table 1).

Table 1.

"Decoupling Efficiency" observed in the analysis period between the GDP of the Republic of Azerbaijan and water taken from natural sources in 2019-2020

Main parameters	***2019***	***2020***
GDP. mln man.	***81896,2***	***74432,2***
Volume of water taken from natural sources. mln.m3	***13227,0***	***12961,0***
Decoupling Index	**-**	***1,0781***
Decoupling Factor	**-**	***(-) 0,0781***

Note: *The table was compiled by the author based on the Statistical Collections of the State Statistics Committee of the Republic of Azerbaijan "Environment in Azerbaijan" Baku-2017, Baku-2021.*

The analysis shows that (Table 1.) there is a decrease in (-) 9.1% and (-) 9.8% in 2020 in both GDP and water indicators from natural sources, respectively, compared to 2019. Even though the *"Decoupling Factor"* has a value of (-) 0.0781, this *"Decoupling Factor" is smaller than 0* and is characterized by a dependence on it. As a result, this dependence shows that the resource capacity of economic development in the country and the power of anthropogenic impact on the environment has been growing over the years, while the *"Decoupling Efficiency"* is not observed in economic development and does not meet OECD-sustainability. The same situation was observed in the dynamics of change of the analysis between 2014 and 2020. Thus, as a result of our analysis based on statistical information during this period, it was determined that the *"Decoupling Factor"* in 2014-2015 was (-) 0.13, in 2015-

2016 0.08, 2016-2017 and 2017-2018 0.17 in 2018, 0.08 again in 2018-2019, and (-) 0.07 in 2019-2020, and there was almost no fundamental change in this direction.

The same result was obtained in our analysis of anthropogenic impact on wastewater. For this purpose, we analyzed the *"Decoupling Factor"* between the dynamics of GDP change and wastewater discharged into the environment for the period 2014-2020. As a result, this indicator is equal to 0.0 in 2014-2015, 0.03 in 2015-2016, 0.16 in 2016-2017, 0.0 in 2017-2018, and 0.10 in 2019-2020. was. The general results prove once again that there has been no significant change in the resource capacity of the *Decoupling Factor* in the country and that it is continuing under the influence of the "frontal economy" dynamics (Table 2).

Table 2.

"Decoupling Efficiency" observed in the analysis period between the GDP of the Republic of Azerbaijan and water taken from natural sources and waste water discharged into the environment between 2014-2020

Key indicators	***2014 /2015***	***2015 /2016***	***2016 /2017***	***2017 /2018***	***2017 /2018***	***2017 /2018***
Decoupling Factor (resource consumption)	***-0,13***	***0,08***	***0.17***	***0.17***	***0,08***	***-0,07***
Decoupling Factor (on environmental impact)	***0.00***	***0,03***	***0.16***	***0.19***	***0.00***	***0,10***

Note: *The table was compiled by the Author based on the Statistical Collections of the State Statistics Committee of the Republic of Azerbaijan "Environment in Azerbaijan" Baku-2017, Baku-2021.*

To determine the effectiveness of the obtained results, for the first time we analyzed the indicators by the feedback method, with the correlation of the two most widely used variables. *Spearman's correlation coefficient* was used for the analysis and the calculation was based on the following mathematical dependence [(4;) (8;)]

$$R = 1 - \frac{6\sum d^2}{n(n^2-1)} \qquad (3)$$

Here:

R - correlation coefficient;

d - the difference between the indicators reflecting the cause and effect;

n -is the sequence number of the indicators reflecting the cause and effect;

To calculate the *correlation coefficient* (R), we used the dynamics of changes in the indicators of GDP in the Republic of Azerbaijan and water taken from natural sources between 2013-2020 (Table 3).

Table 3.

Dynamics of change of GDP and water taken from natural sources in the Republic of Azerbaijan between 2013 and 2020 to determine the correlation coefficient

Years	*GDP (million manats)*	*Volume of water taken from natural sources (mln. Man)*	*Increase (+) and decrease in GDP compared to 2013 (-)*	*Increase (+) and decrease in water volume from natural sources compared to 2013 (-)*
2013	***58182,0***	***12509,0***	***-***	***-***
2014	***59014,1***	***12123,0***	***(+)832,1***	***(-)386,0***
2015	***54380,0***	***12285,0***	***(-)380,2***	***(-)224,0***
2016	***60425,2***	***12504,0***	***(+)2243,2***	***(-)5,0***
2017	***70135,1***	***12781,3***	***(+)11953,1***	***(+)272,3***
2018	***80092,0***	***12847,0***	***(+)21910,0***	***(+)338,0***
2019	***81896,2***	***13227,0***	***(+)23714,2***	***(+)718,0***
2020	***72432,2***	***12961,0***	***(+)14250,2***	***(+)452,0***

Note: The table was compiled by the author on The basis of the Statistical Collections of the State Statistics Committee of the Republic of Azerbaijan "Environment in Azerbaijan" Baku-2017, Baku-2021.

The analysis of our materials (Table 3) shows that in 2014, 2015, and 2016, compared to 2013 alone, there is a tendency for a continuous link between the value of GDP and water from natural sources. Thus, compared to 2013, the GDP in 2014 amounted to 832.1 million. The volume of water taken from natural sources decreased by 386.0 million m^3 in exchange for the growth dynamics of AZN,

then in 2015 the dynamics of this decrease was (-) 380.2 mln. Manats, (-) 224 million m3, and then in 2016, on the contrary, in GDP (+) 2243.2 mln. In contrast to the dynamics of man growth, a decrease in the volume of water taken from natural sources (-) by 5.0 million m^3 was observed, which should be assessed as a positive trend in terms of sustainability. However, in subsequent years, or rather between 2017-2020, the dynamics of GDP growth were accompanied by positive dynamics of growth of water from natural sources, respectively, which is a negative trend in terms of sustainable economic development or *"Decoupling Factor"* should be taken as a reverse efficiency trend.

In terms of resource consumption and capacity, as well as anthropogenic impact on the environment, this negative trend is clearly reflected in our correlation analysis of GDP and water from natural sources between 2013 and 2020. Analyzes based on Spearman's correlation model (3) show that the correlation between these two indicators (R = 0.81) is close to the unit, which is the dynamics of GDP over the years with the growth dynamics of water from natural sources. Finally, in general, the water capacity of GDP for the period 2013-2020 is higher than the intensity of resource recovery, and, above all, the *"Decoupling Efficiency"* was determined by reverse analysis, which is not observed in economic development. If we analyze this in more depth in terms of optimality, we will see that the intensity of the connection is characterized by a higher indicator of the correlation criterion. Thus, the following threshold level intervals have been identified for the correlation intensity correlation criteria in economic development: [4; 7; 8;]

- R <0,3 - *contact is practically absent;*
- 0.3 <R <0.5 - *the connection is weak;*
- 0,5 <R <0,7 - *the connection is considered significantly higher;*
- R> 0.7 - *the connection is strong and there is a high degree of dependence between the elements;*

Our analysis based on Spearman's correlation model (3) shows that the overall correlation between the country's GDP and water from natural sources over the past 8 years is characterized by a high degree of dependence. In general, the above dependence interval criteria show that the value of the coefficient *"R" varies between = 0 (+) (-)* and has intervals of change. When this coefficient *(R = 1*) is equal to the unit, the correlation relations between the two processes are completely consistent, when it is negative *(R = -1)* these relations are opposite to each other, and when it is equal to zero *(R = 0)* no relationship between them indicates that it is not. As can be seen, the level interval of this relationship in the country ***(R> 0.7*** *- the relationship is strong and there is a high degree of dependence between elements)* is characterized by a fourth degree of 0.81, and GDP dependence on water or water capacity is still high. The location of the Republic of Azerbaijan and its regional economic regions in the lower reaches of the Transcaucasian cross-border flows, the formation of 69-70% of surface flows outside its territorial boundaries, 0.02% of the world's average annual river flow and 0.3% of the average annual river flow of the European continent. For the republic, which includes and is located in an arid climate zone, this indicator proves to be "frontal" in terms of economic sustainability. From this point of view, the analysis of the problem of efficient use of water resources, ensuring transboundary water security and their integrated management, as well as the development of strategic principles of common water use is considered one of the most important regional strategic issues in the region.

It is important to keep in mind that in the region of Azerbaijan, 50% of river flows are formed within 31% of the country's average water supply per year, and this figure is 28.9% per year for 75% of moderate water supply, 95 % in the year of maintenance, i.e. in previous years, the drought decreased to 27.7%. It is also possible to conclude that the 3.4% decrease in river flow compared to the average water in dry years depends entirely on the transit flow of the population, irrigated agriculture and other economic sectors of the region, located in the arid climate zone. It should be noted that only 10% of the water resources of the South Caucasus region falls on the share of the Azerbaijani region, and Azerbaijan lags far behind other countries in the South Caucasus in terms of water resources per km^2, as well as per capita. If all these indicators are assessed in terms of impact on resources in the context of global climate change, it is already possible to predict the difficulties that the economic complex of the region may face in the near future, i.e. in 2023-2025. The analysis conducted by the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan in 1961-1990, 1991-2000, 2001-2015 proves that the average temperature in the region warmed up to 0.520 C compared to previous years, and the average annual precipitation, respectively. A decrease of 9.8% was observed. Against the background of climate change, our calculations suggest that the river flow in the region will decrease by an average of 23% to 29% in 2022-2050. Under such conditions, the total volume of surface water resources of Azerbaijan in the average water year (50% guarantee) will vary from 23842 million m^3 to 21984 million m^3, and it is clear that in the current situation it is lower than the full arid year. Therefore, the inclusion of Azerbaijan in the list of key regions that will face water shortages in the near future in the groupings conducted by the UN should be taken as a result of the analysis of real life. Therefore, the main analysis indicators of *"Decoupling Efficiency"* in economic development were conducted by us with water taken from natural sources, on the dynamics observed in GDP, which is the main macroeconomic indicator.

If we analyze the above results in terms of sustainable economic development with *P. Victor's Sustainability Model*, we can see that the *"green dynamics" (Green growth)* of the model or the current sustainability of economic development in the country is still not provided at the required level. Forms the need to implement "eco-economic" measures in all areas of the current economic complex (Table 4). [(9)]

Table 4. (9)

Determining the direction of Sustainable Economic Development in the Republic of Azerbaijan based on P. Victor Model

Dynamics of economic performance	**Dynamics of ecological intensity**	**Features of the interaction of eco-economic indicators**	**Characteristics of economic development**
Growth dynamics (+)	*Decline dynamics (-)*	The growth dynamics of economic development are lower than the dynamics of reduction of pollution intensity.	"Green dynamics" (Green growth)

Growth dynamics (+)	*Decline dynamics (-)*	The growth dynamics of economic development are higher than the dynamics of reducing the intensity of pollution	*"Gray dynamics" .(Beown growth)*
Growth dynamics (+)	*Growth dynamics (+)*	Mutual growth dynamics of economic development and pollution intensity.	*"Black dynamics" (Black growth*
Growth dynamics (+)	*Growth dynamics (+)*	The increase in the intensity of pollution is accompanied by a downward trend in economic development.	*"Black decrease" (Black degrowth)*
Growth dynamics (+)	*Growth (+) / (-) dynamics*	"Absolute green" reduction dynamics are possible only if economic growth and pollution are accompanied by downward dynamics.	"*Green reduction" (Green degrowth)*

As can be seen from the *Victor Sustainability Model* (Table 4), 5 main types of the nature of economic development and the interrelationships of more stringent eco-economic indicators have been identified. At the same time, the dynamics of environmental intensity in economic development are characterized by declining trends for the first two types: *"Green growth" and "Gray dynamics" (Brown growth), and for the other 3 types of economic development, they are, respectively, an increase in eco-economic intensity. Is accompanied by "Black growth", "Black growth" and "Green regrowth".* As can be seen, being a very rigid model allows us to determine economic development more efficiently in terms of sustainability.

If we analyze our calculations for the Republic of Azerbaijan (Table 1, and Table 2.) on the basis of this model, we see that the dynamics of economic development in all cases exceeds the dynamics of reducing the intensity of pollution, and as a result, the type of *"Gray growth" (Brown growth).* When approaching the problem in terms of sustainability, it is clear that some progress has already been made in this direction. However, this proves once again that development trends are still lagging behind the requirements of sustainable economic development in terms of resource decaplination and impact decaplination.

4. Conclusion:

- Analysis of sustainable economic development in the Republic of Azerbaijan with the "Decoupling Efficiency" index shows that the results obtained in the field of macroeconomic indicators of economic development are accompanied by an increase in the unit of resources spent on production and anthropogenic impact on the environment;
- This process is more clearly reflected in the analysis of the "Decoupling Efficiency" index of water taken from natural sources with the dynamics of GDP growth;
- Our long-term analysis proves that currently the production capacity of all sectors of the economy in the country does not meet the requirements of sustainable development with high water capacity;

- Against the background of climate change, if our calculations show that river flow in the region will decrease by an average of 23% to 29% by 2022-2050, the main direction of the sustainable development strategy is to take practical measures to reduce GDP water capacity. should be defined as;
- Considering that the total volume of surface water resources of Azerbaijan in the average water year (50% supply) will vary from 23842 million m3 to 21984 million m^3 and it is lower than in the current dry year, the structure of the farm complex is balanced with water from natural sources. sustainability must be ensured;
- The inclusion of Azerbaijan in the list of key regions that will face water shortages shortly in the groupings conducted by the UN should also be taken as a result of the analysis of real life.
- From the point of view of sustainable development, the use of alternative water sources in the economic structure, achieving a 20-25% reduction in water capacity in macroeconomic indicators through the implementation of appropriate changes in water use technologies should be included in the list of key measures to ensure "Decoupling Efficiency".

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