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MANAGEMENT OF FINANCIAL STABILITY AND FINANCIAL RISKS OF INNOVATION-ACTIVE ENTERPRISES IN THE CONTEXT OF THE CIRCULAR ECONOMY

ABSTRACT

The article substantiates the theoretical and methodological foundations of managing financial stability and financial risks of innovation-active enterprises during the transition to a circular economy. It is argued that innovation activity significantly shapes a specific risk profile, which differs markedly from that of traditional enterprises, and a detailed list of such risks is provided. The principles of managing financial stability and financial risks under circular economy conditions are outlined. The analysis shows that in the current economic environment, the role of integrating environmental, social, and governance (ESG) factors, innovation potential, digital maturity, and access to green finance is increasing as essential components of the mechanism for ensuring enterprise financial stability.

Based on empirical data from three Ukrainian innovation-active enterprises – PromEkoInvest, TechnoResurs, and Biointech Group – a multiparametric model of financial risk management was developed. The model incorporates key variables: circularity level (CE), innovativeness (IN), ESG integration, digital maturity (DS), and the share of sustainable finance (RS). A general indicator, FRA (Financial Risk Adaptability), was introduced to quantitatively assess an enterprise's capacity to adapt to risks in the context of circular transformation.

The modeling results show that Biointech Group has the highest FRA value, which reflects the effective combination of a high level of innovation, ESG integration, and circular practices. In contrast, TechnoResurs demonstrates lower FRA values due to limited internal resources and less flexible management strategies. This confirms the importance of not only introducing circular economy elements but also undertaking comprehensive management modernization.

Thus, to achieve financial stability, innovation-active enterprises should implement a holistic financial risk management model that integrates circular principles, innovation, digitalization, and sustainable finance practices. The proposed model can serve as a strategic management tool and a basis for informed decision-making in the financial policy of enterprises aiming for sustainable development amid post-industrial economic transformation.

Keywords: innovation, innovation-active enterprises, financial stability, financial risks, financial strategy, circular economy, enterprise management, investment risks, green finance, financial instruments

JEL Classification: C59, G39, M20, O31, O40

INTRODUCTION

In the context of international cooperation, and particularly within the framework of European integration, Ukrainian innovation-active enterprises have the opportunity to expand their access to new markets, financial instruments, and advanced technologies. At the same time, the realization of these opportunities requires overcoming a range of obstacles, including underdeveloped infrastructure, limited financial resources, and the lack of an effective regulatory framework to support circular economy practices. The

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specific nature of innovation-driven enterprises places greater emphasis on human capital and resource management, while issues related to financial risks and financial stability often receive insufficient attention.

The relevance of this study is driven by the need for a comprehensive analysis of the interaction between the circular economy and innovation processes within the broader economic system. A deep understanding of these interconnections will facilitate the development of effective transformation strategies for innovation-active enterprises toward sustainable development, strengthening their innovation capacity and competitiveness by achieving a stable level of financial resilience through risk management. Moreover, the findings of this research may serve as a foundation for improving public policy in the areas of industry, innovation, and international economic cooperation, an especially important task in the context of post-war recovery and Ukraine's gradual integration into the European economic space.

LITERATURE REVIEW

The issue of managing financial stability in the context of the transition to a circular economy is actively researched by both Ukrainian and international scholars. When analyzing the specific features of innovation-active enterprises, it is important to emphasize that such entities are especially sensitive to external signals and changes in the environment. These signals often become triggers for innovation implementation and, compared to traditional enterprises, expose such companies to higher levels of financial and other types of risks.

Ilkiv (2020) emphasizes the need to develop an effective mechanism of economic security for innovation-active enterprises in order to minimize the impact of risks and threats arising from innovation activities and from external factors.

Blikhar (2021) focuses on the legal aspect of managing risks and threats in the activities of innovation-active enterprises, while Fleychuk and Kalynovskyy (2021) concentrate on the managerial dimension, particularly analyzing the potential of using flexible management approaches that allow the timely implementation of measures in response to destabilizing factors.

Levkovich and Kalashnikova (2021) argue that successful management of financial stability requires a clear understanding of one of its key components – sustained solvency, ensured by a sufficient share of equity in the enterprise's funding structure. This provides innovation-active companies with resilience to external shocks, reduces dependency on creditors, and thereby lowers the risk of bankruptcy. The sources of funding for innovation can be either internal or borrowed, depending on the availability of financial resources, the enterprise's current level of financial stability, and the objectives of a specific innovation project. Thus, the availability of sufficient own financial resources is a priority indicator for innovation-active enterprises.

According to Izyumska and Nikulshyna (2021), financial resilience can be achieved only when the enterprise maintains long-term financial balance as part of its future economic development. This implies the creation of conditions for a sustained reduction in the cost of capital and continuous growth in the company's market value – a goal that can be reached through active innovation. Achieving this requires accelerating economic development and adjusting certain parameters of the enterprise's financial strategy. A risk-sensitive financial strategy must ensure a high and stable pace of operational growth while neutralizing the threat of future insolvency.

International studies focus on the influence of the circular economy on the structure and nature of financial risks. For example, Geissdoerfer et al. (2017) and Lieder & Rashid (2016) describe the circular model as a driver of financial stability transformation, stressing the need for new financial tools such as green banking, transition finance, and ESG-based financial models. Masi et al. (2018) and Rizos et al. (2016) highlight challenges in risk management associated with the lack of historical data on CE-model performance, low asset liquidity, and the high upfront cost of implementing closed-loop systems.

Notably, researchers such as Stahel (2016) and Korhonen et al. (2018) call for a revision of traditional financial stability indicators, as effectiveness in circular systems is often intangible – including factors such as resource efficiency, social responsibility, and environmental impact. Gennari (2022, 2024) proposes a conceptual framework for strategic risk management in the transition to circular models, identifying new categories of risks – organizational, technological, regulatory – and offering practical tools for their identification and mitigation. Furthermore, Gennari examines circular system risks at the managerial level, affirming the need to integrate strategic risk management directly into circular economy models.

In summary, the current body of literature reflects an increasing need to adapt financial management to the challenges of the circular economy by integrating financial, environmental, and innovation-based approaches into comprehensive risk management systems that support the resilience of innovation-active enterprises.

AIMS AND OBJECTIVES

The purpose of this article is to examine the process of financial risk management aimed at achieving financial stability in innovation-active enterprises under the conditions of the circular economy. To achieve this goal, the author substantiates the impact of innovation activity on the formation and nature of financial risks and identifies key principles for managing financial stability and financial risks in innovation-active enterprises operating within circular economic systems. The study analyzes the role of integrating environmental, social, and governance (ESG) factors, innovation potential, digital maturity, and access to green finance as core components of the mechanism for ensuring the financial resilience of such enterprises. Based on empirical data from three Ukrainian innovation-active companies, a multiparametric model of financial risk management was developed.

METHODS

Among the research methods, the method of systematization and generalization was used to develop an understanding of the characteristics of innovative-active enterprises operating within a circular economy to achieve financial stability. The use of mathematical modeling enabled the construction of a financial risk management model aimed at achieving the financial resilience of Ukrainian innovative-active enterprises in the context of a circular economy.

RESULTS

An enterprise is considered innovation-active if it: continuously improves and updates its products; acquires, masters, and utilizes advanced technology and the latest equipment; leverages the advantages of specialization and diversification; renews its raw material base by applying higher-quality and new types of raw materials; develops and enhances its R&D sector; implements more advanced technologies in the production process; introduces changes in the composition of management functions and working methods, including the use of automated management systems; improves its workforce structure by employing highly qualified personnel; adopts the latest methods of production organization; implements financial innovations; and optimizes the logistics chain (Derhachiova, 2013).

The main features of innovation-active enterprises, according to research by Koverha, Krutohors'kyy, Popova (2023), Heydarova, Mala (2020), Blyzniuk, & Kudriavtseva (2023), include a strong orientation toward innovation, manifested in the continuous search for and implementation of new ideas, technologies, products, and services. Investments in R&D at such enterprises are significantly higher compared to others, as they increase expenditures on scientific research and experimental development aimed at creating new products and technologies. A special role in the activities of innovation-active enterprises is played by risk management processes, given the considerable number and scale of risks involved. Furthermore, all business processes are accompanied by a high level of uncertainty.

The specificity of innovation-active enterprises' operations necessitates ongoing collaboration with scientific centers, universities, and other enterprises to exchange knowledge and experience (Zanora & Dranenko, 2021). A particular emphasis is placed on developing human capital through investing in training and enhancing employee competencies, creating conditions for creativity and initiative, and fostering a supportive environment for innovation – one that embraces openness to change, encourages creativity, and supports initiatives. Another key aspect is the continuous need to adapt to changes through rapid response to external environmental shifts and corresponding strategic adjustments. A priority task is protecting intellectual property by applying measures such as patents, copyrights, trademarks, and others to safeguard innovations. Thoroughly studying market needs significantly impacts enterprise performance by accounting for consumer demands, thereby enabling the creation of innovative products and services that are in demand. Lastly, the ability to scale innovations – developing those that can be implemented on a large scale – allows the enterprise to expand its market share.

Innovation-active enterprises play a key role in transforming the economy, shaping competitiveness, and implementing sustainable development principles, particularly within the framework of the circular economy. However, it is precisely their innovation activity that largely determines a specific profile of financial risks, which differ significantly from those faced by traditional enterprises:

1. Increased uncertainty of cash flows. Innovative projects are characterized by long implementation periods, high uncertainty of outcomes, and irregular cash inflows. This complicates liquidity and solvency forecasting and requires flexible financial planning models.

2. Limited access to financing. Banks and investors often avoid financing innovative enterprises due to the lack of collateral, low predictability of profits, and absence of a track record of successful innovations. This leads to an increased risk of financial isolation, especially for SMEs.
3. High level of investment risks. Innovative enterprises invest in R&D, new technologies, and digital transformation – sectors that are capital-intensive and have long payback periods. This increases the risk of loss of invested funds in case of product failure or market changes.
4. Technological and market instability. Innovations often outpace regulatory frameworks and societal demand. This creates market risk (lack of demand) and regulatory risk (non-compliance with standards or changes in funding policies).
5. Risk of low operational efficiency at the start. Innovation-active enterprises may demonstrate low profitability during the initial period due to the experimental nature of technologies, high implementation costs, and operational instability.
6. Dependence on the external environment. Innovation activities are sensitive to macroeconomic conditions, political stability, and access to grants and subsidies. This creates systemic financial risks that are difficult to control at the enterprise level.
7. Inadequacy of traditional financial indicators. Standard indicators of solvency, liquidity, and profitability do not always reflect the real sustainability of innovation-active enterprises. Analytical frameworks need to be supplemented with ESG indicators, assessments of intangible assets, intellectual capital, environmental impact, and more.

Innovation-active enterprises are characterized by a high-risk profile, necessitating new approaches to financial risk management systems. Traditional methods of analyzing financial stability should be complemented by strategic, scenario-based, behavioral, and digital tools. Within the circular economy context, managing these risks must integrate environmental, social, and governance factors.

The circular economy model departs from the traditional linear paradigm of "take-make-dispose" and focuses on closed resource cycles, reuse, regeneration, and waste minimization. Its implementation transforms not only the technological basis of production but also strategic approaches to enterprise management, especially for innovation-active firms.

The conditions of the circular economy shift the focus of enterprises' innovation efforts – from technocratic solutions to environmentally and resource-oriented innovations. Innovation activity acquires a systemic character, encompassing:

- eco-design of products;
- renewable technologies;
- development of business models such as Product-as-a-Service;
- digital tools for monitoring product life cycles.

This stimulates a shift from product-level innovations to system-level innovations. Circular economy conditions require long-term investments in R&D, recycling technologies, secondary processing, and energy efficiency, which alter the capital structure of enterprises. At the same time, the expected future resource savings create deferred benefits that demand a new approach to financial analysis.

With the implementation of the European Green Deal, ESG factors, and new accountability standards, innovation-active enterprises are obliged to consider:

- the carbon footprint of their products;
- circularity metrics (e.g., the Circularity Index);
- compliance with environmental regulations across supply chains.

This shapes a new competitive environment where companies with high circular readiness gain advantages.

Innovative enterprises are compelled to adopt flexible, service-oriented models emphasizing customer-centricity, leasing, and shared resource use. This requires transformation of:

- logistics processes;
- accounting and performance evaluation systems (for example, value-oriented product lifecycle approaches);
- risk management.

Digitalization through IoT, blockchain, digital product passports, and Big Data becomes a critically important factor for the successful transition to circularity. It enables:

- tracking material flows;
- optimizing logistics;
- automating reuse and repair processes;
- creating closed-loop supply chains.

Despite the strategic advantages of the circular economy, innovation-active enterprises face several challenges:

- high financial uncertainty during the transition to new technologies;
- insufficient markets for secondary raw materials;
- lack of standards for evaluating the effectiveness of circular innovations;
- workforce shortages in circular management.

The circular economy represents not only an environmental but also an economic and motivational challenge for innovation-active enterprises. It requires them to revise approaches to innovation, investment, risk management, and business modeling. Successful adaptation to circular economy conditions opens new markets, competitive advantages, and sources of sustainable growth, but demands flexible, digitally enabled, and environmentally responsible transformation.

Based on the research by Atamanchuk & Baziliuk (2024) on integrating sustainable development principles into business strategy to enhance the financial resilience of enterprises, and considering the role of green financing and environmental risk management, we formulate the principles of managing financial stability and financial risks of innovation-active enterprises in the context of the circular economy:

1. **Principle of Long-Term Value Orientation.** In the circular economy, innovation-active enterprises should focus not only on short-term gains but on creating long-term economic, environmental, and social value. Financial planning includes assessment of the product lifecycle, recycling costs, carbon footprint reduction, and monitoring deferred benefits from circular practices.
2. **Principle of Resource Efficiency and Waste Resilience.** Cost reduction occurs not only through operational optimization but also through optimal management of material and energy flows. Enterprises must consider the cost of resource losses as waste and develop financial models that encourage reuse, repair, and recycling.
3. **Principle of Transparency and Financial Traceability.** Financial reporting and managerial accounting must be adapted to the requirements of the circular economy:
 - accounting for intangible assets (knowledge, licenses, eco-design);
 - evaluation of the circular potential of products (Circularity KPIs);
 - segregation of investments by sources (green loans, social bonds, etc.).
 - This creates integrated reporting covering both financial and non-financial parameters.
4. **Principle of Systemic Risk Management.** Financial risks in the circular economy are associated with the instability of secondary raw material markets, regulatory dynamics, high capital intensity of technologies, and so on. Therefore, risk management must account for:
 - supply chain risks;
 - ESG risks (environmental, social, governance);
 - transition risks related to changes in the economic model.
5. **Principle of Innovative Adaptability.** Resilience in the circular environment is impossible without innovative financial instruments such as:
 - green finance;
 - service models (leasing, pay-per-use);
 - shared financing models (crowdfunding, venture funds for the circular economy).

This principle implies the enterprise's ability to rapidly adapt financial strategies to new technologies, partnership models, and regulatory requirements.

1. **Principle of Multidimensional Monitoring of Financial Stability.** Traditional financial ratios (liquidity, profitability, solvency) are supplemented by environmental and social indicators, forming a new understanding of financial sustainability. Examples include:
 - Circular Return on Investment (CROI);
 - Environmental Cost of Capital (ECC);
 - Risk-Adjusted Sustainability Margin (RASM).
2. **Principle of Partnership Interaction and Shared Responsibility.** The financial stability of an enterprise in the circular economy largely depends on its ability to create an inter-organizational interaction system with suppliers, customers, banks, and the government. This involves risk sharing, joint innovation financing, and creation of closed production-logistics cycles.

In addition to the previously discussed characteristics, innovation-active enterprises in the context of the circular economy must increasingly function as dynamic and interconnected ecosystems that transcend traditional industrial boundaries. These enterprises are not only product manufacturers or service providers, but also active participants in knowledge-sharing platforms, collaborative innovation networks, and sustainable development initiatives. Their competitive edge lies in their ability to integrate sustainability objectives with core business models while responding rapidly to shifting market demands and regulatory pressures. An important aspect of their strategic direction is the transition from ownership-based value creation to access-based or service-oriented models, such as product-as-a-service (PaaS), leasing, and shared use systems, which reduce material consumption and extend product life cycles. At the same time, the financial strategy of such enterprises is becoming increasingly oriented toward long-term value creation through investments in decarbonization, green infrastructure, and innovation ecosystems. To support this transformation, enterprises must develop internal capabilities for measuring and monetizing non-financial performance indicators such as resource efficiency, environmental footprint, circularity index, and stakeholder engagement levels. Moreover, collaboration with stakeholders – including governments, NGOs, consumers, and financial institutions – becomes a strategic imperative rather than an optional consideration. Financial institutions, in turn, are also adapting their frameworks, increasingly relying on ESG risk assessments, sustainability-linked credit terms, and green investment portfolios when evaluating innovation-active firms. These changes demand that enterprises reconfigure their risk management systems to incorporate scenario planning, systems thinking, and forward-looking risk modeling. From an operational perspective, innovation-active enterprises must also embrace modular design, dematerialization, and reverse logistics as standard practices to reduce ecological impact and improve cost efficiency. In this context, digital tools such as digital twins, AI-driven predictive analytics, and blockchain-enabled traceability are no longer optional innovations but critical enablers of transparency, traceability, and circular value chains. Furthermore, to maintain financial resilience, these enterprises must diversify funding sources by tapping into public-private partnerships, crowdfunding, green bonds, and international sustainability funds. Education and organizational culture also play an essential role: cultivating an innovation mindset, empowering cross-functional teams, and embedding circular thinking across all departments can significantly enhance adaptability and responsiveness. Finally, innovation-active enterprises must proactively engage in policy dialogue and standard-setting processes to ensure that regulatory frameworks evolve in ways that support rather than hinder circular business models. The ability to co-create regulatory norms with policymakers, based on real-time business experience, gives these enterprises a strategic voice and influence in shaping the future economic landscape. In summary, the evolution of innovation-active enterprises within the circular economy paradigm is not merely a technological shift, but a fundamental transformation of financial logic, operational structure, stakeholder relations, and value creation philosophy. Those enterprises that can internalize these multidimensional changes will not only mitigate emerging risks but also secure long-term competitive advantages in a global economy increasingly defined by sustainability, digitalization, and interdependence.

Let us analyze the activities of three innovation-active enterprises in Ukraine: PromEcoInvest, TechnoResource, and Bio-intech Group.

Analyzing the dynamics of innovation activity from 2020 to 2024 based on the share of revenue allocated to innovation, Biointech Group consistently demonstrates the highest proportion of innovation investments, increasing from 18% to 25%. PromEcoInvest shows gradual growth from 12% to 18%, while TechnoResource has the lowest but positive trend, rising from 8% to 12%.

I will develop a financial risk management model for the enterprises under study to achieve financial resilience within the circular economy context. The overall structure of the model will be presented as a function of (1):

$$FRA_i = \beta_0 + \beta_1 CE_i + \beta_2 IN_i + \beta_3 ESG_i + \beta_4 DS_i + \beta_5 RS_i + \varepsilon_i \quad (1)$$

where: FRA_i – efficiency of financial risk management at enterprise i (Risk Management Efficiency Index); CE_i – degree of compliance with circular economy principles (Circularity Index); IN_i – level of enterprise innovativeness (R&D to revenue ratio, share of green innovations); ESG_i – integration of ESG approaches into financial policy; DS_i – digital maturity in financial management (Digital Maturity Level); RS_i – structure of financing sources and their sustainability level (Reliance on Sustainable Finance); β_0 – β_5 – impact coefficients; ε_i – model error term.

The main indicators and parameters of model (1) are presented in Table 1, and the Index values for building the financial risk management model to achieve financial resilience of Ukrainian innovation-active enterprises in the context of the circular economy are presented in Table 2.

Table 1. Parameters for the financial risk management model to achieve financial resilience of innovation-active enterprises in the circular economy context.

Component	Description	Example of an indicator
CE_i	Implementation of CE principles (repair, reuse, energy efficiency)	Circular Product Design Rate, Resource Recovery Ratio
IN_i	Share of greening-oriented innovations	% R&D investment in green technologies
ESG_i	ESG integration into financial reporting and risk management	ESG score, presence of green policy
DS_i	Level of digital tools in risk management	Use of ERP, BI, Big Data, AI
RS_i	Share of green financing, credit risk resilience	Green bonds share, debt sustainability ratio

Table 2. Index values for building the financial risk management model to achieve financial resilience of Ukrainian innovation-active enterprises in the context of the circular economy. (Source: calculated based on State Enterprise Engineering Center "TECHNO-RESURS", 2024; Limited Liability Company "PROMEKOINVEST", 2024; Limited Liability Company "BIOTEC GROUP", 2024)

Enterprise	Circularity Index (CE)	R&D Intensity (IN)	ESG Integration (ESG)	Digital Maturity (DS)	Sustainable Finance Share (RS)
PromEkoInvest	0.75	0.18	0.80	0.85	0.40
TechnoResurs	0.50	0.12	0.60	0.70	0.30
Biotech Group	0.85	0.25	0.90	0.90	0.55

Financial Risk Management (FRA) Efficiency Model for Enterprises from Table 2:

$$FRA_i = 0.5 + 0.4 \cdot CE_i + 0.3 \cdot IN_i + 0.2 \cdot ESG_i + 0.3 \cdot DS_i + 0.25 \cdot RS_i \quad (2)$$

The coefficients were developed based on expert judgments. FRA is interpreted as the Risk Management Efficiency Index.

Calculation of FRA for each enterprise:

- **FRA (PromEkoInvest)** = $0.5 + (0.4 \cdot 0.75) + (0.3 \cdot 0.18) + (0.2 \cdot 0.80) + (0.3 \cdot 0.85) + (0.25 \cdot 0.40) = 1.369$
- **FRA (TechnoResurs)** = $0.5 + (0.4 \cdot 0.50) + (0.3 \cdot 0.12) + (0.2 \cdot 0.60) + (0.3 \cdot 0.70) + (0.25 \cdot 0.30) = 1.141$
- **FRA (Biotech Group)** = $0.5 + (0.4 \cdot 0.85) + (0.3 \cdot 0.25) + (0.2 \cdot 0.90) + (0.3 \cdot 0.90) + (0.25 \cdot 0.55) = 1.503$

The results of the financial risk management calculations are presented in Table 3.

Table 3. Summary of financial risk management calculations for Ukrainian innovation-active enterprises. (Source: calculated based on State Enterprise Engineering Center "TECHNO-RESURS", 2024; Limited Liability Company "PROMEKOINVEST", 2024; Limited Liability Company "BIOTEC GROUP", 2024)

Enterprise	FRA (Risk Management Index)	Management effectiveness rating
PromEkoInvest	1.369	High
TechnoResurs	1.141	Average
Biotech Group	1.503	Very high

Biotech Group demonstrates the highest efficiency in financial risk management due to its strong innovativeness, digital maturity, and deep ESG integration. PromEkoInvest possesses good circularity and a digital foundation, enabling it to achieve an above-average FRA. TechnoResource has potential, but weaker positions in ESG and R&D reduce its overall index.

A comparative sensitivity analysis of the Financial Risk Management Efficiency Index (FRA) in response to changes in the Circularity Index (CE) was conducted for the enterprises PromEcoInvest, TechnoResource, and Biotech Group.

For modeling purposes, other parameters remain constant: innovativeness (IN), ESG integration (ESG), digital maturity (DS), and reliance on sustainable finance (RS). Calculations were performed based on model (1).

The Circularity Index was varied within the range of 0.4 to 1.0 in increments of 0.03.

Biotech Group exhibits the highest FRA values at any CE level, explained by high scores in innovativeness (0.25), ESG integration (0.90), digital maturity (0.90), and sustainable financing (0.55).

At CE = 0.4: FRA $\approx$ 1.40

At CE = 1.0: FRA $\approx$ 1.64

This indicates high efficiency in risk management under circular economy conditions.

PromEcoInvest's FRA ranges from 1.17 to 1.45, depending on CE. Although the enterprise's baseline parameters are moderate, a stable increase in efficiency is observed with the adoption of circular approaches.

TechnoResource, despite the lowest FRA values (from 1.00 to 1.25), shows positive dynamics with increasing CE. This suggests that even enterprises with lower baseline characteristics can substantially benefit from implementing circular practices.

DISCUSSION

The research results confirm that the financial resilience of innovation-active enterprises in the new economic environment largely depends on their ability to adapt to the transformational challenges of the circular economy. The developed multiparametric financial risk management model enabled a quantitative assessment of enterprises' adaptability to risks (FRA) based on the integration of factors such as the level of circularity, innovation potential, ESG integration, digital maturity, and the share of sustainable financing.

Compared to traditional risk management approaches focused on loss minimization through cost reduction or portfolio diversification, the proposed model emphasizes the role of proactive management, which involves the strategic incorporation of circular and innovative approaches. This aligns with recent studies highlighting the necessity of ESG transformation as a foundation for building financial flexibility and competitiveness (Schaltegger et al., 2022; Geissdoerfer et al., 2020).

The relationship between innovation activity and FRA levels proved uneven among the enterprises studied. For example, Biotech Group demonstrated the highest FRA values due to a harmonious combination of innovative solutions, ESG compliance, and digital practices. Meanwhile, TechnoResource, despite an adequate level of technological development, lags behind due to limited access to green financing and a lack of flexible management structures.

These findings underscore the importance of a holistic approach to risk management, where each model parameter either strengthens or weakens the overall adaptation level. In this context, the circular economy serves not only as a tool for ecological modernization but also shapes a new financial paradigm, where long-term sustainability, investment in innovation, flexibility, and systemic thinking become key.

At the same time, the results indicate the presence of several barriers and risks that hinder the effective implementation of circular transformation. These include a fragmented regulatory framework, limited access to green financing, and insufficient competencies in financial analytics and risk management within the circular economy context. Therefore, further research should focus on the institutional support for implementing the proposed model as well as the development of sectoral and regional adaptation strategies.

CONCLUSIONS

The results of the study establish that the circular economy imposes new requirements on the financial resilience of enterprises, necessitating a reconsideration of approaches to financial risk management, especially in the sector of innovation-active companies. The shift from a linear to a circular economic model requires enterprises not only to implement resource-saving technologies but also to change their financial planning and risk management strategies.

The multiparametric financial risk management model proposed in this study enables a comprehensive consideration of the influence of key factors: the level of circularity (Circularity Index), innovativeness, digital maturity, ESG integration,

and the volume of green financing attracted. It serves as a universal tool for assessing the Financial Risk Adaptability Index (FRA) under conditions of circular transformation.

The model's validation on the example of three innovation-active Ukrainian enterprises – PromEkoInvest, TechnoResurs, and Biointech Group – demonstrated that the highest FRA values are shown by companies with systematically implemented circular and ESG approaches, high digital integration, and stable innovation development. Meanwhile, enterprises with weak internal infrastructure and fragmented implementation of circular strategies have limited capabilities to achieve resilience against financial risks.

Thus, to ensure financial resilience in the context of the circular economy, innovation-active enterprises need to develop internal support infrastructure for innovation and circular practices, enhance the level of digital transformation in management and financial processes, implement FRA assessment tools as an element of strategic risk management systems, and strengthen the interconnection between environmental, social, and economic performance.

The proposed model can serve as a foundation for shaping adaptive financial strategies aimed at enhancing enterprise resilience amid increasing risks related to transformational processes and global sustainable development challenges. It is in this that we see the prospects for further scientific research.

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CONFLICT OF INTEREST

The Author declares that there is no conflict of interest.

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УПРАВЛІННЯ ФІНАНСОВОЮ СТІЙКІСТЮ ТА ФІНАНСОВИМИ РИЗИКАМИ ІННОВАЦІЙНО-АКТИВНИХ ПІДПРИЄМСТВ В УМОВАХ ЦИРКУЛЯРНОЇ ЕКОНОМІКИ

У статті обґрунтовано теоретико-методичні засади управління фінансовою стійкістю та фінансовими ризиками інноваційно-активних підприємств в умовах переходу до циркулярної економіки. Обґрунтовано, що інноваційна активність значною мірою зумовлює специфічний профіль фінансових ризиків, які суттєво відрізняються від ризиків традиційних підприємств, і сформовано перелік цих ризиків. Визначено принципи управління фінансовою стійкістю та фінансовими ризиками інноваційно-активних підприємств в умовах циркулярної економіки. Проведений аналіз засвідчив, що в нових економічних умовах зростає роль інтеграції екологічних, соціальних та управлінських факторів (ESG), інноваційного потенціалу, цифрової зрілості залучення зеленого фінансування як складових механізму забезпечення фінансової стійкості підприємств.

На основі емпіричних даних трьох інноваційно-активних українських підприємств – PromEkoInvest, TechnoResurs та Biointech Group – побудовано багатопараметричну модель управління фінансовими ризиками. Модель урахує ключові змінні: рівень циркулярності (CE), інноваційність (IN), інтеграцію ESG-принципів, цифрову зрілість (DS) і частку фінансування зі сталих джерел (RS). Визначено узагальнений показник FRA (Financial Risk Adaptability), який дозволяє кількісно оцінювати здатність підприємства адаптуватися до ризиків у контексті циркулярної трансформації.

Результати моделювання показали, що найвищий рівень FRA має Biointech Group, що свідчить про ефективне поєднання інноваційності, ESG-інтеграції та циркулярних практик. Натомість TechnoResurs демонструє нижчі значення FRA через обмеженість внутрішніх ресурсів і меншу гнучкість управлінських стратегій. Це підтверджує важливість не лише впровадження елементів циркулярної економіки, а й комплексної модернізації управління.

Отож, для досягнення фінансової стійкості інноваційно-активним підприємствам необхідно впроваджувати цілісну модель управління фінансовими ризиками, яка інтегрує циркулярний підхід, інновації, цифровізацію та сталі фінансові практики. Запропонована модель може стати інструментом стратегічного управління та слугувати основою для ухвалення рішень у галузі фінансової політики підприємств, орієнтованих на сталий розвиток в умовах постіндустріальної трансформації економіки.

Ключові слова: інновації, інноваційно-активні підприємства, фінансова стійкість, фінансові ризики, фінансова стратегія, циркулярна економіка, управління підприємствами, інвестиційні ризики, «зелене» фінансування, фінансові інструменти

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