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ECONOMIC AND MATHEMATICAL SUBSTANTIATION OF THE THEORY OF CRITICAL CONVERGENCE: MODELING AND VERIFICATION

The article is devoted to the economic and mathematical substantiation of the theory of critical convergence, which interprets large-scale socio-economic transformations as the result of the interaction of several global processes simultaneously approaching their critical threshold values. Unlike conventional approaches that primarily examine individual drivers of economic development, the theory of critical convergence is based on the systemic interaction of technological, demographic, resource, and institutional convergences capable of generating nonlinear effects on a global scale. The study provides an economic and mathematical substantiation of the core propositions of the theory through the formalization of its conceptual framework, system of indicators, and the integrated Critical Convergence Index. The mechanisms governing the interaction among individual convergences are generalized, the formation of resonance effects is explained, and the transition of socio-economic systems into a critical operating regime is described. Based on the proposed analytical framework, an approach to scenario modeling is developed to assess possible trajectories of global economic development depending on the accumulation of critical factors. The theoretical propositions are verified through comparison with major contemporary global transformations, including the COVID-19 pandemic, the global energy crisis, the Russian-Ukrainian war, demographic changes in developed economies, and the rapid advancement of artificial intelligence technologies. The obtained results demonstrate that the theory of critical convergence can serve as a methodological framework for long-term forecasting of nonlinear socio-economic transformations, assessment of systemic risks, and development of strategic policy decisions. The results of the study may be useful for scientists, government agencies, international organizations, and think tanks that forecast global socio-economic transformations. The proposed toolkit can be used for early detection of systemic risks, scenario assessment of critical changes, and justification of strategic management decisions.

Keywords: critical convergence; economic and mathematical modeling; Critical Convergence Index; scenario modeling; global socio-economic transformations; systemic risks; theory verification.