Economics of knowledge-intensive and high-tech enterprises and industries. Management in organizational systems

Экономика наукоемких и высокотехнологичных предприятий и производств. Управление в организационных системах

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RESEARCH ARTICLE

Short-term stock indices as a tool for assessing and forecasting scientific and technological security

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Abstract
Objectives. Ensuring scientific and technological sovereignty, defined as one of the objectives of the Concept of Technological Development for the period until 2030, approved by the Order of the Government of the Russian Federation No. 1315-r dated May 20, 2023, implies the use of effective mechanisms for managing the country's economy. Under contemporary conditions, technology is a crucial element in the country's economic development and a key component of scientific and technological security. Thus, the aim of the present work is to develop existing methods for analyzing economically significant information relating to the monitoring and diagnostics of scientific and technological security at the meso- and macrolevels.
Methods. The developed method for scientific and technological security level monitoring and forecasting, which is based on the dynamics analysis of the values of corporate securities, includes economic and statistical analysis methods, machine learning and time series analysis tools.
Results. The approach towards information processing and enhancement of analysis mechanisms in managerial decisions, which relies on diagnostic, analysis, and forecasting tools for socioeconomic system scientific and technological security, is based on information-processing, economic, and mathematical methods. The presented results constitute a developed method for the analysis of systemically important enterprises stock indices, supporting research and development to assess and predict scientific and technological security dynamics at meso- and macro levels of the economy. In order to verify the methodology, a numerical experiment was carried out using statistical data from systemically important companies.
Conclusions. The developed methodology is aimed at improved managerial decision-making accuracy and speed when solving problems connected with scientific and technological security underpinning socioeconomic systems. The experimental results quantitatively confirm the significant contribution made by systemically important companies to Russian Federation's scientific and technological security ensuring.

Keywords: scientific and technological safety, information analysis methods, economic and mathematical modeling, scientific development, stock indices, decision support tools

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НАУЧНАЯ СТАТЬЯ

Краткосрочные биржевые индексы как инструмент оценки и прогнозирования научно-технологической безопасности

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Резюме
Цели. Обеспечение научно-технологического суверенитета, определенное как одна из задач Концепции технологического развития на период до 2030 г., утвержденной Распоряжением Правительства Российской Федерации от 20 мая 2023 г. № 1315-р, предполагает использование эффективных механизмов управления экономикой страны. В современных условиях технологическое развитие экономики является императивом развития страны и ключевой составляющей научно-технологической безопасности. Цель работы – развитие существующих инструментальных методов анализа экономически значимой информации для мониторинга и диагностики научно-технологической безопасности на мезо- и макроуровне.
Методы. Использована авторская методика мониторинга и прогнозирования уровня научно-технологической безопасности на основе анализа динамики стоимости ценных бумаг компаний, включающая методы экономико-статистического анализа, инструменты машинного обучения и анализа временных рядов.
Результаты. Представлен авторский подход к совершенствованию механизмов обработки и анализа информации в ходе принятия управленческих решений. Для этого осуществлена разработка инструмента диагностики научно-технологической безопасности социально-экономической системы на основе экономико-математических методов обработки информации. Предложена методика интегральной оценки научно-технологической безопасности на макроуровне на основе анализа и прогнозирования стоимости ценных бумаг экономических агентов – системообразующих компаний. Научный результат – разработанная методика анализа биржевых индексов системообразующих предприятий, осуществляющих исследования и разработки для оценки и прогнозирования динамики научно-технологической безопасности на мезо- и макроуровне экономики. Для верификации методики проведен численный эксперимент с использованием статистических данных системообразующих компаний.
Выводы. Разработанная методика направлена на повышение точности и быстродействия управления в задачах обеспечения научно-технологической безопасности социально-экономических систем. Результаты эксперимента количественно подтверждают предположение о значительном вкладе системообразующих предприятий в обеспечение научно-технологической безопасности Российской Федерации.

Ключевые слова: научно-технологическая безопасность, методика анализа информации, экономико-математическое моделирование, научное развитие, биржевые индексы, инструменты поддержки принятия решений

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INTRODUCTION

Contemporary tools for monitoring, analyzing, and forecasting the state of the economy imply the use of relevant information processing tools. The conducting of scientific research and development of large enterprises under the jurisdiction of the Russian Federation plays a key role in ensuring economic security. At the same time, the activity of science-based enterprises is characterized by uncertainty due to the complexity of the tasks to be solved, the variety of influencing factors, and the dynamics of changes in the influence of the external environment.

Under such conditions, it is advisable to consider not only methods for directly assessing scientific and technological security (STS) on the basis of indicators of scientific activity of an enterprise or a company, but also the more general processes underpinning its improvement. For example, in order to establish a quantitative relationship between the value of securities of large technology companies at the STS level, indirect evaluation mechanisms are required. For example, the generally recognized indicator systems include characteristics for determining the level of innovation activity, as well as costs and results of enterprise functions carried out in the field of scientific activity and the development of high technology. An additional factor determining the possibility of such an assessment is the significant participation of the state in large businesses—for example, for many large companies, including those carrying out research and development within the framework of business interests, state institutions are included among the shareholders.

Key factors in the efficiency of management decision-making are accuracy and speed. However, reliance on statistical assessments, which include indicators significant for STS, involve significant intervals between the periods of receipt of statistical data. Under the conditions of dynamic changes in the indicators characterizing the socioeconomic system, it is advisable to consider tools with greater sensitivity and less time delays. Hence, there is a need to use methodological approaches based on the analysis of rapidly changing data, as well as to improve existing and develop new tools for processing and analyzing information.

LITERATURE REVIEW

While considering the tasks of ensuring STS, it is necessary to determine its position in the structure of modern economy. It seems reasonable to consider STS as an integral part of economic security. The current understanding of a competitive national economy assumes a close relationship with scientific and technological progress. The concept of ensuring scientific and technological sovereignty, defined as one of the priorities of Russia's development[1], also implies the actualization of the existing independent scientific and technological basis, as well as its further development. STS plays an important role in the specialized literature. A.E. Varshavskii in [1] postulated the principles of STS provision. In the study by M.S. Vlasova, O.S. Stepchenkova, indicators of economic security in the scientific and technological sphere are considered [2]. A.Yu. Pinchuk considers scientific and technological development in the context of digitalization of the economy and industrial development [3]. A.A. Afanasev considers the role of STS in the tasks of ensuring technological sovereignty [4].

The relationship between innovation activity and STS is reasonable assumed to have a fundamental character [5]. The articles [6, 7] are focused on the problems of methodological support of innovation activity. Studies in the field of assessing the effectiveness of innovation activity of organizations in the context of digitalization of the economy are presented in [8]. A significant layer of works is devoted to analyzing the problems of innovative business development in modern Russia [9–12].

Problems associated with ensuring innovative development are closely related to the competitiveness of organizations under contemporary conditions. The development of innovations, representing one of the main factors of production, involves both a stimulus and a requirement to improve the production toolkit. M.P. Kalinichenko considers the management of enterprise competitiveness through innovation activity [13]. T.A. Burtseva presents approaches to analyzing the evaluation of the effectiveness of information support of innovation management [14]. A.V. Babkin and L. Chen evaluated the efficiency of innovation of high-tech industry on the example of a province in the People's Republic of China [15]. The problems of management of knowledge-intensive organizations were considered in the works of A.M. Batkovsky [16, 17], D.Yu. Fraimovich [18]. I.L. Berezin considers the institutional forms of innovation activity management and their limitations [19], while S.A. Filin discusses the principles of management in the context of transition to the digital economy [20]. It should be noted the actualization

[1] Decree of the President of the Russian Federation No. 145, dated February 28, 2024, On the Strategy for Scientific and Technological Development of the Russian Federation. http://www.kremlin.ru/acts/bank/50358 (in Russ.). Accessed April 03, 2024.

of research in the field of ensuring scientific activity and economic security in the context of sanctions pressure [21]. The authors [22] consider approaches to overcoming Russia's technological dependence. The available mechanisms and tools of transition to the sixth technological mode are studied in [23].

Researchers note the need to transition to a sovereign, import-independent model of scientific and technological development. For example, T.D. Stepanova in [24] identified the key threats to technological development and, consequently, economic security. Staffing problems represent an important aspect of scientific discussions. Noting the need to improve personnel training in the context of economic security, V.I. Avdiyskiy offers recommendations that facilitate this process [25].

An acknowledged mechanism for ensuring economic security is the monitoring of key indicators of socioeconomic development [26]. Current studies are devoted to various aspects of monitoring and evaluation of economic security. Thus, A.P. Suvorova and N.Yu. Sudakova consider the scientific and technological development of Russia through the prism of the effectiveness of the implementation of state programs [27]. In [28] the theoretical and methodological approaches to the study of economic security, the development of theory and practice of information processing in the context of its provision are improved. The works by V.K. Senchagov, S.N. Mityakov [29] describe the approach to the application of short-term indicators assessment models for analyzing economic security. The authors consider the monitoring of regional innovation activity in the context of ensuring economic security and scientific sovereignty. Other studies are devoted to assessing the effects and implementation of projects in production systems as part of the scientific potential of the country [30]. The paper [31] presents conceptual aspects of STS ensuring and tools for STS monitoring of the regions of Russia.

The review of scholarly publications demonstrates the relevance of the topic under consideration in the context of ensuring economic security at the regional and federal levels. Thus, most of the works are devoted to the formation of an instrumental and methodological basis for the study of STS on the basis of existing statistical information. While this is certainly justified in the context of data collection and the possibility of their further comparative and retrospective analysis, existing approaches can be supplemented on the basis of alternative assessment methods. Moreover, such tools, which are based on indirect indicators of economic activity that have a significant impact on the state of STS, enable additional verification of existing official statistical data.

METHODOLOGY FOR MONITORING AND FORECASTING STS LEVEL ON THE BASIS OF ANALYZING THE DYNAMICS OF THE VALUE OF COMPANIES' SECURITIES

With the development of data transmission networks, mechanisms for organizing, storing, and presenting information, many Russian and foreign researchers use stock exchange quotations to analyze the financial component, assess the prospects of development of industries of the real sector of the economy, and clarify the parameters of developed simulation models. Here, the system of indicators is based on short-term indices. While such an approach is applicable to the tasks of selective assessment and forecasting of the constituent elements of the economic security structure, it seems reasonable to switch to monitoring changes in key indicators in the medium term when setting out to improve its scientific and technological component. This is due to more complex properties of the impact of changes in financial instruments of companies and corporations engaged in research and development at the STS level of the socioeconomic system. It is also due to the presence of deferred influence of innovation processes, which effectiveness affects the overall STS level as well as influencing the value of the company's shares on the stock exchange.

Relevant methods of predictive modeling used for evaluation and analysis of time series on the basis of machine learning can be combined with formal models of mathematical statistics to predict dynamics of changes in the value of securities of companies with a certain degree of probability. In other words, the methodology of STS monitoring based on the analysis of the dynamics of the value of companies' securities includes two key components: (1) a system of indicators formed on the basis of a set of leaders of scientific and technological progress for the direct construction of an integral index and (2) methods of time series analysis for forecasting (Figure).

Let us consider a methodology for monitoring and forecasting the STS level based on the analysis of the dynamics of the value of securities of Russia's leading companies. The methodology involves analyzing the value of securities of companies grouped by types of economic activity where there is a direct relation to research and development on top of science and technology investments. Thus, we will consider companies engaged in mining, manufacturing, as well as those belonging to the collective classification grouping of economic activities "Information and Communication Technologies Sector."

The formal component of the methodology includes tools for time series analysis, which are used to build predictive models in the presence of a sufficient amount

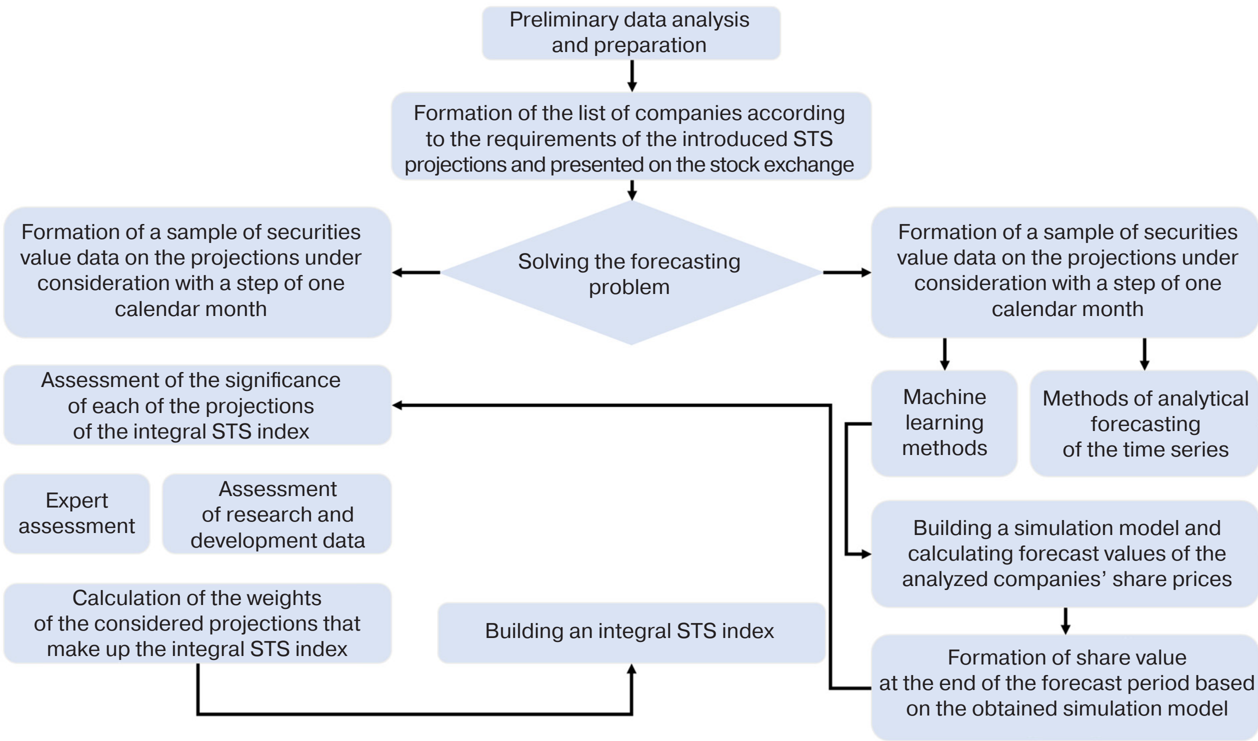

Figure. Structural scheme of the methodology for monitoring and forecasting the STS level on the basis of analyzing the dynamics of the value of the companies' securities

of initial data. While providing opportunities to select the most appropriate mechanisms for the characteristics of the initial data, the existing models require a comparative analysis of the results to select those most adequate to the initial data. Thus, in [32] an example of forecasting short-term economic security indices based on machine learning and time series tools is presented. The authors conduct a comparative analysis of modeling results for various macroeconomic indicators using autoregressive integrated moving average and Holt models, as well as neural network models. With regard to the assessment of STS on the basis of analyzing the value of shares of companies engaged in research and development, it seems appropriate to use a combination of methods of forecasting time series based on the Holt–Winters and Box–Jenkins models, taking into account the importance of comparative analysis of the resulting forecasts. It is also advisable to use machine learning models, which allows us to compare the final results, for example, the long short-term memory network known as the long short-term memory model.

While the described methods are not a mandatory guide to action when forecasting the values of a time series, they can be used to conduct a comparative analysis of forecast accuracy. The analytical component of the proposed methodology involves iterative comparison of the obtained values in accordance with certain accuracy criteria, as well as adaptation of the selected models to solve specific practical problems. The use of machine learning and time series apparatus illustrates the diversity of approaches to forecasting and forms the possibility of selecting the most appropriate of them to solve the specific task of analyzing the dynamics of STS change.

Let us consider the determining ratios necessary for quantitative assessment of changes in the STS level in accordance with the presented methodology. For this purpose, we propose to use the author's formula based on the assumption of a pronounced direct impact of the investment attractiveness of a high-tech company on the research and development sector, and, consequently, on the STS level.

Let us proceed to the construction of an integral STS index on the basis of analyzing the value of companies' shares. For this purpose, it is advisable to use the following ratio:

$$S = \frac{\sum_{i=1}^{n} \beta_i \sum_{j=1}^{m} (1-\rho_j)\alpha_j \frac{x_t}{x_\tau}}{\sum_{i=1}^{n} \sum_{j=1}^{m} \frac{x_t}{x_\tau}}, \qquad (1)$$

where n is the number of projections of companies' economic activities; m is the number of companies in the projection being analyzed; $0 \leq \beta_i \leq 1$ is the projection significance coefficient for STS; $0 \leq \alpha_j \leq 1$ is the company's significance coefficient in the projection; $0 \leq \rho_j \leq 1$ is the risk assessment of the asset under consideration; x_t is the value of the company's financial instrument (e.g., shares) in the last analyzed period; $\overline{x}_\tau$ is the average value of the financial instrument's value at some time interval equal to several periods t preceding the one under consideration.

While the coefficient of the company's significance αj can be determined on the basis of expert assessment, if the initial data is available, its calculation lies in the assessment of statistical indicators of the analyzed organization in the field of completed research and development. Thus, the significance of a particular company can be determined in the context of ensuring STS on the basis of the relative contribution in terms of research and R&D within the scope of the industrial sector. In this case, it is proposed to normalize the values of α_j for the formula under consideration according to the condition of maximum, where $\alpha_j = 1$ is assigned to the most innovative and active company, and the rest are normalized in descending order. In other words, after obtaining the relative weights of the contribution of each of the companies to the number of research and R&D of the industrial sector, the values are proportionally scaled to match the relative weight of the leader of the considered distribution to one.

While the coefficient β_i can also be determined on the basis of expert evaluation, it is advisable to consider its values on the basis of the assessment of statistical data on innovation activity by sector, defined as the ratio of the number of research and R&D of the type of economic activity under consideration to the total number of scientific works performed by all its types. The normalization of β_i value is assumed to be consistent with α_j, i.e., the largest value of the coefficient in the distribution is equivalent to one, and other values are calculated proportionally. For the correct functioning of the methodology, it is necessary to have appropriate statistical data for calculating the coefficients β_i and α_j by types of economic activity and the number of new products and technologies, respectively.

The risk component, represented by the corresponding component $(1 - \rho_j)$ and normalized from 0 to 1, should be specially noted. An assessment of the impact of the dynamics of changes in the value of securities on the STS level must be carried out when taking into account the risks that characterize the investment attractiveness of the selected asset. While the assessment of risks in the proposed methodology refers to the volatility of securities, it can also include the risks of reducing the impact of the dynamics of analyzed financial instruments on the change in the STS level. At the same time, this conflict situation can be resolved in the model by increasing or decreasing the expert values of the significance coefficients of the influence of the dynamics of the analyzed asset on the STS level.

When considering some practically important tasks in detail, it is advisable to resort to differentiated methods of assessing the risk component. Thus, the present methodology does not imply restrictions on the type of securities, which in the context of the assessment implies appropriate adaptation of the risk measure. For the selected time periods, measures based on the value at risk commonly used in financial analysis, calculated specifically for each type of securities under consideration, can be used, along with probabilistic risk assessment, expert assessment or methods based on more complex factor models. The method used in a particular practical task to assess the risk component of a financial instrument is primarily based on the requirements of the study, taking into account available statistical data, as well as time and material and technical resources, in the analysis.

In the basic version of the methodology, the calculation of the relevant component is based on generally known methods of financial risk assessment. Here, the coefficient of variation may serve as a measure. If necessary, the tool used may be supplemented and modified in accordance with the requirements of a particular study. The coefficient of variation used in this methodology is calculated according to the following formula:

$$\rho_j = \frac{SD_j}{M_j}, \tag{2}$$

where SD_j is the standard deviation based on statistical data for the period under consideration; M_j is the average value of the financial instrument under consideration for the time interval under evaluation.

Thus, the final formula includes a conservative assessment of risks while taking into account the coefficient of variation, allows the characteristics of the analyzed set of financial instruments to be further clarified. Formalizing the set of actions defining the methodology of monitoring and forecasting the STS level based on the analysis of the dynamics of the value of securities of companies, the following stages can be outlined:

1. Selection of time interval for STS level assessment.
2. Formation of the list of companies-issuers of financial instruments, according to the directions of their R&D activities and types of economic activities.
3. Preparation of statistical data on selected companies: determination of the current x_t and average value $\overline{x}_\tau$ of a financial instrument, as well as its risk measure ρ_j.

4. Calculation of weights β_i characterizing the contribution of the industry corresponding to the selected companies to the scientific and technological progress of the state.
5. Assessment of company importance in the projection α_j.
6. Building the *S*—integral STS index based on the analysis of the value of companies' shares.

COMPUTATIONAL EXPERIMENT

In order to illustrate the practical application of the presented methodology, let us turn to the rating of the largest companies in Russia by sales volume. Let us select the companies occupying leading positions by this indicator according to the RAEX-Analytica[2] rating agency in accordance with the highlighted evaluation projections. Coefficients β_i were calculated on the basis of the Federal State Statistics Service data, in particular, in accordance with the report[3] on the number of fundamentally new developed advanced production technologies by types of economic activity. Coefficients α_j in the example represent the expert opinion on the importance of a particular company in the context of providing STS. In order to analyze stock exchange quotations and calculate parameters $x_t, \overline{x}_\tau$, we used open data on the value of financial instruments of the companies under consideration using open services such as Investing.com[4], Yahoo Finance[5], Moscow Exchange[6], and others.

In order to assess the STS level for the period of 2022 (Table 1), the data aggregated by means of comparative analysis and mutual verification of the value of financial assets on international platforms were used. For the period of spring 2024 (Table 3), the data of the Moscow Exchange were employed in the calculations due to the delisting of financial instruments of Russian companies from global trading platforms. Under the conditions of an isolated national financial market, the risk component expressed by the volatility of instruments issued by companies is lower on average, as evidenced by a comparative analysis of the relevant statistical data given in the numerical experiment in Tables 1 and 3. In this regard, in further practical calculations it is advisable to supplement the risk component of this methodology with factors that have a quantitative expression.

After preparing the initial data, as well as calculating the coefficients β_i and α_j and the ratio $\frac{x_t}{\overline{x}_\tau}$ for each of the companies under consideration, we proceed to the construction of an integral assessment of the STS level of the socioeconomic system. Using the formula (1), we obtain the value of the integral STS index, which is 0.64. In this case, according to the considered assessment model, the values of the private contribution of companies for each type of economic activity are 26%, 60%, and 14%, respectively (Table 2).

To ensure that the results of the numerical experiment correspond to the actual time interval, it is necessary to use the data of the Moscow Exchange. This is partly due to the exclusion of Russian companies from the list of organizations represented on international exchanges, and partly to the restricted access to statistical reporting of systemically important companies[7]. For some statistical data (for example, the number of fundamentally new developed advanced production technologies), on the basis of which, in particular, the coefficient β_i of the methodology was calculated, the period of values is also 2022. The numerical experiment based on the updated statistical information is presented below (Tables 3 and 4).

Now, based on formula (1), the value of the integral STS index is 0.22. At the same time, according to the evaluation model under consideration, the values of private contribution of companies for each of the economic activities are 24%, 61%, and 15%, respectively (Table 4).

It should be noted that the calculation mechanism of the presented results does not include Rostec State Corporation structures; in particular, Kalashnikov Concern and Russian Helicopters Holding, since their financial instruments are not listed on the Moscow Exchange. To enable a comparative analysis of the results over the reporting period interval (data for February 2022 and April 2024), *S*—STS integral index for the period of February 2022 without participation of the above companies—was calculated. The corresponding value was 0.20, while the private contribution indices of the companies for each of the economic activities were 15%, 61%, and 24%, respectively. This indicates a decrease in the contribution of mining companies and the role of manufacturing, as well as an increase in the importance of the information and communication technology sector.

[2] Rating of Russia's largest companies by sales volume—RAEX-600. https://raex-rr.com/largest/RAEX-600/biggest_companies/2022/ (in Russ.). Accessed April 03, 2024.

[3] Technological development of economic sectors. Federal State Statistics Service. https://rosstat.gov.ru/folder/11189 (in Russ.). Accessed April 02, 2024.

[4] https://www.investing.com. Accessed April 02, 2024.

[5] https://finance.yahoo.com. Accessed April 02, 2024.

[6] https://www.moex.com (in Russ.). Accessed April 02, 2024.

[7] Federal Law No. 55-FZ dated February 28, 2023 "On Amending Article 5 and Suspending Part 7 of Article 8 of the Federal Law "On Official Statistical Accounting and the System of State Statistics in the Russian Federation" and on the Specifics of Official Statistical Accounting in the Territories of Certain Constituent Entities of the Russian Federation." http://publication.pravo.gov.ru/Document/View/0001202302280031 (in Russ.). Accessed April 03, 2024.

Table 1. Data for STS level assessment based on stock market analysis of large R&D companies, February 2022

Type of economic activity / Company performance	Company name		Financial instrument cost in the last analyzed period, x_t (February 2022), RUR	Average value of a financial instrument cost at a certain time interval, $\overline{x}_\tau$ (January 2021 – January 2022), RUR	β_i coefficient calculated on the basis of statistical data given by the maximum value rule	α_j coefficient—expert estimation given by the maximum value rule	Risk assessment $(1 - \rho_j)$
Mining	Gazprom		324.30	287.57	0.21	0.5	0.82
	LUKOIL		70.41	63.48		0.5	0.92
	RUSAL United Company		67.07	77.47		0.25	0.85
	Norilsk Nickel, mining and metallurgical company		21919	23683		0.25	0.94
Manufacturing, mechanic engineering	Rostec State Corporation, structures represented on the financial market	Kalashnikov Concern	99.8	101.27	1	0.75	0.99
		Russian Helicopters	96.48	99.26		0.75	0.97
		KAMAZ	106.08	87.01		0.5	0.76
	Rosseti		1.01	1.36		0.5	0.86
	SIBUR Holding		94.5	98.00		0.25	0.97
Cumulative classification grouping of economic activities “Information and Communication Technology Sector”	AFK Sistema		19.44	29.31	0.46	0.5	0.84
	Rostelekom		71.42	95.45		0.5	0.88

Table 2. Integral STS index values based on the analysis of the securities market of large companies engaged in R&D activities, February 2022

Type of economic activity	Percentage expression of companies’ contribution to the integral STS index for each of the analyzed types of economic activity
Mining	26%
Manufacturing, mechanic engineering	60%
Cumulative classification grouping of economic activities “Information and Communication Technology Sector”	14%

Table 3. Data for STS level assessment based on stock market analysis of large R&D companies, April 2024

Type of economic activity \ Company performance	Company name		Financial instrument cost in the last analyzed period, x_t (April 2024), RUR	Average value of a financial instrument cost at a certain time interval, $\overline{x}_\tau$ (April 2023 – April 2024), RUR	β_i coefficient calculated on the basis of statistical data given by the maximum value rule	α_j coefficient—expert estimation given by the maximum value rule	Risk assessment $(1 - \rho_j)$
Mining	Gazprom		92.53	95.44	0.35	0.5	0.97
	LUKOIL		94.08	90.29		0.5	0.95
	RUSAL United Company		100.59	70.36		0.25	0.57
	Norilsk Nickel, mining and metallurgical company		93.45	97.54		0.25	0.96
Manufacturing, mechanic engineering	Rostec State Corporation, structures represented on the financial market	Kalashnikov Concern	Non-traded instrument[8]	–	1	0.75	0.99
		Russian Helicopters	Non-traded instrument[9]	–		0.75	0.97
		KAMAZ	100.50	99.98		0.5	1.00
	Rosseti		99.87	97.09		0.5	0.97
	SIBUR Holding		93.52	96.98		0.25	0.96
Cumulative classification grouping of economic activities "Information and Communication Technology Sector"	Rostelekom		92.47	96.11	0.33	0.5	0.96
	Rostelekom		91.22	95.52		0.5	0.96

Table 4. Integral STS index values based on the analysis of the securities market of large companies engaged in R&D activities, April 2024

Type of economic activity	Percentage expression of companies' contribution to the integral STS index for each of the analyzed types of economic activity
Mining	24%
Manufacturing, mechanic engineering	61%
Cumulative classification grouping of economic activities "Information and Communication Technology Sector"	15%

[8] On Amendments to the List of Securities Admitted to Trading. Moscow Exchange. https://www.moex.com/n47168?print=1 (in Russ.). Accessed April 03, 2024.
[9] On Keeping Securities on the List of Securities Admitted to Trading. Moscow Exchange. https://www.moex.com/n67495?print=1 (in Russ.). Accessed April 03, 2024.

The comparative analysis of the obtained results shows that the methodology is stable in relation to the number of selected companies within the grouping "Type of economic activity." At the same time, it remains certain that with the increase in the number of organizations-representatives of each of the considered areas of economic activity, influencing the change in the STS level, the objectivity of the assessment increases proportionally. The conducted computational experiment at different time intervals quantitatively shows that the most significant contribution to the integral STS level is made by manufacturing and machine-building enterprises. This allows us to justify the need to increase the industrial potential to ensure scientific and technological sovereignty of the Russian Federation.

CONCLUSIONS

The developed methodology for monitoring and forecasting the STS level on the basis of analyzing the dynamics of the value of company securities is part of a comprehensive toolkit for processing significant retrospective and instantaneous information on the state, dynamics of changes, and forecasting of important indicators of scientific and technological development in the context of ensuring economic and national security. Tools of statistical analysis and economic and mathematical modeling used in this methodology are used to provide an objective assessment of the state of research and development of the socioeconomic system. The presented methodology combines the simulation modeling of complex systems into a unified structure to conduct operational monitoring of the research and development sphere on the basis of assessing the dynamics of the integral index for selected industries and spheres of economic activity.

A distinctive feature of the presented methodology is its high adaptability and the possibility to build the main or additional sources of information into the functioning mechanisms of management decision support. Given a statistical sample of sufficient volume and quality, it is possible to build an integral assessment of the STS level using tools from exclusively formal methods, which positively affects the accuracy of the results in comparison with the accepted expert or probabilistic approaches. In the context of monitoring, this contributes to improved accuracy and speed of management—and consequently increased level of economic security.

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