Modeling the Quality of Economic Growth: A Case Study of Armenia

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Տնտեսական աճի որակի մոդելավորումը. ուսումնասիրելով Հայաստանի օրինակը

Նավասարդյան Միքայել Ա.
Տնտեսության կարգավորման և միջազգային տնտեսական հարաբերությունների ֆակուլտետի ասպիրանտ Հայաստանի պետական տնտեսագիտական համալսարան (Երևան, ՀՀ)

Ամփոփագիր. Տնտեսական աճի և հատկապես դրա որակական հատկանիշների ապահովման նպատակով իրականացվող բոլոր գործընթացների արդյունավետությունը մեծապես կախված է պետական և մասնավոր տարբեր օղակներում կայացվող որոշումներից: Դրանց համակարգման, ռիսկերի գնահատման և այլ նպատակներով տարբեր կազմակերպությունների և մարմինների կողմից կիրառվում են ժամանակակից տարբեր մեթոդներ, մոդելներ ու գործիքներ: Սույն աշխատանքում, նախորդիվ գնահատված տնտեսական արդյունքի որակի համաթվի (ՏԱՈՀ) մեթոդաբանության հիման վրա, դուրս են բերվել համաթվին բնորոշ ֆունկցիոնալ կախվածությունները: Դրանց միջոցով նախ հաշվարկվել են համաթվի էլաստիկության գործակիցներ՝ ըստ դրանում ընդգրկված ցուցանիշների, և հակառակը: Այնուհետև կառուցվել է սիմուլյացիոն մոդել, որը թույլ է տալիս ոչ միայն դիտարկել տնտեսության վարքագիծը ցուցանիշների հնարավոր փոփոխությունների արդյունքում, այլև մշակել ՏԱՈՀ բարելավման հստակ նախագիծ: 3 տարվա ընթացքում այլ հավասար պայմաններում ՀՀ տնտեսության որակը հնարավոր է ընդհուպ մոտեցնել դիտարկված երկրների տնտեսական արդյունքի որակի միջին մակարդակին՝ պահպանելով աշխատանքում ներկայացված՝ աճի հստակ կառուցվածքը: Հետազոտության շրջանակում տնտեսական արդյունքի որակի մշտադիտարկման նպատակով մշակվել է առցանց հարթակ, որտեղ կարելի է ոչ միայն ուսումնասիրել երկրների ՏԱՈՀ դինամիկ շարքերը, վարկանիշները, տնտեսության որակի տեսանկյունից դրանց ուժեղ և թույլ կողմերը, այլև իրականացնել համապատասխան սիմուլյացիաներն ու դիտարկել երկրի տնտեսության որակի արձագանքը դրանց:
Հանգուցաբառեր՝ տնտեսական աճի որակ, սիմուլյացիոն մոդել, տնտեսական համաթիվ, համաթվի հաշվարկման առցանց գործիք, տնտեսական շոկերի իմիտացիա

Моделирование качества экономического роста: пример Армении

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Аннотация. Эффективность всех процессов, осуществляемых с целью обеспечения экономического роста, и особенно его качественных характеристик, во многом зависят от решений, принимаемых в различных государственных и частных кругах. Различные современные методы, модели и инструменты используются различными организациями для их координации, оценки рисков и других целей. В данной статье на основе методики расчета индекса качества экономического продукта (ИКЭП), оцененного ранее, выделены функциональные зависимости, характерные для индекса. С их помощью сначала рассчитывались коэффициенты эластичности индекса по входящим в него показателям, и наоборот. Затем была построена имитационная модель, позволяющая не только наблюдать за поведением экономики в результате возможных изменений показателей, но и разработать план совершенствования ИКЭП. В течение 3 лет при прочих равных условиях можно приблизить качество экономики Республики Армении к среднему уровню качества экономики рассматриваемых стран, сохранив четкую структуру роста, представленную в работе. В рамках исследования была разработана онлайн-платформа для мониторинга качества экономики, где можно не только изучить динамики и рейтинги ИКЭП стран, их сильные и слабые стороны с точки зрения качество экономики, но и проводить соответствующие симуляции и наблюдать за реакцией на качества экономики страны.
Ключевые слова: качество экономического роста, имитационная модель, экономический индекс, онлайн-инструмент расчета индекса, имитация экономических шоков

In today's world of diversity and uncertainty, as well as the interaction of economic phenomena at an ever-higher level than ever, observing quantitative indicators separately leads to wrong predictions. In order to ensure long-term economic growth and develop a reliable strategy, it is necessary to study the entire economic conjuncture, while not abstracting from social, political, climatic, psychological and other important aspects. As a result, the study of the economic result moves to a new, more complex level.

When studying the economy and economic growth, only quantitative assessments are not enough, because the nature of economic growth implies not only quantitative but also qualitative changes. After all, targeting, planning and recording economic growth are not ends in themselves: they are aimed at increasing the level of welfare of the society, as well as creating new opportunities for growth. And the implementation of the latter directly implies the assessment and improvement of the quality of economic growth.

Over the past decade, various attempts have been made to produce a measure of the "quality of growth" or a nation's "well-being" to capture the multidimensional concept, which is represented by many separate indicators. Since the United Nations Development Programme's (UNDP) seminal work on its Human Development Index in 1990 [**15**], composite indices have been widely used. According to methodological characteristics, these indicators for assessing the quality of growth were quite different" This multidimensionality approach is suitable "to shift the focus of development economics from national income accounting to people-centered policies" including intergenera-tional aspects of development by giving weight on dimensions other than GDP growth [**7**, p. 2].

On the other hand, many economists have also referred to the assessment of gaps between the quantity and quality of economic growth. Back in 2007, Easterlin and Angelescu [**4**, p. 28], referring to subjective measures of well-being rather than objective indicators, concluded that the breakdown between economic growth and quality of life becomes even greater. Although the evidence remains limited, the common pattern both in rich and poor countries, is that typically increases in per capita income ranging from a doubling to quintupling, fail to raise levels of happiness and life satisfaction. People may have many more goods and a much wider variety, but whether that means they find their lives more satisfying remains questionable.

In this way, modern economics is moving from mere evaluations of economic performance to the creation of complex systems, which not only allows to reach the most valuable and qualitative conclusions, to understand the nature of systems and the behavior of the economy, but also to form systems for monitoring the quality of economic growth. Studying the quality of economic results allows you to get a much more complete picture of the country's development, and when quantifying the quality, figures can really tell a lot about reality, than many individual indicators describing economic reality.

Based on the study of professional literature and the empirical research experience of the quality of economic growth, Mkrtchyan and Navasardyan proposed a new composite indicator [**8**], which evaluates the quality of the gross economic result generated in the country - the index of quality of economic output (EOQI). It is fundamentally different from the assessments presented so far. In particular, referring to the quality of economic growth, the already developed metrics primarily or exclusively focus on its social aspect. Obviously, the most important effect of economic growth is social welfare gained as a result, but the authors state that the approach would be complete if the preconditions and causes of economic growth and the formation of its quality were taken into account as well. Eventually they aimed to examine these characteristics in the context of the quality of economic output too. Thus, the authors propose to distinguish two main processes that charachterize the quality of the economic output. The proposed EOQI was calculated according to this approach, and the index consist of two subindices – economic output quality generation index (EOQGI) and economic output quality effect index (EOQEI).

The calculated quality index provides an insight into the quality of the country's economic growth and the dynamics of its change, to identify the factors influencing it and to give a certain diagnosis. It provides an opportunity to study not only the individual picture of each country and to bring out its certain qualitative features, but also to compare the competitive advantages of different countries from the point of view of the quality of the economy.

Thus, proposing a new approach of assessing the qualitative dimension of the economy, forming the system of relevant indicators for each stage and weighting each of them in that system, collecting, processing, normalizing and aggregating the annual data of the selected indicators for the years 2005-2022 for 78 countries, the authors calculated EOQI. The current study is aimed at the modeling and application of the estimated index.

The efficiency of all the processes carried out to ensure economic growth, and especially its qualitative features, largely depends on decisions

taken in various public and private sectors. For their coordination, risk assessment and other purposes, government agencies use various modern methods, models and tools. For example, forecasts of the macroeconomic framework of the State budget of the Republic of Armenia for 2021 were implemented by the Ministry of Finance of the Republic of Armenia using econometric models and comparing the dynamic stochastic general equilibrium model of the fiscal policy with estimates of the impact of a number of external, internal shocks and fiscal measures caused by the pandemic [**12**, p. 28] " Such successful models have become an important component of the public policy development process, especially simulations, which has been used as a tool to support decision making in different areas such as manufacturing, services, healthcare, public services and many more, being an essential element of daily process in enterprises [**6**, p. 1].

In the context of the development of any policy and in general, the scientific study of any system or phenomenon can be carried out using real or artificial experiments. Real testing is rare because it involves high costs and risks, while artificial testing is able to provide simulated reality, although it sometimes requires great intellectual and financial efforts, contains subjective elements and may face the problem of data imperfection.

Simulation or simulation modeling serves as an important tool for understanding complex systems, analyzing policy alternatives, and predicting possible outcomes of decisions. They allow testing possible policy scenarios in a virtual environment before its implementation, thus reducing potential losses of time, money and other resources. Traditional social science methods are being complemented and/or substituted by modelling and simulation (M&S) methods. Consequently, scientific methodologies have moved from a "model-building era" to a "simulation era" [**2**, p. 1].

In the policy-making process, simulation models are becoming more and more widespread within decision-making units, including state bodies. Simulation models used the U.S. Government Accountability Office [**13**], Department for Transport of the UK Government [**14**], Canadian Institute for Health Information [**10**], Australian Department of Agriculture, Water and the Environment [**5**] and many other state bodies. Moreover, the applicability of models is not limited only to economic spheres.

On the other hand, there is a tendency to publicize the simulation tools of state policy development. Due to this, the society is also involved as an interested party in the process of policy development. These are signs of transparency of state policy and openness to cooperation, which are quite important in modern state policies.

Table 1. *Notations and their meanings used in the simulation model.*

Notation	Meaning
i	country index
$EOQI_i$	EOQI of the i-th country
$EOQGI_i$	EOQGI of the i-th country
$EOQEI_i$	EOQEI of the i-th country
n	number of countries
j	indicator index
m	number of indicators in corresponding subindex
x_{ij}	absolute (non-normalized) value of the j-th indicator of the i-th country
x_{max}	upper bound of the current indicator
x_{min}	lower bound of the current indicator
w_j	weight of the j-th indicator

Turning to the construction of the model, we conditionally divide it into two stages: the construction of the methodological framework of the system under consideration and the derivation of formulas describing its inherent functional dependencies. We can consider the first stage completed, as the paper mentioned above completely presents the index methodology. Before moving on to the second one, we first introduce the basic formulas of the system describing the functional dependence of the index on the system components. In table 1 there are respresented the corresponding designations and their meanings.

The high level EOQI formula is:

$$EOQI_i = \sqrt{EOQGI_i * EOQEI_i},\ i = \overline{1, n}, \quad (1)$$

Each subindex represents the weighted geometric mean of its components.

$$EOQGI_i = \prod_{j=1}^{n} \left(\frac{x_{ij} - x_{min}}{x_{max} - x_{min}} * 100\right)^{w_j},\ i = \overline{1, n},\ j = \overline{1, m} \quad (2)$$

$$EOQEI_i = \prod_{j=1}^{n} \left(\frac{x_{ij} - x_{min}}{x_{max} - x_{min}} * 100\right)^{w_j},\ i = \overline{1, n},\ j = \overline{1, m} \quad (3)$$

Next, let us highlight the functional dependencies inherent in the system, which will allow giving a mathematical description of the

behavior of the system as a result of simulations corresponding to the scenarios that will be built.

For simplicity, we denote the subindex of the i-th country by y_i, which refers both EOQGI and EOQEI. All things being equal if x_{ij} is increase by one percent, the new value of the subindex will be:

$$y_i' = \prod_{j=1}^{n} \left(\frac{1.01 \times x_{ij} - x_{min}}{x_{max} - x_{min}} * 100\right)^{w_j}, \quad (4)$$

The subindex will change by

$$\Delta y = y_i' - y_i \quad (5)$$

Representing the new value of the subindex as:

$$y_i' = y_i \times \frac{\left(\frac{1.01 \times x_{ij} - x_{min}}{x_{max} - x_{min}} * 100\right)^{w_j}}{\left(\frac{x_{ij} - x_{min}}{x_{max} - x_{min}} * 100\right)^{w_j}}, \quad (6)$$

and simplifying it, we get:

$$y_i' = y_i \times \left(\frac{1.01 \times x_{ij} - x_{min}}{x_{ij} - x_{min}} * 100\right)^{w_j} \quad (7)$$

Inserting the equation 7 into the equation 5, and taking the y_i as common multiple, we have

$$\Delta y = y_i \times \left[\left(\frac{1.01 \times x_{ij} - x_{min}}{x_{ij} - x_{min}}\right)^{w_j} - 1\right] \quad (8)$$

It turns out that a one percent increase in the indicator will lead to an increase in the corresponding subindex by the following percent:

$$\Delta y\ (\%) = \left[\left(\frac{1.01 \times x_{ij} - x_{min}}{x_{ij} - x_{min}}\right)^{w_j} - 1\right] \times 100, \quad (9)$$

The formula 9 represents the elasticity coefficient of the subindex with respect to 1% increase of its component change. Eventually, the change of the affected subindex will result in the following percentage change of the EOQI:

$$\Delta EOQI\ (\%) = \left[\left(\frac{1.01 \times x_{ij} - x_{min}}{x_{ij} - x_{min}}\right)^{\frac{w_j}{2}} - 1 \times 100\right] \quad (10)$$

Summarizing the formula, we can extract the amount of the percentage change of the EOQI affected by some "a" percentage change of one of the indicators.

$$\Delta EOQI\ (\%) = \left[\left(\frac{\left(1 + \frac{a}{100}\right) \times x_{ij} - x_{min}}{x_{ij} - x_{min}}\right)^{\frac{w_j}{2}} - 1\right] \times 100 \quad (11)$$

In table 2 there are introduced the opportunities of the model in the form of formulas that can be realized - the expected response of the system as a result of any imitations, and in both directions. That is, it allows both to measure the behaviour of the quality of the economy as a result of possible shocks, and to develop a clear policy program, having a target result in advance.

Table 2. *Imitations and responses of the system as a result of them.*

Imitation	Response of the system
Δx_{ij} = a (point)	$\Delta EOQI = EOQI \times \left[\left(\frac{x_{ij} + a - x_{min}}{x_{ij} - x_{min}}\right)^{\frac{w_j}{2}} - 1\right]$, (point) (12)
Δx_{ij} = a (%)	$\Delta EOQI = \left(\frac{\left(1 + \frac{a}{100}\right) \times x_{ij} - x_{min}}{x_{ij} - x_{min}}\right)^{\frac{w_j}{2}} \times 100 - 100$, (%) (13)
$\Delta EOQI$ = a (point)	$\Delta x_{ij} = \left(x_{ij} - x_{min}\right) \times \left[\left(1 + \frac{2a \times EOQI_i + a^2}{EOQI_i^2}\right)^{\frac{1}{w_j}} - 1\right]$, (point) (14)
$\Delta EOQI$ = a (%)	$\Delta x_{ij} = \left(100 - \frac{100 \times x_{min}}{x_{ij}}\right) \times \left[\left(1 + \frac{200 \times a + a^2}{10000}\right)^{\frac{1}{w_j}} - 1\right]$, (%) (15)

In table 3 there are presented the elasticity coefficients of the EOQI according to each indicator. For example, a 1% increase of the prosperity index will lead to an improvement of the EOQI by 0.28%, or a 1% concentration of the export market decrease will improve the quality of the RA economy by about 0.05%.

It is clear that the elasticity coefficient depends on the weight of the corresponding indicator. In figure 1, the indicators are listed in descending order of the absolute values of the elasticity coefficients. However, their order does not match their position in descending order of their weight. Based on the the formula 13, it can be stated that the elasticity coefficient also depends on the indicator's distance from the minimum value. Moreover, the closer the index value is to its lower bound, the higher the elasticity coefficient is. It turns out that the

indicators for which the country recorded results close to the minimum will contribute much more to the growth of the index than others, which are higher than the minimum, even if they have a lower weight. It is for this reason that the EOQI elasticity coefficient with respect to the share of government expenditure on education in the GDP, is one of the highest, despite the fact that its weight is much lower than that determined for most of the indicators. Thus, through the arrangement of the presented elasticity coefficients, it is possible to notice the channels and opportunities for rapid improvement of the quality of the economy.

Table 3. *The elasticity coefficients of the EOQI with respect to corresponding indicators.*

Indicator	Value
Prosperity index (1-100)	0.27524
Government expenditure on education (% of GDP)	0.14546
GDP per capita (constant 2015 US$)	0.13407
Total factor productivity (0-100)	0.11203
Global Competitiveness Index (1-7)	0.10618
Gross fixed capital formation per labour force unit (constant 2015 US$)	0.09692
Happiness index (1-10)	0.06986
Market concentration index (0-1)	-0.05215
Research and development expenditure (% of GDP)	0.0484
Medium and high-tech manufacturing value added (% of manufacturing value added)	0.04732
Gini index (1-100)	-0.04671
Domestic credit to private sector (% of GDP)	0.04
CO2 emissions (kg per 2015 US$ of GDP)	-0.02347

Thus, having the methodological skeleton of the simulation model of the economic output quality and the functional dependencies extracted from them, we have developed an online platform [**9**] where the corresponding simulations can be carried out, and the changes in the behavior of the constructed system can be observed. It is a dynamic tool representing the simulation model of the EOQI, which also provides an opportunity to study the list of observed countries, their results and ratings, strengths and weaknesses from the economic output quality perspective, and download the dynamic series of the indices and their components. The tool is cabable of to be filled by excel file sourced with dynamic data, that is, it is possible to recalculate the indices after new data is published - just upload them and observe the new results. It is also possible to modify the list of components of the index, their weights, percentiles and normalization bounds. Thus, without methodological and chronological limitations, the observation of the quality of the economy is automated. The use of such tools should be a permanent in the policy development process, as they save time, human and other resources.

Next, we created several scenarios, implemented the corresponding simulations using the mentioned tool, and monitor the changes in the quality of the RA economy. We will present the scenarios only with materials of the RA, and we will consider the results when other things being equal, because simulations carried out in parallel for the other 77 countries will not be appropriate and realistic. So, first, we consider the changes in the EOQI of Armenia simulating the following years of the three main crisis in the economy of the RA - financial and economic crisis on 2008, the currency crisis 2014 and the 2020 pandemic and the Artsakh war. In other words, we will try to understand how the RA EOQI will be affected if history repeat. The years following the crises describe the qualitative changes more vividly, as anomalous situations bring about structural changes, and the opportunities for quality economic growth are disrupted not at once. Especially in small and developing countries, that wave can arrive later and be overcome for quite a long time.

The simulation of the post-crisis 2009-2010 situation on 2022. In 2008, the global financial crisis unfolded, affecting every country worldwide. The crisis resulted from a combination of lax financial regulations and unpredictable practices related to debt and leverage, affecting even the most stable economies. And as is often the case in major disasters, both natural and man-made, the most vulnerable were hardest hit [**3**]. Armenia was not an exception either.

As a result of such post facto statements, the need to study the quality of the economy becomes obvious. Bearing the severe consequences of the crisis, in 2009 the RA EOQI decreased by 1.7%, the

root causes of which was the decline of 5 indicators - 18.3% of GDP per capita, 3.9% of efficiency, 33.5% of capitalization, 10.2% of happiness and 0.9% of competitiveness. Through the formulas of table 2 and the online simulation tool, we calculated the simulated change of the RA EOQI on 2022 as a result of the indicators decline with the same structure as in 2009. Thus, as a result, all things being equal, the EOQI of the country decreased by 8%, from 32.6 to 29.9. Eventually, Armenia dropped from 59th to 62nd in the rating table. As we understood, the decline was mostly due to the decline of the EOQGI (by more than 14%).

The decline in the quality of the economy in multiple directions was recorded in 2010 as well, when 5 of the components of the EOQGI and 3 of the of the EOQEI components experienced a decline. Among them is also the GDP production efficiency indicator, which recorded the biggest decline (by 4.6%) in the observed period that very year. In case of the repetition of such a decline simulation, the RA EOQI on 2022 decreased by 0.6%. And as a result of the simulation of the declines of 2010, the RA EOQI decreased by about 40%, mainly due to the more than 63% decline in the EOQGI. Such drastic decline of the latter was due to more than 34% decrease of the government expenditure's share in GDP. Consequently, the country dropped from its position in the EOQI ranking table, falling behind 9 countries and trailing Guatemala, which is ranked 68th.

The simulation of the post-crisis 2015-2016 situation on 2022. In 2014, against the background of the events unfolding around Crimea, a currency crisis began in RA. Within the framework of the member states of the Eurasian Economic Union, during 2014 and the beginning of 2015, there was a downward trend in the exchange rates of national currencies against the world's leading currencies, which became more tangible at the end of 2014 and the beginning of 2015. As a result, the average monthly exchange rate of the Russian ruble to US dollar in the period from January 2014 to January 2015 decreased by 84.4%, and the exchange rate of the Armenian dram decreased by 16.8% as well. Due to the deterioration of the general economic situation in the member states, the export to third countries declined, and as a result of the adoption of restrictive measures, the import also decreased [**11**, p. 4]. People who were used to receive remittances from the Russian Federation were also affected, and this also had a negative impact on total demand.

Thus, in 2015, the GDP of Armenia increased by 6.2%, to which the country made a large contribution only in terms of the share of government expenditure on education in GDP, rising from 2.2% to 2.8%. In case of their normalized values, the increase was about five times. 6 of the other indicators experienced a decline. Two of the components of GDP have decreased: the share of domestic credit to the private sector in GDP and the share of value added in manufacturing industries through medium and high technologies, by 9% and 23%, respectively. All the indicators of the EOQI decreased: the prosperity index - by 0.05%, the index of happiness and competitiveness - by 2.3% each, the Gini coefficient - by 1.3%. As a result of the simulation, the GDP of the country decreased by 2.1%, and the country maintained its 59th position, despite the fact that, according to the EOQEI, it lost one position to Peru.

The following year, in 2016, Armenia's GDP decreased by 1.1%, which was the result of a drop of 8 EOQI indicators. The simulation the quality of the RA economy worsened by 3.6%, and the country lost its place to Albania in the ranking table of the EOQGI.

The simulation of the post-crisis 2020-2022 situation on 2022. The COVID-19 pandemic and the Artask war on 2020 had a very negative impact on both the social and economic sectors of RA. The lockdown, labor shortages, supply chain disruptions and intermediate goods shortages have severely impacted the country's economy [**16**, p. 15]. In addition, already after the pandemic, the world mostly resembled a segmented, fragmented world, rather than a leveling one. Geopolitical transformations of the "big chess board" and geostrategic realignment of power centers have always been accompanied by major economic and political upheavals, which are usually expressed in various crises, hybrid, proxy conflicts [**1**, p. 97]. It is in this kind of economic-military-political system that the RA economy operates in the post-epidemic and post-war period.

As we have already mentioned, the other side of the application of the simulation model refers to the development of policies and decision-making mechanisms in that process. The model allows calculating the level of indicator changes required to achieve a predetermined output. In other words, thanks to this, one can define a desired level of EOQI improvement, choose which indicators they want to improve at the expense of, use the model to determine how much each of the indicators should increase or decrease, and conduct a separate policy in each direction. As a result, there is a clear guide for improving the quality of the economy. Thus, this aspect of the simulation model will allow not only to develop the state policy of improving the quality of the economy through an automated system, but also to integrate it with state resources to understand whether it is realistic and how much the probability of the achievement of the predefined goals is.

Table 4. *The elasticity coefficients of the corresponding indicators with respect to EOQI.*

Indicator	Value
Prosperity index (1-100)	3.67
Government expenditure on education (% of GDP)	7.78
GDP per capita (constant 2015 US$)	7.72
Total factor productivity (0-100)	9.25
Global Competitiveness Index (1-7)	9.78
Gross fixed capital formation per labour force unit (constant 2015 US$)	10.96
Happiness index (1-10)	15.23
Market concentration index (0-1)	20.91
Research and development expenditure (% of GDP)	23.71
Medium and high-tech manufacturing value added (% of manufacturing value added)	24.54
Gini index (1-100)	-23.62
Domestic credit to private sector (% of GDP)	27.27
CO2 emissions (kg per 2015 US$ of GDP)	-54.70

Through Formula 15, based on the RA data, for each indicator, we calculated the amount of the necessary percentage change, which will lead to a 1% EOQI improvement. The results are presented in table 4. Thus, for example, for a 1% increase in the EOQI, it is necessary to increase the share of government expenditure on education in GDP from 2.77% to 2.99%, that is, increase the indicator by 7.78%. Or, for example, to achieve the same goal, the concentration level in the export market should be reduced by 20.91%, reducing the Herfindahl-Hirschman index from 0.16 to 0.13. According to this classification, the efficiency of GDP production is the fourth in importance: for the improvement of the RA EOQI by 1%, Armenia must ensure a 9.25% increase in TFP.

Thus, through the model, we can not only observe the behavior of the system in case of possible shocks of indicators, but also develop a clear strategy for improving the EOQI. For that it is necessary to set a clear goal, a target value, that is, the desired level of the EOQI, and then decide with which growth structure the pre-determined target can be achieved. In other words, in this case, one need to develop certain scenarios, find out whether it is feasible, and as a result, detect the necessary steps for improving the quality of the economy.

As we revealed earlier, the quality of the RA economy is lower than the average of the studied countries. As the target value of the EOQI, we set the average EOQI recorded by the 78 studied countries in 2022. According to the latest data of 2022, the RA EOQI is below the average by about 8.2 points, and in order for the RA indicator to be equal to the average, it should increase by more than a quarter. Next, it is necessary to look for such a growth structure (according to the indicators), as well as such a time interval, under which conditions the increase of the RA EOQI until the average of 2022 will be reasonable and achievable

The simulation of achieving the average level of the RA EOQI on 2022 through equal growths of all indicators: Let's try to understand how it is possible to achieve this with a comprehensive approach, without giving advantage to one or set of indicators in the context of the necessary level of improvement. Equally dividing the "burden" of the necessary change on all indicators, it turns out that each of them should provide an additional 0.63 points of the EOQI, that is, increase it by about 1.93%. Achieving such a result mathematically is not feasible, just because for some indicators it is simply impossible to provide the necessary growth calculated through formula 14. For example, in order for RA EOQI to increase by 0.63, the indicator of CO2 emissions per unit of GDP should decrease by more than 136%, i.e. by about 0.77 points, which is practically impossible, because in 2022 its value (0.56) was less than the required change. On the other hand, for some indicators, increasing EOQI by 1.93% is not reasonable. For example, the Gini coefficient should be reduced by about 14 points, and halving the Gini index of the RA (27.9) would be an illogical issue, because during the observed 18 years, the best value, i.e., the lowest Gini coefficient was 23.2 (Slovakia). Taking into account the mentioned statements, as well as the potential of the country and the trends of changes in the indicators, it turns out that it will be possible to achieve the previously defined goal in the best case in the medium term and through the unequal contribution of the indicators to the growth. It remains to understand what combination of

changes in indicators will ensure the target value for the quality of the RA economy.

The Simulation of achieving the average level of RA EOQI on by priorities of the indicators: Arranging the RA indicators based on their ranking within each country yielded a list of indicators sorted by their priorities for improvement. Accordingly, in order to reach the targeted level of the EOQI, we detected the necessary growth structure, which will smooth out the structural asymmetries of the EOQI. Then we proportionally calculated the necessary amount of growth of each indicator. The lower the country's position according to the index, the higher the necessary level of its participation in the targeted growth of the EOQI. Going forward, let's note that the components of the EOQGI have received the highest priority in the growth structure designed to achieve the defined medium-term goal.

Table 5. *The growth structure (in absolute values) necessary to achieve EOQI defined targets in periods t+1, t+2 and t+3*

Indicator	t	t+1	t+2	t+3
CO2 emissions (kg per 2015 US$ of GDP)	0.565	0.780	1.000	1.193
Domestic credit to private sector (% of GDP)	52.583	59.181	66.468	75.494
GDP per capita (constant 2015 US$)	5111.370	5377.588	5689.441	6063.764
Gini index (1-100)	27.900	28.952	29.735	30.490
Global Competitiveness Index (1-7)	4.191	4.447	4.648	4.843
Government expenditure on education (% of GDP)	2.771	2.967	3.259	3.704
Gross fixed capital formation per labour force unit (constant 2015 US$)	1913.051	2077.491	2278.207	2555.834
Happiness index (1-10)	5.382	4.445	3.625	3.839
Market concentration index (0-1)	0.163	0.147	0.134	0.161
Medium and high-tech manufacturing value added (% of manufacturing value added)	8.212	9.929	12.324	16.225
Prosperity index (1-100)	61.218	62.354	63.588	65.032
Research and development expenditure (% of GDP)	0.209	0.249	0.306	0.386
Total factor productivity (0-100)	0.978	0.996	0.997	0.998

***t** refers to the last year observed (2022)*

By distributing the target 25% improvement in the quality of the economy equally over 3 years, it turns out that the country's GDP should increase by about 2.7 points every year. Tables 5 and 6 present the roadmaps to reach the final result, with absolute values and growths, respectively. Let's designate the starting year for simulations with t, which in our case is 2022.

For the simulation for the first year, the EOQI should be increased by about 8.4%, increasing it from 32.6 to 35.3. In the growth structure, the highest shares were given to the share of government expenditure on education in GDP and the share of added value obtained through medium and high technologies in the added value of the manufacturing. According to the first, the country took the 74th place in 2022, according to the second - the 70th. Moreover, these two indicators remained unchanged in the structure of growth imitations in the first 2 places of priorities for all 3 years. To achieve an increase of 2.7 points in the first year of the simulation, it is necessary to increase the 2.78% share of government expenditure on education in the GDP by 0.2%, and the 8.2% share of medium and high-tech manufacturing in the total added value of manufacturing by 1.7%. The lowest priorities were given to the Gini coefficient and GDP production efficiency, according to which the country ranks 14th and 16th, respectively. To ensure the growth of the first year, the Gini coefficient should be reduced by 1 point (3%), and the TFP should be improved by 0.02 points. Thus, as a result of the mentioned changes for the year t+1, the ranking of the RA EOQI will rise from 59th to 55th place, the index will improve by 2.4 points, instead of the expected 2.7. The deviation is a consequence of the non-linear character of EOQI. However, the deviation does not diminish the significance or applicability of

the model, because the deviations between expected and actual results as a result of the simulations are insignificant, about 1%. In addition, we have recalculated the necessary growth of EOQI for each year to achieve the short-term goal, in order to compensate for the previous year's deviation in the next period. In other words, we performed the simulation of the next year t+2 not with 2.7 points defined for the simulation of t+1, but with 2.9 points. The levels of components' contributions in the growth structure of the EOQI set as a short-term goal were also recalculated.

As a result of the next (t+2) year simulation, according to the position occupied by the EOQI, Armenia rose from 55th to 47th place, and the country's index improved by 7.6%. No particularly tangible changes were recorded in the priorities of the growth structure. However, in each subsequent period, a higher growth is assumed in the direction of the underdeveloped indicators than in the direction of the indicators of the country, which registered a relatively higher value, that is, the concentration level in the structure of the expected EOQI eases.

Table 6. *The increase in EOQI (%) and the growth structures necessary to achieve them in periods t+1, t+2 and t+3*

Indicator	t+1	t+2	t+3
EOQI	7.51	7.12	7.56
CO2 emissions (kg per 2015 US$ of GDP)	-38.14	-28.18	-19.26
Domestic credit to private sector (% of GDP)	12.55	12.31	13.58
GDP per capita (constant 2015 US$)	5.21	5.80	6.58
Gini index (1-100)	-3.77	-2.70	-2.54
Global Competitiveness Index (1-7)	6.10	4.52	4.18
Government expenditure on education (% of GDP)	7.07	9.83	13.66
Gross fixed capital formation per labour force unit (constant 2015 US$)	8.60	9.66	12.19
Happiness index (1-10)	10.19	8.66	5.91
Market concentration index (0-1)	-17.42	-18.44	-19.97
Medium and high-tech manufacturing value added (% of manufacturing value added)	20.91	24.12	31.65
Prosperity index (1-100)	1.86	1.98	2.27
Research and development expenditure (% of GDP)	19.26	22.62	26.18
Total factor productivity (0-100)	1.78	0.12	0.15

In the last stage of the considered medium-term simulation, in the period t+3, the country recorded a value quite close to the target value of the EOQI (40.4). As a result of such a scenario, the ranking of the country improved by 2 positions, and Armenia ranked the 45th. The contribution levels of indicators in the structure of growth certainly changed for the last period. Relatively, the share of domestic credit to private sector in GDP and the prosperity index had higher priority, and the priority of contributing to the growth of the happiness index decreased.

Thus, within 3 years, other things being equal, it is possible to bring the quality of the RA economy closer to the average of the 78 countries considered, maintaining the growth structure presented in table 6. As a result of the implemented simulation, the RA economy saw a 24% improvement, slightly below the targeted 25% medium-term goal. Consequently, the country ascended from the 59th to the 45th position. To achieve such a result, it is necessary to ensure an average growth of 7.4% in EOQI for 3 years in a row. According to the position occupied by the EOQGI, the country rose from the 61st position to the 48th position, and from 44th to 27th from EOQEI perspective. A much greater participation in the provision of the presented scenario for the improvement of the country's EOQI is expected from the EOQGI: the latter should be improved by 11.5% on average for 3 years in a row, while the EOQEI should be improved by 3.4% on average.

In summary, it turns out that by means of the presented simulation model, defining a certain feasible goal in advance, determining a certain period of implementation of the growth policy necessary to achieve that goal, and a certain pattern of the expected growth structure, as for example in

our scenarios (equally and by priorities), for each period it is possible to obtain a clear structure of necessary growth for achieving the determined output.

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