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Managing risk resilience and risk capacity at defense-industrial complex enterprises engaged in the production of dual-use products

Specialty 5.2.3. Regional and sectoral Economics

Abstract of the dissertation

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Relevance of the Research Topic

Is determined by a complex of interrelated factors shaping the current state and development prospects of the defense-industrial complex (DIC) of the Russian Federation. Amidst progressive geopolitical instability, the avalanche-like intensification of sanctions pressure from unfriendly states, and the concurrently pursued policies of import substitution and production diversification, DIC enterprises face a fundamentally new challenge: to ensure not merely current accident-free operation, but long-term sustainable functioning under conditions of constant external and internal turbulence. Environmental uncertainty manifests itself in the disruption of logistics chains, restricted access to critical components and technologies, volatility of the state defense order, and the need for rapid retooling of production capacities toward civilian and dual-use products (DUP). The production of DUP, which can be utilized for both military and civilian purposes, today acts not merely as one promising avenue for DIC diversification but as a strategic imperative, ensuring the state's defense capability, its technological sovereignty, and competitiveness in high-tech markets. However, the specifics of developing, certifying, serial production, and subsequent support of DUP entail an exceptionally high degree of risk, significantly exceeding risks associated with purely civilian or purely military production. Such risks include dual regulatory standards, the necessity of maintaining secrecy while simultaneously entering open markets, pricing complexity, high R&D capital intensity, and prolonged investment-production cycles. An analysis of existing risk management theory and practice within DIC organizations indicates that, to date, approaches to the quantitative assessment of two fundamental, interrelated parameters of enterprise activity—risk resilience and risk capacity—remain insufficiently developed. Risk resilience is understood as the enterprise's ability to maintain specified parameters for fulfilling the state defense order and DUP production plans under the impact of individual risks and their combinations, while risk capacity is defined as the maximum permissible volume of accumulated risks, the exceeding of which leads to irreversible loss of functionality. The absence of a unified methodology for their joint measurement and interpretation prevents

management from making informed, predictive decisions in conditions of multiple risk situations and their sequential, chain-like combinations.

The Aim of the Dissertation Research is to develop, theoretically substantiate, and methodologically elaborate a set of provisions for managing risk resilience and risk capacity at defense-industrial complex enterprises engaged in the production of dual-use products. The proposed approach is grounded in the principle of assessing the total cost of risk situations and their combinations (both simple and complex, including the domino effect), thereby enabling a transition from fragmented accounting of individual threats to a systemic analysis of their mutual influence and cumulative effect on the enterprise's final performance indicators.

The Main Objectives of the Research are detailed as follows, considering the logic of achieving the stated aim:

1. To conduct a critical analysis and refine the conceptual and categorical framework in the field of managing risk resilience and risk capacity as applied to the specifics of DIC enterprises producing DUP. This task entails distinguishing between related concepts (e.g., "risk resilience" and "financial stability," "risk capacity" and "risk appetite"), as well as introducing authorial definitions that account for security regimes, mobilization requirements, and the dual-use nature of the products.

2. To develop a scientifically grounded approach for forecasting two key types of cost flows: (a) direct and indirect losses from the realization (materialization) of identified risks; (b) necessary expenditures for the prompt liquidation of consequences of realized risk events, including the restoration of the production cycle.

3. To create a detailed, step-by-step algorithm for forecasting the aforementioned losses and expenditures, which accounts for the sectoral and organizational-technological specifics of DIC enterprises (including classified projects, mobilization capacities, and the lengthy DUP creation cycle).

4. To develop and test a method for the quantitative determination of the level of risk resilience and risk capacity, enabling the ranking of enterprises according

to their degree of protection against risks and maximum permissible load, as well as the use of the obtained indicators in decision support systems.

5. To propose a holistic concept for managing risk resilience and risk capacity, based on the paradigm of the total cost of risk situations and their combinations, encompassing organizational, methodological, and instrumental components.

The Object of the Research is the set of defense-industrial complex enterprises of the Russian Federation (regardless of their scale, departmental subordination, or legal form) that carry out the full or partial cycle of development, production, testing, and disposal of dual-use products.

The Subject of the Research is the managerial relations (economic, organizational, informational, and legal) arising in the process of ensuring, maintaining, and enhancing risk resilience and risk capacity at DIC enterprises concerning the production of dual-use products, as well as the methods, tools, and decision-making models in this area.

The Theoretical and Methodological Framework of the Research is structured on three interrelated levels. The first (theoretical) level comprises the fundamental works of domestic and foreign scholars in the fields of regional and sectoral economics, risk management theory, economic security, as well as specialized studies on DIC enterprise management and production diversification. The second (methodological) level is based on the systemic approach as a general scientific principle, methods of economic and logical analysis, classification, analogy, as well as methods of abstraction and formalization. The third (instrumental) level includes applied methods of economic-mathematical modeling (including probabilistic and stochastic models), scenario forecasting, risk assessment and forecasting methods (VaR, stress testing, sensitivity analysis), as well as elements of decision theory under uncertainty.

The Provisions Submitted for Defense and Possessing Scientific Novelty are presented through four mutually complementary results:

1. **An approach to forecasting losses from risk realization and costs of consequence liquidation**, which fundamentally differs from traditional methods that assess risks in isolation. In contrast, the proposed approach views risks as a sequential (chain-like, escalating) reaction, where the realization of one risk acts as a trigger for the emergence and intensification of others. This allows the enterprise manager not merely to record the occurrence of a risk event, but to promptly (in near-real-time) identify the most vulnerable, "critical" stages of the DUP production cycle and, on this basis, economically justify the volume and structure of reserve funds (material, financial, temporal). Within the framework of this approach, the division of all relevant costs into three functional blocks is substantiated: (a) prevention costs (preventive measures); (b) costs of liquidating direct consequences; (c) costs of compensating indirect losses (lost profit, reputational damage, penalties under the state defense order). This provision corresponds to paragraph 1.16 of the passport for specialty 5.2.3.

2. **An algorithm for forecasting losses from risk realization in dual-use product production**, which explicitly accounts for the specifics of DIC enterprises: the presence of security constraints, a dual-circuit management system (civilian and military acceptance), mobilization capacities, as well as a special pricing and reporting order. The algorithm is implemented as a sequence of logically and chronologically linked stages — from risk event identification to the calculation of integral loss and cost estimates. An important feature is that the algorithm not only enables the assessment of potential losses but also solves an optimization problem: finding the least costly ways to liquidate consequences without harming the fulfillment of the state defense order. Furthermore, the algorithm functions as a decision support tool in emergency and crisis situations, ensuring enterprise adaptability to rapid changes in the external environment (paragraph 1.7 of the passport for specialty 5.2.3).

3. **A concept for managing risk resilience and risk capacity at DIC enterprises based on the paradigm of the total cost of risk situations and their**

combinations. Within this concept, an authorial conceptual apparatus of independent theoretical value is introduced and substantiated. Specifically, "risk resilience" is defined as the immanent (inherent but bounded by the limits of accumulated and possible experience) ability of an enterprise's production-economic system to maintain planned parameters for fulfilling the state defense order and DUP production under the impact of individual risks and their combinations. "Risk capacity" is interpreted as the maximum permissible total volume (probabilistically weighted value) of risks that the system can absorb without encountering irreversible consequences (loss of technological sovereignty, bankruptcy, failure of the mobilization assignment). Based on these categories, an algorithm for managing DUP production processes has been developed, implementing the closed PDCA (Plan-Do-Check-Act) management cycle, adapted to the tasks of risk management at DIC enterprises (paragraph 1.7 of the passport for specialty 5.2.3).

4. **A method for determining the level of risk resilience and risk capacity at DIC enterprises producing DUP**, built on a systemic and multifactorial approach. The method includes an original classification of total risk cost indicators into four key categories: financial risks (currency, interest rate, inflationary), technical-technological risks (equipment failures, defects, instrumentation failures), personnel risks (shortage of cleared qualified specialists, turnover), and political-regulatory risks (legislative changes, export restrictions). A distinctive feature of the method is its consideration of such specific factors as the secrecy regime (imposing restrictions on insurance and the engagement of external auditors) and the presence of mobilization capacities (requiring the maintenance of idle capacity, which increases risk capacity). The proposed approach allows for the quantitative assessment of expected and marginal damage at each stage of the DUP life cycle (R&D — pilot production — serial production — disposal) and, on this basis, for making economically justified management decisions. In particular, it becomes possible to selectively (targetedly) approach risk insurance, concentrating limited financial and organizational resources specifically on critically

significant, highest-risk-capacity zones of the production cycle (paragraph 1.7 of the passport for specialty 5.2.3).

The Theoretical Significance of the Research lies in the following. Firstly, a detailed functional structure of the total cost of risk situations and their combinations, as applied to DUP production processes, has been developed. Secondly, the most significant factors influencing strategic management processes in DUP production have been identified and empirically verified. Thirdly, the proposed and substantiated conceptual-categorical apparatus ("risk resilience," "risk capacity," "total cost of risk combinations") enables a transition from the currently prevailing qualitative, descriptive risk models to rigorous, quantitatively verifiable parameters for managing the stability of DIC enterprises. This creates a theoretical foundation for the further development of applied risk management methods in high-tech sectors with dual regulation.

The Practical Significance of the Research consists of creating a set of application-ready tools. Firstly, the developed algorithm for forecasting losses from risk realization in DUP production can be directly implemented into corporate risk management systems. Secondly, detailed recommendations have been formulated for managerial work types (regulations, functional matrices, reporting templates) necessary for the practical management of risk resilience and risk capacity. The results of the dissertation research have been successfully tested and implemented into the actual production process of dual-use products at two enterprises: Machine-Building Plant "Arsenal" (Saint Petersburg) and JSC "SKB Orion" (Moscow). Furthermore, the developed materials are used in academic courses on DIC economics and management at the North-West Institute of Management of the Russian Presidential Academy of National Economy and Public Administration (NWIM RANEPA) and at the Military Academy of Logistics named after Army General A.V. Khrulev.

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Validity and Approbation of Results. The validity of the obtained scientific provisions, conclusions, and recommendations is ensured by: (a) the correct application of proven methods of system analysis and economic-mathematical modeling; (b) the representativeness of the empirical data used (including the reporting of actual DIC enterprises); (c) positive results from the testing of the developed methodologies under real production conditions; (d) the publication of key results in peer-reviewed scientific journals with high selection standards. The research results were realized within the framework of a research project under a state assignment from the Ministry of Science

and Higher Education of the Russian Federation (registration number 123011600034-3), confirming their alignment with priority directions of state scientific and technical policy.

Publications. On the topic of the dissertation research, 13 scientific works have been published, totaling 16.93 conventional printed sheets (the author's personal contribution is 6.20 printed sheets). These include: 7 articles in peer-reviewed scientific journals recommended by the Higher Attestation Commission (VAK) under the Ministry of Science and Higher Education of the Russian Federation; 2 articles in journals recommended by the Academic Council of the Academy; as well as two co-authored monographs, which systematically present the theoretical and methodological foundations of managing risk resilience and risk capacity at DIC enterprises.

Structure and Volume of the Work. The dissertation follows the classical canon and includes an introduction, three logically interconnected chapters (theoretical-methodological, analytical-methodical, and applied), a conclusion presenting the main findings and recommendations, as well as a list of references and appendices containing calculation tables, graphs, and implementation certificates.