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System Balance Index as an Indicator of the Russian Gas Industry's Sustainable Growth

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ABSTRACT

The paper examines an approach to developing a strategy for the Russian gas industry's sustainable growth based on the system economic theory's methodology. The **aim** of the study is to evaluate the current state of the industry by calculating sustainable growth indices. Grey Relational Analysis (*GRA*) reveals a deep relationship between sustainable growth indices and Return on equity (ROE), Lambert Energy Index (LEI), Return on environmental investments (ROE_{env}), and Return on social investments (ROE_{sr}). The system balance index (SBI) is calculated, which expresses the intensity of links between the financial, energy, environmental and social subsystems of the gas industry. The results show that the Russian gas industry companies are characterized by a low level of ROE_{env} or ROE_{sr}, negatively affecting the SBI value. The authors **conclude** the importance of environmental protection and social responsibility for achieving sustainable industry growth should not be underestimated. This circumstance should be taken into account when setting strategic goals for companies in the gas industry. According to the authors, applying system economic theory to achieve sustainable growth goals has huge potential to overcome economic phenomena and improve company management practices.
Keywords: Russian gas industry; sustainable growth; system economic theory; Sustainable Balance Index (SBI); systems thinking; system methodology; system balance; system paradigm

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Индекс системной сбалансированности как индикатор устойчивости роста российской газовой промышленности

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АННОТАЦИЯ

Авторы исследуют подходы к формированию стратегии устойчивого роста предприятий российской газовой промышленности на основе методологии системной экономической теории. **Цель** исследования — дать оценку текущего состояния отрасли посредством расчета индексов устойчивости роста. В результате серого реляционного анализа (*GRA*) выявлена глубокая взаимосвязь темпов устойчивого роста с рентабельностью собственного капитала (ROE), энергетическим индексом Ламберта (LEI), доходностью экологических инвестиций (ROE_{env}), доходностью социальных инвестиций (ROE_{sr}). Рассчитан индекс системной сбалансированности (SBI), который выражает интенсивность связей между финансовой, энергетической, экологической и социальной подсистемами газовой промышленности. Результаты показывают, что, российские газовые компании характеризуются низким уровнем ROE_{env} или ROE_{sr}, что негативно влияет

на значения индекса системной сбалансированности. Отсюда следует **вывод**, что значимость как охраны окружающей среды, так и социальной ответственности бизнеса для достижения устойчивости роста не стоит недооценивать. Данное обстоятельство должно учитываться в процессе постановки стратегических целей компаний газовой промышленности. По мнению авторов, применение системной экономической теории для достижения устойчивого роста имеет огромный потенциал для преодоления кризисных экономических явлений и совершенствования практики управления компаниями.
Ключевые слова: российская газовая промышленность; устойчивый рост; системная экономическая теория, индекс системной сбалансированности (SBI); системное мышление; системная методология; системная парадигма

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INTRODUCTION

The paper addresses the theory of sustainable growth under the system paradigm. In the research, sustainable growth is treated as a system, where the result concerns the interconnection among energy, environmental, economic and social subsystems [1]. During the 1980s, researchers began a fundamental reappraisal of thinking on economic growth. Nowadays, we observe contradictions of the sustainable financial growth traditional organization model as "alone" functional focused on the finance aspects only [2]. The most crucial problem is the theoretical and empirical study of the interconnections among energy, environmental, economic and social systems.

Considering sustainable growth approach under the system paradigm has enormous potential for developing a sustainable economy. The system paradigm was introduced into scientific practice by J. Kornai in 1998 and was complemented with other well-known economic paradigms, such as the neoclassical, institutional, evolutionary, etc. [3–5]. In the papers of G. Kleiner [6–8], the concept of system paradigm in economics was developed and created a model of a tetrad — a stable complex of four basic types of systems (object, environment, process and project). As Eric Pappas said, "the systems theory approach to sustainability in five contexts (social/cultural, economic, environmental, technical, and individual) is a realistic and useful approach to sustainability" [9]. The systems approach in dealing with complex problems is the best way to develop methods for achieving sustainability [10]. System thinkers, such as Senge [11], Wheatley, Bertalanffy [12], Wilber and Meadows [13], claimed that everything has interconnections and need to develop complex methods for evaluation processes [14]. Ludwig Von Bertalanffy (1968) emphasized that all things could be considered as a system [13, 15]. Flood and Jackson (1991) describe a system as a difficult and highly interlinked network [16]. Further, Checkland defines a system as a model of a whole society, which may apply to human activity [8]. Accordingly, the actual problem of the modern economic theory is finding such a paradigm that could reflect economic processes taking place in the objective reality with a high degree of reliability [17]. Long before the Santa Fe Institute was opened, Belgian Nobel laureate Ilya Prigogine was making research on questions about the sources of the order and structure in the world. Waldrop (1992) indicates that systems can organize themselves spontaneously into complex structures [18].

The authors consider sustainable growth as a system between financial, energy, social, and environmental subsystems. Each subsystem represents by itself a group of factors influencing sustainable growth. In this paper, the authors calculating System Balance Index (further — SBI) as an indicator for the Russian gas industry's sustainable growth. Schematic views on the components of sustainable system growth and its interactions based on the Hester and Adams model [13] are shown in *Fig. 1*.

Society needs to change the old way of measuring financial sustainability to the new one [19, 20]. The dynamics of ecosystems and human systems need to be examined in the context of post-normal science based on complex systems thinking [21]. Nowadays, the complexity of subsystems for achieving green growth is the necessary method for developing [22].

Indeed, the development of the economy in developing countries is expected to contribute most to the growth of world energy consumption, thus coupling sustainable growth with energy consumption is the primary foresight method for future economic development [23, 24]. One of the characteristics of scientific and technical development is the influence on the ecological state [25, 26]. Uneconomic growth is a term used in Environmental Economics to define a kind of economic growth that does not lead to an increase in the welfare of society [27–29]. Indeed, Charles A.S. Hall emphasized that society could transform links between natural science and financial processes [30–33]. It is essential to have found methods for the evaluation of energy efficiency and environmental protection for increasing sustainability [25, 34, 35].

According to the Russian Federation Energy Strategy up to 2030, Russia has appointed an innovative way of growing the oil and gas industry to strengthen leading line items [36]. Since the Russian gas industry provides about 10% of national gross domestic product, which translates to 25%

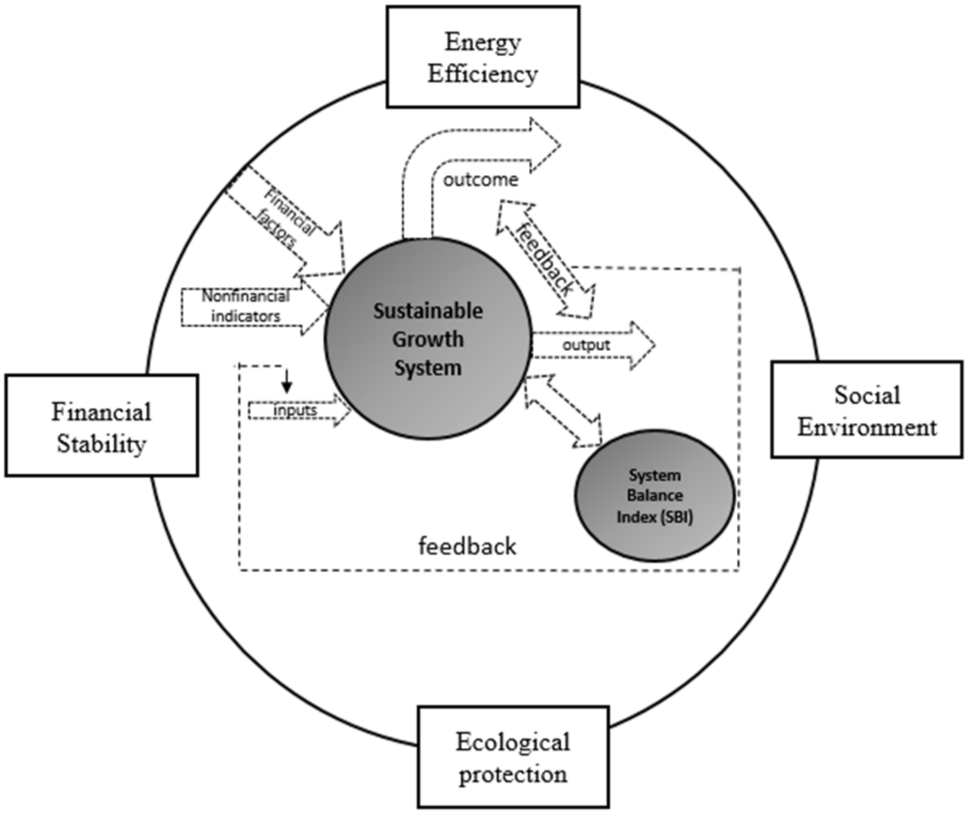

Fig. 1. **Schematic view on the components of sustainable growth system**

Source: the authors' understanding of sustainable growth system.

of the country's income in the government budget, the energy companies' sustainable growth plays a significant role in Russia's growth as a whole. Thus, the research is about sustainable growth providing set and balance of the social and economic points concerning gas industry growth in Russia. Over the last few years, sustainable growth has become increasingly crucial in the Russian Federation; thus, there were many circumstances for a transition from fast growth to sustainable growth in Russia. This is evident from the ongoing reform in government, taxes, and financial legislation.

The structure of the paper is as follows. Section 2 reviews the relevant literature. Chapter 3 elaborates on the employed research method, while Section 4 analyses and discusses the findings. The final parts offer some concluding remarks.

METHODOLOGY

Sample and software

Take into consideration Russian oil and gas industry data between the 1996 and 2019 period. Data was used from the three biggest Russian gas companies' annual reports. Gazprom, Rosneft, Novatek together have about 90% of the Russian gas market production share, therefore, by these three companies, we can judge the state of sustainable growth for the industry as a whole. Data was classified according to the sustainable areas regarding finance, environmental, energy and social factors. The set of indices has been chosen according to sustainable growth functions assessment. Also, the Environmental Ratings of the Russian gas companies were used in the paper.

The authors have done the following steps:

1) Data collection;
2) Data classification;
3) Sustainable growth indices calculations;
4) Testing how financial and non-financial factors influence sustainable growth indices;
5) SBI calculation

Calculations were done with the help of the R language programme [37].

Grey correlation analysis methodology

The authors used grey relation analysis (GRA) to analyse the degree of proximity between system' parent factors and sub-factors [38, 39]. The authors have chosen GRA because it is a method to measure the degree of correlation among factors according to the degree of similarity or dissimilarity of the development trend among factors. The authors tested four indices as the sustainable growth primary indicators:

Higgins sustainable growth rate (SGR) [40, 41], Ivashkovskaya sustainable growth index (SGI_{iv}), Varaya' sus-

Table 1

Detailed formula

Sustainable Growth Indices	Proxy	Calculation method	Meaning
Higgins Sustainable Growth Rate	SGR_H	$g = f(P, R, A, T)$	Where, g – it is the index of sustainable growth, expressed in percent; P – profit after taxes; R – rate of reinvestment; A – turnover of assets; T – the ratio of assets to equity or leverage.
Ivashkovskaya Sustainalbe Growth Index	SGI_{Iv}	SGI_{Iv} =(1+ g_s)$\times X_k^1$ - $X\sum_{i=1}^{k} max\left[(0,\left(ROCE_i - WACC_i\right)\right]$	Where (1+g_s) – the average growth rate of sales; k – the number of years of observations; l – the number of years during which there was a positive spread of return on invested capital; $ROCE_i$ – return on capital employed per year; $WACC_i$ – weighted average cost of capital per year.
Varaya Sustainable Growth Index	SGI_{ROE-r_e}	SGI_{ROE-r_e} = $G_{sales}^{aver} \times X_k^1$ - $X\sum max\left[(0,\left(ROE - r_e\right)\right]$	Where, ROE – return on equity; r_e – the cost of equity.
Ivashkovskaya Modif. Sustainalbe Growth Index	SGI_{wacc}	SGI_{ce} = $G_{sales}^{aver} \times X_k^1$ - $X\sum max\left[(0,\left(ROCE_i - WACC_i\right)\right]$ $X\sum max\left[(0,\left(G_{ce} - aver\right)\right]$	Where, G-aver – average growth tempo; $ROCE_i$ – return on invested capital per year; $WACC_i$ – the weighted average cost of capital in year; G_wacc – growth rate of invested capital for the period; G_aver – average growth rate of invested capital.

Source: [2, 40, 41].

tainable growth index (SGI_{ROE-r_e}), Ivashkovskaya index modifications SGI_{WACC}. The higher the ratio l / k, the more reliable it is (more substantial number of periods the company generates a positive economic profit) [42]. SGI_{ROE-r_e} means that profit and capital growth can occur, if the rate of return on equity ROE is higher than the cost of equity r_e. *Table 1* shows a detailed formula description.

Firstly, the authors collected financial, social energy and social indicators from the three biggest Russian gas companies:

- Finance indicators: $EBIT$ (Earnings before interest and taxes), ROA (Return on assets), ROS (Return on sales), ROE (Return on equity), $NWCT$ (Net working capital turnover), CR (Current Ratio), NPG (Net profit growth), NAG (Net assets growth), FL (Financial leverage), DOL (Operation leverage degree), CL (Combine leverage), DER (Debt equity ratio), $WACC$ (Weighted average cost of capital).
- Energy indicators: $EROI$ (Energy Return on Investment), ES (Energy savings).
- Social indicators: ROE_{sr} (Return on social expenses), RER (Revenue per employee ratio).
- Ecological indicators: ROE_{env} (return on costs concerning environmental protection), ER (environmental ratings).

Then by using grey relation analysis GRA, the authors chose financial and non-financial indicators, that have the biggest influence on the sustainable growth indices.

System equilibrium' methodology

In the research analysis the authors use the primary principles of the system balance concept according to

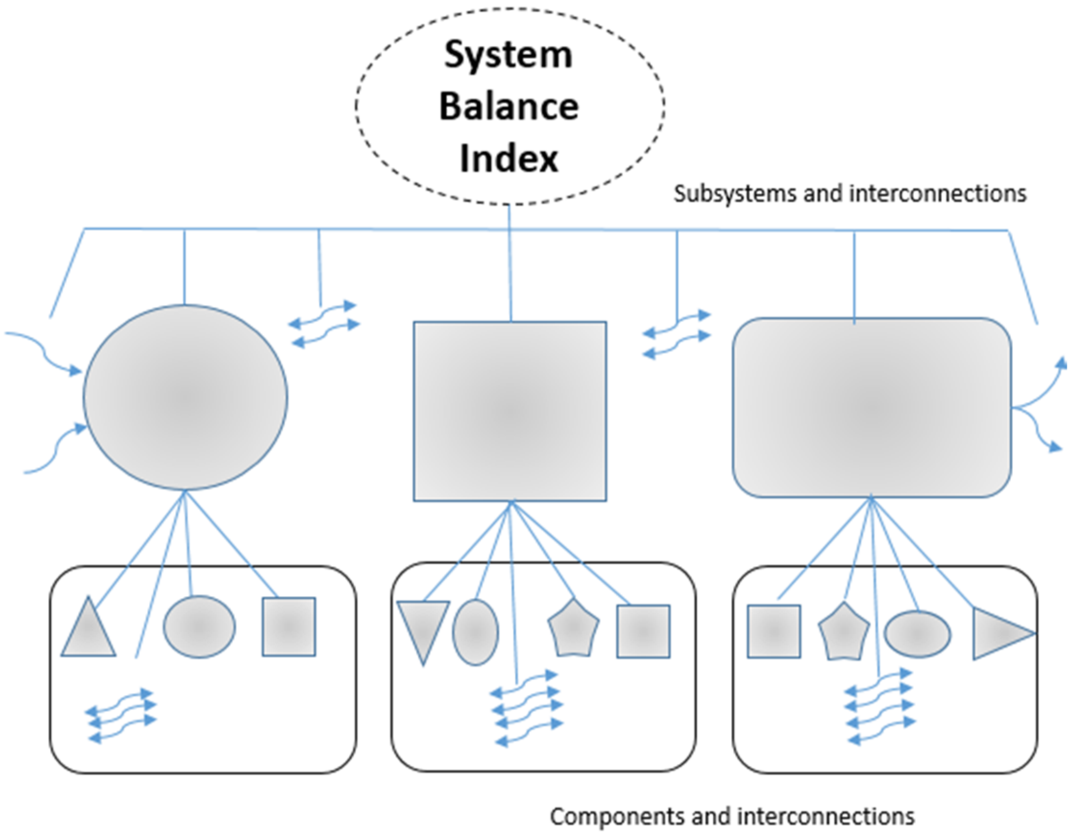

Fig. 2. **System, subsystems and components form a structural hierarchy**
Source: the authors' system balance index subsystems and components understanding.

the system economic theory [7, 42]. In the tetrad system analysis, a, b, c, d factors characterized the interaction of existing systems intention [4]. Kleiner suggested a system balance index reflecting disparities in the development of four tetrad subsystems. Kleiner' system index [43] is in *Eq. 1*

$$I=\frac{1}{\left(\frac{a}{b}+\frac{b}{a}+\frac{a}{c}+\frac{c}{a}+\frac{a}{d}+\frac{d}{a}+\frac{b}{c}+\frac{c}{b}+\frac{b}{d}+\frac{d}{b}+\frac{c}{d}+\frac{d}{c}-11\right)} \quad (1)$$

According to Kleiner's system index methodology, the next stage that is required is a representation of the system as a 100×100 square located in the Cartesian reference system with vertices (0.0). (0.100). (0.100). (100.0). On the square sides we need to plot the points reflecting the obtained relations between the subsystems [6].

SBI is the universal instrument for everyone who can try another variety of factors to create a financial sustainable index for industry and companies. SBI could be interpreted by the following way: $0\le SBI\le0.2$ — fragile balanced connection, the $0.2\le SBI\le0.5$ — delicate balance, $0.5\le SBI\le0.7$ — average balance, the $0.7\le SBI\le0.9$ — strong balance, $0.9\le SBI\le1$ — solid balance. SBI shows the balance between the components. In the strategic plan (ideal case) the weight of the components in the index and the attention to them in the economic policy plan should be the same. A balanced system provides more opportunities for management (it clearly shows how much this or that criterion deviates from the balance, this allows to justify the direction of development in this or that direction). The authors modified system balance index subsystems and components to form a structural hierarchy that is shown in *Fig. 2.*

Fig. 2 shows the system balance index subsystems and components. Thus, any subsystems could be linked together. In the research, the authors analyse the sustainable growth system with subsystems like energy, finance, ecology and social subsystem. The authors' approach to consider sustainable growth from a position of the system economics theory opens new opportunities for the development of sustainable economic analysis.

RESULTS

GRA results

The authors have tested more than twenty energy, environmental and social indicators that influence four types of sustainable growth coefficients. The most influential nonfinancial indicators were chosen as the parts of *SBI*. As we see the results in *Table 2.*

LEI, ROE_{env}, ROE_{sr} are the nonfinancial factors that have the biggest influence on SGR. Indices

Table 2

Grey correlation method' results

No.	SGR (H)		SGI (I)		SGI (ROE)		SGI (WACC)	
1	ROEsr	0.999631755	WACC	0.997044625	ROEsr	0.999631755	ROEsr	0.992635548
2	ROE	0.996857084	NWCT	0.996882854	ROE	0.996857084	ROEenv	0.989161429
3	NWCT	0.996731913	LEI	0.996859862	NWCT	0.996731913	ROE	0.989160053
4	LEI	0.996461302	FL	0.996771869	LEI	0.996461302	ROA	0.989154941
5	RG	0.996430353	RG	0.996653973	RG	0.996430353	FL	0.98915173
6	WACC	0.996317117	ROE	0.995680909	WACC	0.996317117	RG	0.989147647
7	FL	0.996256888	ROA	0.995580778	FL	0.996256888	LEI	0.989147298
8	ROA	0.995392176	ROEenv	0.995326027	ROA	0.995392176	WACC	0.98914482
9	ROEenv	0.995260265	ROEsr	0.994625289	ROEenv	0.995260265	NWCT	0.989144626
10	ROCE	0.994025443	ROCE	0.994299553	ROCE	0.994025443	DER	0.98914204
11	DER	0.993286149	EBIT	0.99325541	DER	0.993286149	EBIT	0.989050387
12	EBIT	0.992391333	DER	0.992578558	EBIT	0.992391333	ROCE	0.989030059
13	RER	0.992005782	RER	0.991805588	RER	0.992005782	RER	0.988747758
14	ROS	0.991997208	ROEs	0.99118176	ROS	0.991997208	ROEs	0.988689877
15	NWC	0.991591822	NWC	0.991164141	NWC	0.991591822	NWC	0.988547244
16	ROEs	0.991253955	ROS	0.990507554	ROEs	0.991253955	ROS	0.988256609
17	ROFA	0.979212675	ROFA	0.975124238	ROFA	0.979212675	ROFA	0.985550664
18	CL	0.946137523	NAG	0.945970554	CL	0.946137523	CL	0.947088786
19	DOL	0.945171051	CL	0.945887173	DOL	0.945171051	DOL	0.946125041
20	NAG	0.944745681	DOL	0.944918486	NAG	0.944745681	NAG	0.943378757
21	NPG	0.933981343	NPG	0.933920898	NPG	0.933981343	NPG	0.93407283
22	ER	0.398638304	ER	0.398919673	ER	0.398638304	ER	0.398393491

Source: the authors calculations.

show the quite similar results for four coefficients: SGR_H , SGI_{iv} , SGI_{ROE} and SGI_{WACC} . The biggest influence on sustainable growth coefficients is $ROA, ROE, FL, RG, WACC, NWCT$.

The logic of the study is the following. There are three gas companies that cover almost the entire gas market of the Russian Federation. Every company has its own financial performance. To organize these companies' sustainable growth evaluation as well as the entire gas industry in Russia, the authors believe that equal emphasis should be placed concerning four areas — economy, society, ecology and energy. How to understand by what indicators to evaluate these four areas and their relationship with sustainable growth indicators? In order to understand this, the authors perform grey relation analysis (GRA) to account for the impact of indicators on sustainable growth indices. From the obtained table (see *Table 2*) we select one indicator from every group (economy, society, ecology and energy) that has the greatest impact on the sustainable growth indices. The authors focus research on the necessity of the equivalence between economic, social, ecological and energy indicators in the long-term perspective. The current SBI value was calculated, which should tend to the ideal. As a result, the most influential factors on sustainable growth indices in the economy were chosen — ROE , energy — LEI , ecology — ROE_{env} and social — ROE_{sr} . All of these four indicators should be expressed equally for achieving the sustainability of growth.

SBI calculations results

The authors determine a ratio between types of intra-corporate subsystems by pairs, having designated their interaction through four independent parameters: a (pair “ $ROE - LEI$ ”); b (pair “ $LEI - ROE_{env}$ ”); c (pair “ $ROE_{env} - ROE_{sr}$ ”); d (pair “ $ROE_{env} - ROE$ ”) (*Fig. 3*).

SBI expresses smoothly tend. Results have shown that Lambert Energy Index (LEI) is the primary factor for supporting balance in the system. The actual SBI in 1996 was 0.11, in 2015 was 0.15 and in 2019 was 0.23. Results show that if ROE_{env} and ROE_{sr} is suffering in

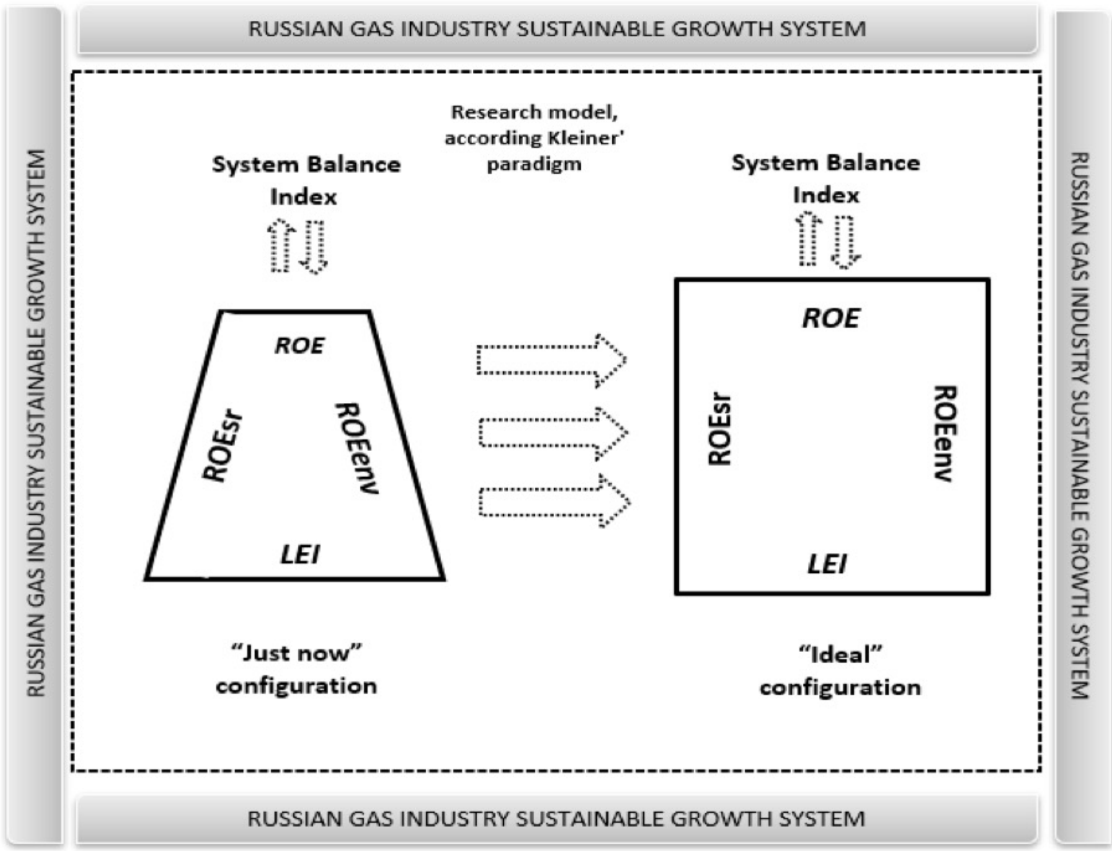

Fig. 3. **Russian gas industry sustainable system**

Source: the authors' methodology.

the industry, SBI would suffer too. This fact could help to determine the importance of an ecological protection factor in the sustainable growth system as a whole (see *Table 3*).

In the strategic perspective, none of the components (factors) included in the model should prevail over others, i.e., the closer to 1 index results, the more balanced the situation is considered at the moment. With the proposed approach sustainable financial growth would have a completely different quality, more significant social and environmental responsibility and focus on the future of human well-being. Most likely the balance model (when the contribution of all four factors is equal) would not be optimal from the standpoint of profitability but focused on sustainability because the task is not only to make a profit but also to get an environmentally-oriented and socially responsible industry or company. The authors build a system index interconnections link, using the observations of the interaction flowing process between 1996 and 2019. The strongest links can be observed between LEI with ROE_{env} and ROE_{sr} as well as we confirmed the close intensity of links between parts of SBI, with high intensity of links between internal four sustainable parameters.

The SBI dynamics from 1996 to 2019 is shown in *Fig. 4*.

In gas companies, it is necessary to set strategic goals based on the system balance index. Thus, for example, if we look at the SBI structure in 1996, LEI reached the highest level — 0.41. Thus, the LEI indicators should be planning for the next year not lower than the current one. For the remaining indicators, the same increment values should be set so that the SBI can reach an ideal (close to ideal 1) state.

Table 3

SBI and its subsystems results

	1996	2015	2019
ROE	0.22	0.28	0.38
LEI	0.41	0.54	0.58
ROE_{sr}	0.02	0.04	0.05
ROE_{env}	0.02	0.02	0.02
SBI	0.11	0.15	0.23

Source: the authors' calculations.

CONCLUSIONS AND POLICY IMPLICATIONS

The Russian gas industry also could be considered as the source of sustainability, the source of social responsibility, energy efficiency and environmental protection measures in progress. Sustainable analysis in

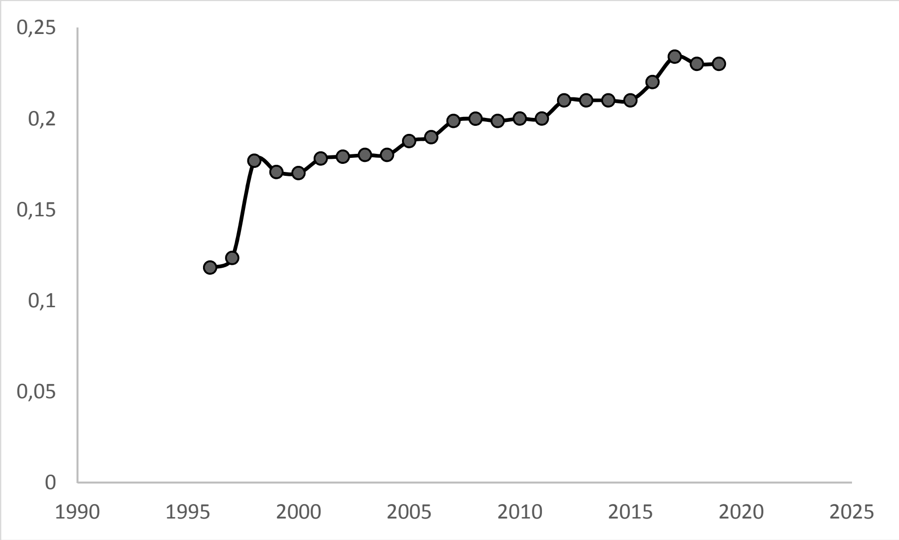

Fig. 4. **SBI dynamics from 1996 to 2019**

Source: the authors' calculations.

energy companies could be built on the basis of system methodology [44]. The authors argue that energy, environment and social responsibility are much more critical factors for the sustainability of growth and development than Russian gas companies' management suppose. Indeed, according to nowadays reality, the meaning of sustainable growth should be reconsidered in the context of environmental protection, energy efficiency, and social responsibility.

The authors suggested that it is expedient to use the complex estimated indicator characterizing sustainable growth for a better understanding of companies' sustainability growth system. The choice of indicators and extent of factors that influence interaction inside the Russian gas industry's system is determined. If necessary, the company's management could revise the indicators every year, based on its own sustainable growth goals and methodology. Intrinsic high-quality influence of non-financial factors (energy, social, environmental) on the Russian gas industry's sustainable growth indices was revealed.

Nowadays, the authors have a heated discussion on what is better — financial sustainable growth should be balanced (all parts of the model are equal at the end) or this model is not useful in our society, because it expresses only "ideal" balanced World. The authors firmly intended to research an all-level-equilibrium system index concerning various sets of subsystems and factors. The authors intended to continue research under the system paradigm.

The authors have used System Balance Index (SBI) formula to ensure the Russian gas industry's sustainable growth. As the main Research conclusion, the links between financial sustainability and sustainable factors, such as LEI, ROE_{env}, ROE_{sr} were obtained. Russian gas companies' financial policy results should also depend on sustainable factors. As we know, SGR_H is related to $ROE, FL, RG, WACC, NWCT$ to contribute to financial sustainability, that is why companies should pay more attention to these financial coefficients that have a great influence on financial sustainable growth rate. But SGR_H is also related to nonfinancial factors to contribute to financial sustainability. That is why the authors decided to include nonfinancial factors in the System Balance Index (SBI). SBI expressed the intensity of links between model' factors components, trends equilibrium. The way from "just now" non-balanced Russian gas industry configuration to future "ideal" balanced (sustainable) configuration was found. Results show that if ROE_{env} and ROE_{sr} are suffering in the company, SBI would suffer too. This fact could help to determine the importance of environmental protection and social responsibility factors in the sustainable growth system as a whole. It has been shown that on the assumption of the nature of their spatial and temporal boundaries, the sustainable system can be influenced not only financial factors, but also by non-financial factors, like energy saving, environmental protection and social responsibility factors.

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