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MANAGEMENT OF INNOVATIVE INVESTMENT SECURITY OF AN ENTERPRISE IN CONDITIONS OF A DYNAMIC EXTERNAL ENVIRONMENT THROUGH THE EVALUATION OF EXISTING PROJECTS

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ABSTRACT

The purpose of the study is to build a practical toolkit for managing innovative investment security of an enterprise in conditions of a dynamic external environment through the assessment of its existing innovation projects. The object of the study is the process of managing an enterprise's innovative investment security, which includes the formation and implementation of five innovation and investment projects for a selected enterprise. A scenario-stochastic evaluation model is proposed, which combines Monte Carlo modeling, an autoregressive process for the turbulence index of the external environment, and geometric Brownian motion for cash flows from innovation projects. The key effective variable is the net present value, calculated taking into account the variable discount rate sensitive to the turbulence index. Portfolio risk is reflected through the probability of negative net present value, value at risk, and conditional value at risk. The initial data consists of five projects of one enterprise with different margins, revenue growth rates, volatility, and sensitivity to external shocks, under budget constraints. Within the baseline scenario with increased turbulence in the external environment, the expected values of the net present value turned out to be negative, which indicates a high price of uncertainty and the need to correct project parameters. A moderate scenario with softer dynamics improves the results, but does not ensure a stable excess of the zero threshold for the expected value of the net present value. The practical usefulness of the model lies in the ability to check the viability of the innovation portfolio, taking into account the variability and hyper-dynamics of the external environment, compare alternative project compositions, and form decision-making rules with risk restrictions in order to ensure an acceptable level of innovational-investment security at the enterprise.

Keywords: management of innovative-investment security of the enterprise, innovation projects, innovation portfolio, scenario-stochastic modeling, Monte Carlo modeling, autoregressive index of external environment dynamics

JEL Classification: C15, D81, E22, G32

INTRODUCTION

Today, in the conditions of a highly dynamic external environment, ensuring effective management of the enterprise's innovation and investment activities is of key importance, which in the long term can ensure the competitiveness and long-term development. It should be noted that it is the pace of change in the capital markets, technological development, the behaviour of consumer groups, and regulatory requirements that significantly exceeds the existing capabilities and framework of traditional planning. Based on this, innovations and investments should be considered as an integrated, managed system, and not as separate domains of enterprise activity. In our opinion, the central idea of the modern management paradigm should be focusing on ensuring security potential. At the same time, it can be argued that only such integration will allow maintaining an optimal level of one's economic security, opening up opportunities and prospects for technological progress and structural changes.

Modern technologies based on artificial intelligence fundamentally strengthen both the innovativeness and investment attractiveness of an enterprise. It should be noted that new systems based on artificial intelligence create a tangible increase in efficiency, reduce time lags in decision-making, and reduce information asymmetry between investors and management. In our opinion, it is data transparency, real-time hypothesis validation, and other capabilities of modern technologies that can significantly increase the reliability of investment capital, reduce the cost of financial expenses, and facilitate access to strategic partnerships. It can be argued that artificial intelligence is becoming not only an automation tool but also a driver for shaping new avenues to enhance internal economic security. We believe that in conditions where most innovations are based on or depend on artificial intelligence systems, an effective management system comes to the fore. Thus, the correctness of the management decisions depends not only on the return on investment but also on the overall level of security.

LITERATURE REVIEW

A review of the scientific and applied literature on the selected research issues demonstrates the convergence of three baseline areas. Specifically, this concerns the strategic design of innovation-investment decisions, the organizational and institutional mechanisms for their implementation, and the security-environmental conditionality of these decisions. It should be noted that the theoretical and methodological foundations for the formation of an investment and innovation security strategy determine the logic of selecting priorities, indicators, and financing instruments, as well as the place of innovation in creating long-term added value. A synthesis of approaches indicates that innovation is not an autonomous process, but the core of a corporate growth trajectory, where the choice of investment instruments, time horizons, and portfolio balance determines the ability of an enterprise to scale (Zoria & Serhienko, 2020; Audretsch, Coad, & Segarra, 2014). It can be argued that innovation increases competitiveness through productivity effects, differentiation, and speed of response to market signals, provided that processes and management structures are correctly organized (Pozniak, 2015; Popadynets & Skrypko, 2020). In our opinion, it is the strategic integration of innovations and investments into a single security system that allows an enterprise to accumulate security potential.

Research on the impact of state support to stimulate innovation activity demonstrates that financial incentives are the most effective in this context, and tax instruments and support programs increase, which ultimately aim to increase the intensity of innovation. At the same time, it should be noted that this effect largely depends on the targeting, stability of rules, and the level of compliance with the needs of the enterprise (Kokot-Stępień & Krawczyk, 2020). Considering the features of modern innovative projects, the effectiveness is determined by specific investments that form internal communications and relationships between participants. No less important aspects are the design of agreements, management mechanisms, and behavioral norms that minimize opportunism and transaction costs (Wu, Wang, & Chen, 2017). It should be noted that a number of scientists define the priority of forming optimization models of investment management in innovative enterprises. Thus, in their opinion, in conditions of resource limitations, these models will make it possible to achieve the desired performance indicators, forming project strategies indicating the stages of financing, monitoring of efficiency, and control points for making management decisions. (Ganushchak-Efimenko, Hnatenko, Kozhushko, Rębilas, Rubezhanska, & Krakhmalova, 2020). In this context, we argue that the rational combination of contemporary management methods, stimulating institutional influence, and high-quality corporate governance will lead to the formation of conditions under which investments will be transformed into innovative outcomes, thereby ensuring a high level of the enterprise's economic security.

The security dimension of innovation and investment decisions has taken a special place in modern research. Investment resources are considered a key factor in the economic safety of a company. At the same time, their attraction is interpreted as a process that requires financial engineering, reputational transparency, and integration with the principles of a circular economy. (Pohrebniak, Arefieva, Boiarynova, Arefiev, & Davydenko, 2021). The conceptualization of the economic security of an enterprise emphasizes the systematic nature of this category and its grounding in organizational, financial, informational, and personnel subsystems, which, in interaction, form the ability to withstand shocks and maintain target development parameters. (Avanesova & Chuprin, 2017). Research on sustainable resource management offers a framework in which investment and innovation are directed towards achieving environmental goals and social value, improving economic efficiency through technological solutions and new models of stakeholder engagement (Tytoniuk, Burkynskyi, & Andryeyeva, 2021).

Systematization of project-based, organizational, and network forms of innovation activity demonstrates that contemporary security models facilitate faster penetration of innovations, generate economies of interaction scale, and better synchronization with consumer needs (Popadynets & Skrypko, 2020). Therefore, this is consistent with the findings that enterprise growth and its innovative activity are mutually reinforcing, but not automatically guaranteed. This requires appropriate

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incentives, competencies, and project selection mechanisms (Audretsch et al., 2014). Nevertheless, substantial gaps remain that sustain the high scientific and practical relevance of the topic. In this context, there is a lack of coordinated approaches to the study of the enterprise innovation and investment security management system, replacing the fragmented approach, which considers either investment security or innovation security separately.

AIMS AND OBJECTIVES

The purpose of the study is to build a practical toolkit for managing the enterprise's innovation-investment security in the context of a dynamic external environment, based on the assessment of its existing innovation projects. The object of the study is the process of managing the enterprise's innovation-investment security, which includes the formation and implementation of five innovation and investment projects for the selected enterprise. The main task of the study to achieve the set goal is to assess the effectiveness of innovation and investment security management through five selected innovation projects, their evaluation through a scenario-stochastic model.

METHODS

In the course of the study, we used our modernized vision of scenario-stochastic modeling of a portfolio of innovative projects with the search for the "best" portfolio composition based on the expected net present value, taking into account risk (Ali, et.al., 2022). The method combines Monte Carlo modeling for project cash flows, a first-order autoregressive process for the environmental dynamism index, and the determination of risk constraints due to value at risk and conditional value at risk. This allows us to reproduce how environmental changes affect both revenue and the discount rate simultaneously. The environmental dynamism index is modeled as an autoregressive process (1):

$$I_t=\mu+\varphi(I_{t-1}-\mu)+\varepsilon_t,\ \varepsilon t\sim N(0,\sigma_I^2) \quad (1)$$

The cash flows of an innovative project i in year t depend on the base revenue, growth trend, random volatility, and the influence of an external index (2):

$$R_{i,t}=R_{i,1}(1+g_i)^{t-1}\cdot\exp(\sigma_i Z_{i,t}-1/2\sigma_i^2)\cdot\exp(-\beta_i I_t) \quad (2)$$

where $Z_{i,t}\sim N(0,1)$ σ_i – annual revenue volatility, β_i – index sensitivity.

Free cash flow as a share of marginal income (3):

$$FCF_{i,t}=m_i\cdot R_{i,t} \quad (3)$$

The discount rate changes along with the dynamism index (4):

$$r_t=r_0+\lambda I_t,\ r_t\in[\bar{r},\bar{r}] \quad (4)$$

where λ – sensitivity of the rate to the index, and the limits prevent unrealistic values.

Net present value of the project (5):

$$NPV_i=-I_i+\sum_{t=1}^{T}\frac{FCFi,t}{\prod_{T=1}^{t}(1+rt)} \quad (5)$$

Thus, we used scenario-stochastic modeling, Monte Carlo modeling, autoregressive indices of environmental dynamism, dynamic discount rate, and risk measures such as value at risk and conditional value at risk in combination with portfolio optimization. The reason for choosing these methods is that they simultaneously reproduce demand uncertainty, variability of the cost of capital, and loss tails, transferring them into manageable performance and safety indicators. It should be noted that such a technique allows not only to calculate the expected net present value, but also to manage the safety potential through explicit threshold rules.

RESULTS

Therefore, we believe that modern management of innovation and investment security of an enterprise is a systemic coordination of a portfolio of innovation projects (selection, financing, stages, diversification, flexible allocation of resources) under measurable risk limits and target profitability, ensuring the stability of cash flows and the preservation of external potential. The innovation and investment security of an enterprise is best demonstrated through innovation projects, because it is in them that technological novelty, the need for capital, time lags in monetization, and the risks of a dynamic external environment intersect. Thus, in the context of our study, we consider a number of innovation projects that the enterprise is implementing in order to properly assess the effectiveness of innovation and investment security management. Therefore, we have chosen the HarvEas enterprise. This is a Ukrainian company that manages the agricultural assets of the State Enterprise "Ilyich-Agro Donbas", LLC "Agro-Holding MS", as well as the enterprises «Harvest Trading», «Harvest Assets». It should be noted that the consistent increase in investments over two years indicates the preservation of the financial capacity to support the innovation portfolio, which directly strengthens the innovation and investment security of the enterprise (Figure 1).

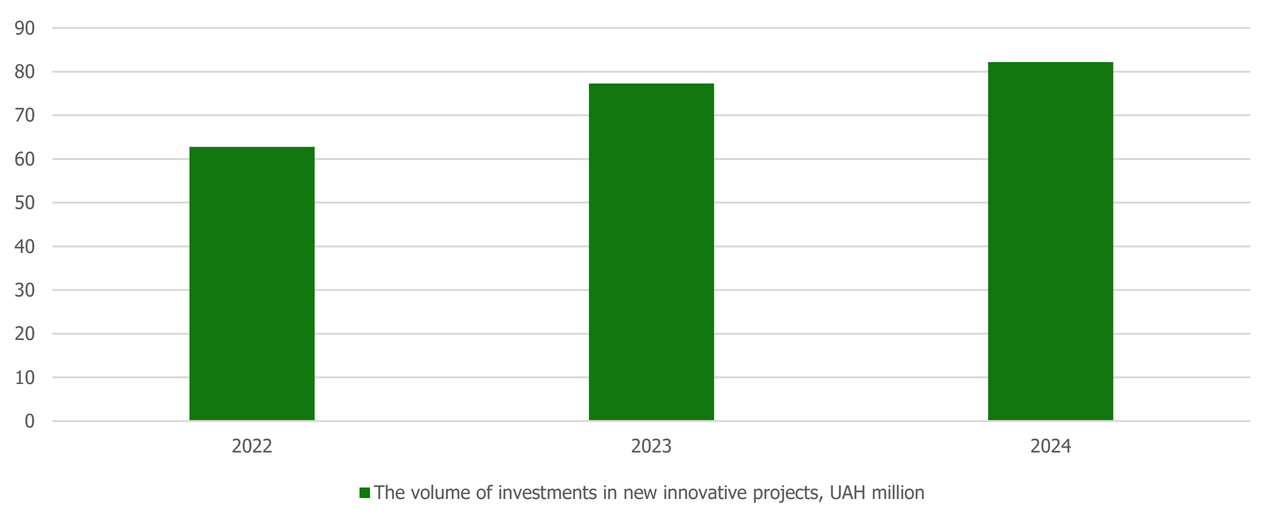

Figure 1. Total investment volumes in innovation development at the enterprise selected for modeling for 2022-2024 (HarvEas enterprise).

In our study, we consider one company (HarvEast), which is simultaneously promoting five innovative projects with different risk and value creation profiles, so for the sake of transparency, we will provide them with their own names and immediately record the correspondence to the letters used in the modeling:

1. "TitanLine" (A) is a robotic production line for deep modernization of the core process with the largest initial investment and a high break-even barrier, which makes it the least flexible to deterioration in external conditions.
2. "MarketPulse" (B) is a digital platform for monetizing customer flows and data with increased marginality and higher growth rates, but also greater volatility and sensitivity to market fluctuations.
3. "EcoTerm" (C) is a module for increasing the energy efficiency of technological nodes with moderate revenue growth rates, more stable dynamics, and lower sensitivity to external shocks.
4. "Quantamate" (D) - a pilot line of new composite materials for high-precision applications with moderate capital intensity and medium risk profile.
5. "AgroSense" (E) - a lightweight investment and analytical sensor kit for quickly installed agricultural producers, has the lowest capital intensity and acts as a "protective" element of the portfolio.

It should be noted that in the framework of the modeling, we assigned these names, abbreviated letter markers A, B, C, D, E, solely to simplify calculations, comparisons, and visualizations. Thus, we will select the initial data for conducting the modeling for each of the innovative projects (Table 1).

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Table 1. Initial data on innovative projects for assessing the effectiveness of management of investment and innovation security of the enterprise (HarvEast).

Project	Initial investment (Millions)	Base revenue year 1 (Millions)	Average annual revenue growth	Gross margin income	Annual revenue volatility
A	6	2.1	0.12	0.28	0.25
B	4	1.4	0.18	0.35	0.35
C	3	1.6	0.1	0.32	0.22
D	5	1.9	0.15	0.3	0.3
E	2	1.1	0.08	0.27	0.18

Next, 20 representative trajectories generated by a first-order autoregressive process with moderate autocorrelation and random disturbances are shown using the corresponding program. Figure 2 is obtained by simulating the index of external environment dynamism as a first-order autoregressive process (AR(1)) using formula (1). The trajectories show fluctuations around the zero level with periods of both positive and negative deviations. Consequently, this means that the discount rate and cash receipts of index-dependent projects will react synchronously to external shocks. In years with higher index values, we expect an increase in the discount rate and a decrease in revenue efficiency, and vice versa.

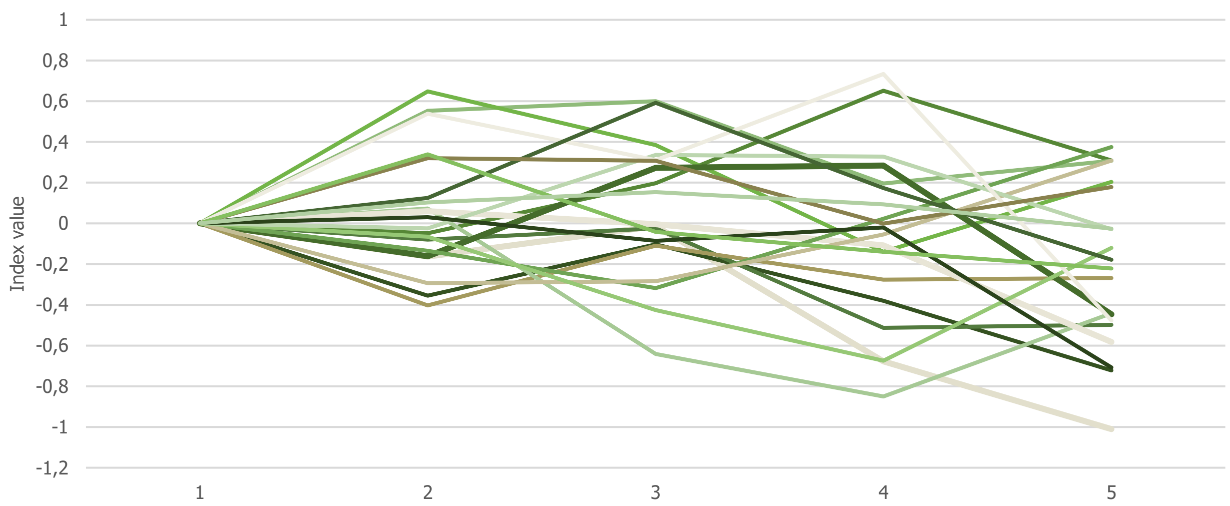

Figure 2. Example trajectories of the external dynamism index for 5 years about projects of HarvEast.

Next, we will demonstrate how individual projects behave in conditions of increased turbulence of the external environment. The baseline scenario is chosen as the main support for further modeling, since it sets a realistic «reference line» for comparing alternatives and forming manageable risk limits. Consequently, the expected net present value is negative for all objects, which signals the need to adjust the parameters of profitability or risk. The standard deviation characterizes the variability of the result, and the probability of a negative net present value shows the share of scenarios with a loss (Table 2).

Table 2. Results of modeling for innovative projects in the HarvEast under baseline scenarios for increasing the dynamism of changes in the external environment.

Project	Expected net present value (millions)	Standard deviation (millions)	Probability of negative net present value	Value at risk 5 percent (millions)	Notional value at risk 5 percent (millions)	Initial investment (millions)
C	-0.733	0.442	0.9362	-1.367	-1.487	3
E	-0.74	0.206	0.9975	-1.043	-1.103	2
B	-1.327	0.977	0.9091	-2.544	-2.718	4
D	-2.145	0.844	0.9812	-3.244	-3.416	5
A	-3.241	0.701	0.9991	-4.197	-4.350	6

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Then, all portfolio combinations of five projects, which are invested in a budget of UAH 20 million, were generated using software. In each scenario, the discounted sum of cash flows summed up by projects forms the portfolio net present value, after which its mathematical expectation was calculated for each portfolio. Consequently, in the base scenario of a more turbulent environment, all combinations have a negative expected net present value. The points in the upper-left part of the plane are relatively better (lower risk and less negative expected value). Here, single-element {C} and {E} stand out. Adding additional projects usually shifts the points to the right (risk increases) and down (expected value worsens), which signals the dominance of negative impacts of the index and the increased discount rate (Figure 3).

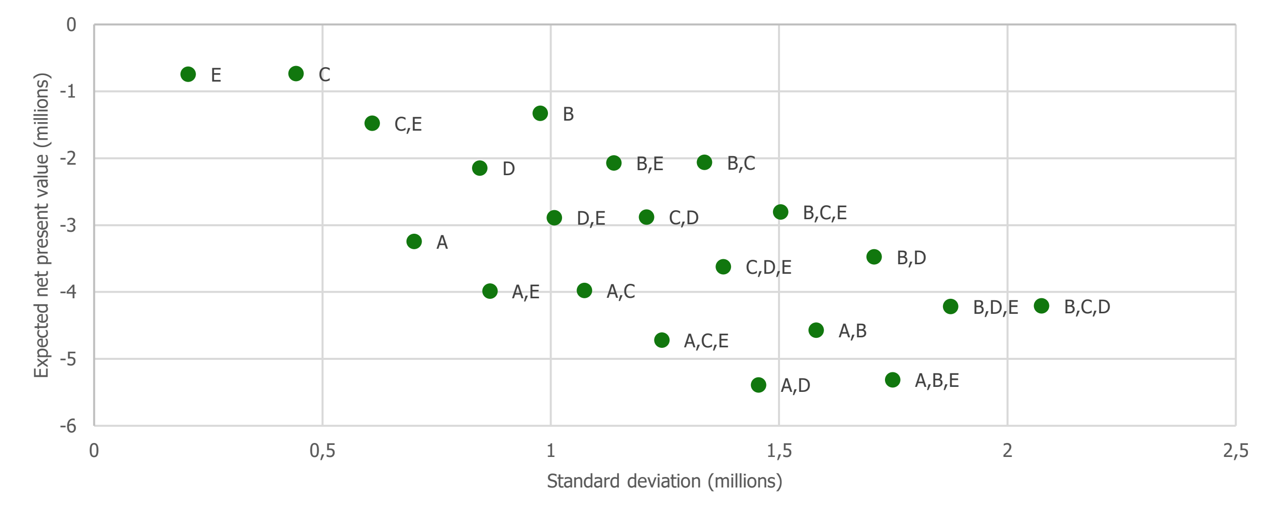

Figure 3. Portfolio efficiency: expected net present value vs risk (base) for each project in the HarvEast.

Next, we present the calculated results of portfolio combinations for the baseline scenarios that we set as indicative for modeling. The rating is based on the sum of the expected values of individual projects, so the single-element portfolios {C} and {E} are in the lead, despite the negative expected result. For the innovation and investment security management system, it is important to look not only at the expected value, but also at-risk indicators, in particular, the conditional value at risk, which provides information on the amount of possible losses in the remainder of the distribution (Table 3).

Table 3. Portfolio combination results (base scenario) for each project in the in the HarvEast.

Portfolio composition	Total investment (millions)	Expected net present value (millions)
{C}	3	-0.733
{E}	2	-0.741
{B}	4	-1.327
{C, E}	5	-1.473
{B, C}	7	-2.061
{B, E}	6	-2.067
{D}	5	-2.145
{B, C, E}	9	-2.811
{C, D}	8	-2.878
{D, E}	7	-2.885

Therefore, the innovative project C has become optimal according to the set risk limits (the maximum probability of a negative net present value and the minimum acceptable conditional value at risk) and, accordingly, is an actual candidate for implementation, whose loss tail and average value are most important to visualize for the management decision. Next, we present a histogram of the distribution of the net present value of the portfolio for the innovative project (C). The vertical lines show the average value and the five percent value at risk. For {C} in the baseline scenario, the average net present value is about (-0.7) million, and the five percent value at risk is approximately (-1.37) million. The probability of a negative result is approximately ninety-three percent, so the portfolio with a high probability will not overcome the zero threshold without improving the parameters (Figure 4).

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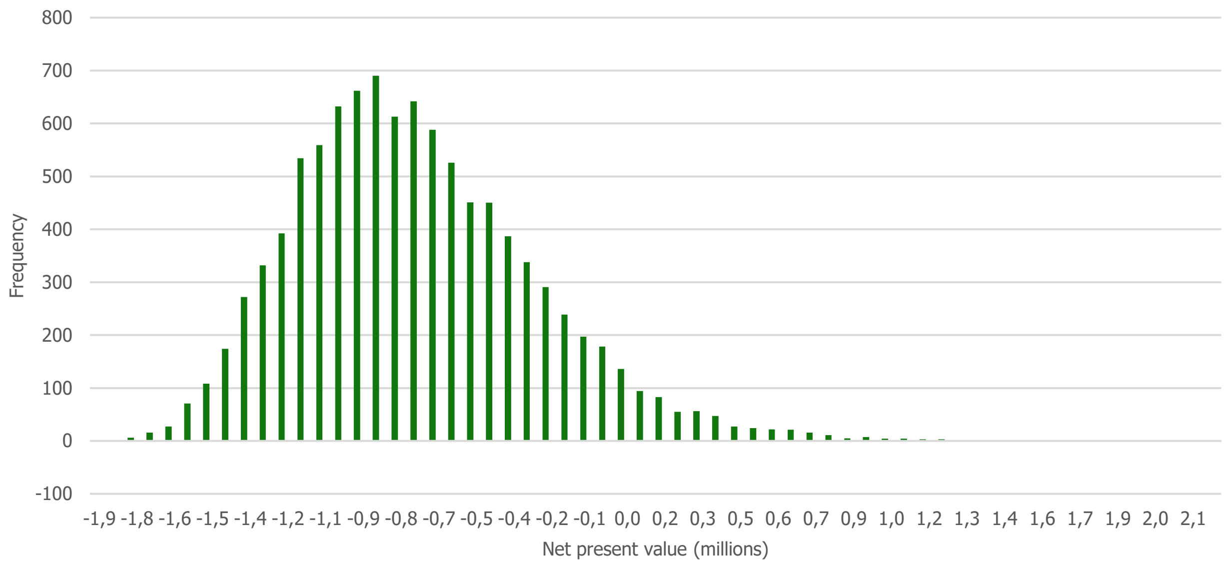

Figure 4. Distribution of optimal portfolio net present value {C} (base).

The next step will be to test the operability of the conclusions at the level of each project. In this context, it will be determined which initiatives will benefit more from mitigating the dynamism of the external environment, and therefore are the first candidates for scaling, and vice versa, requiring additional fuses or staging. Yes, we took moderate dynamism as the second reference scenario to test the operability of the innovation and investment security management system to improve external conditions and to separate the effects of systemic shocks from the parameters of the projects themselves.

We form it with the same calculation pipeline as for the baseline scenario, but with more moderate parameters of the external environment index and less sensitivity of the discount rate to this index, after which we separately calculate the expected net present value, standard deviation, and probability of negative value at risk for each of the five projects in a comparable format from Table 2. With moderate dynamism of the external environment, the expected values improve, but still remain below zero. The reduction in standard deviations and softening of the distribution tails imply lower sensitivity to negative shocks, but do not change the conclusion about the lack of attractiveness of the given parameters (Table 4).

Table 4. Results of modeling for innovative projects of the HarvEast with moderate dynamism.

Project	Expected net present value (millions)	Standard deviation (millions)	Probability of negative net present value	Value at risk 5 percent (millions)	Notional value at risk 5 percent (millions)	Initial Investment (Millions)
C	-0.659	0.301	0.9766	-1.118	-1.218	3
E	-0.692	0.139	1	-0.907	-0.954	2
B	-1.374	0.587	0.9769	-2.212	-2.362	4
D	-2.119	0.534	0.9985	-2.898	-3.034	5
A	-3.196	0.44	1	-3.851	-3.975	6

The next step is to form a similar diagram, but with moderate dynamism of the external environment. Compared to the baseline scenario, the points shift slightly upwards (expected values improve) and to the left (risk decreases). At the same time, the order of priorities is preserved: the best in terms of risk-expected value ratio are combinations that include project C, in particular, the single-element {C}. However, even under moderate conditions, the expected values are still below zero, which requires appropriate actions from the margin management system, investment schedule, and risk management in order to maintain an acceptable level (Figure 5).

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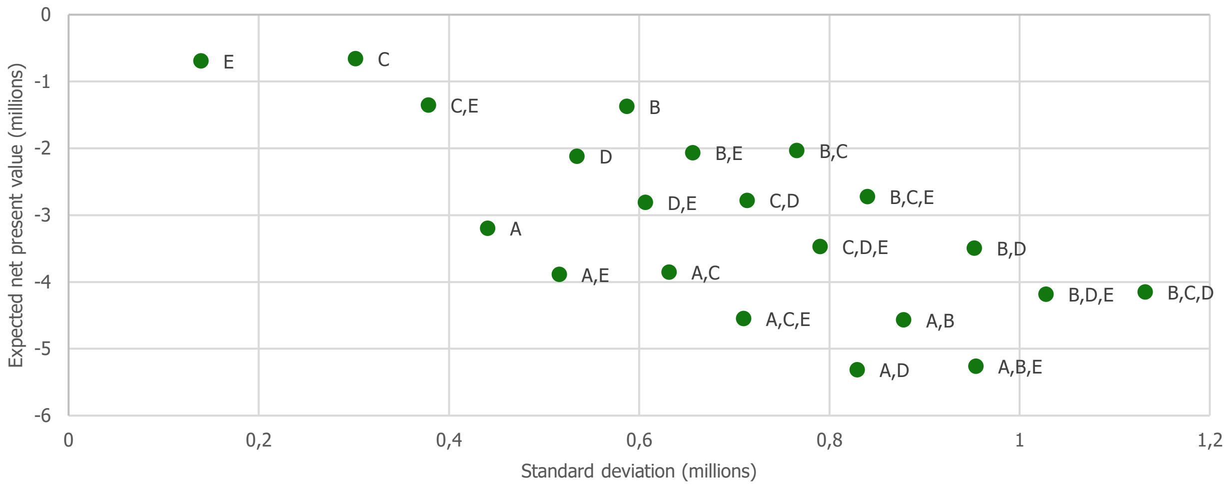

Figure 5. Portfolio efficiency for each project in the HarvEast (moderate dynamism).

We have gone through all subsets of five innovative projects that are invested in a total investment budget of twelve million monetary units. For each combination, a simulation for five years was already performed with moderate dynamism. Therefore, to show how improving external conditions changes the level of management efficiency between portfolios, which of them becomes relatively attractive, and which combinations correspond to the specified risk limits in a more favorable, but still realistic state of the environment. The order of combinations in terms of expected net present value hardly changes, but the relative advantages of pairs including project C increase due to lower sensitivity to the external index (Table 5).

Table 5. Portfolio combination results for each project in the HarvEast (moderate momentum).

Portfolio composition	Total investment (Millions)	Expected net present value (Millions)
{C}	3	-0.659
{E}	2	-0.692
{C, E}	5	-1.351
{B}	4	-1.374
{B, C}	7	-2.033
{B, E}	6	-2.066
{D}	5	-2.119
{B, C, E}	9	-2.725
{C, D}	8	-2.778
{D, E}	7	-2.811

From Table 5, we selected the optimal portfolio according to the rule of maximizing the expected net present value among combinations that satisfy the risk limits (the probability of a negative net present value is no higher than thirty percent, and the conditional value at risk at the level of five percent is no lower than minus two million monetary units). For this portfolio, we took into account all scenario values of the net present value with the modeling of moderate dynamism and constructed a histogram, additionally indicating the average value and the five-percent quantile (value at risk) with vertical lines. That is, similar to the baseline scenario (Figure 6).

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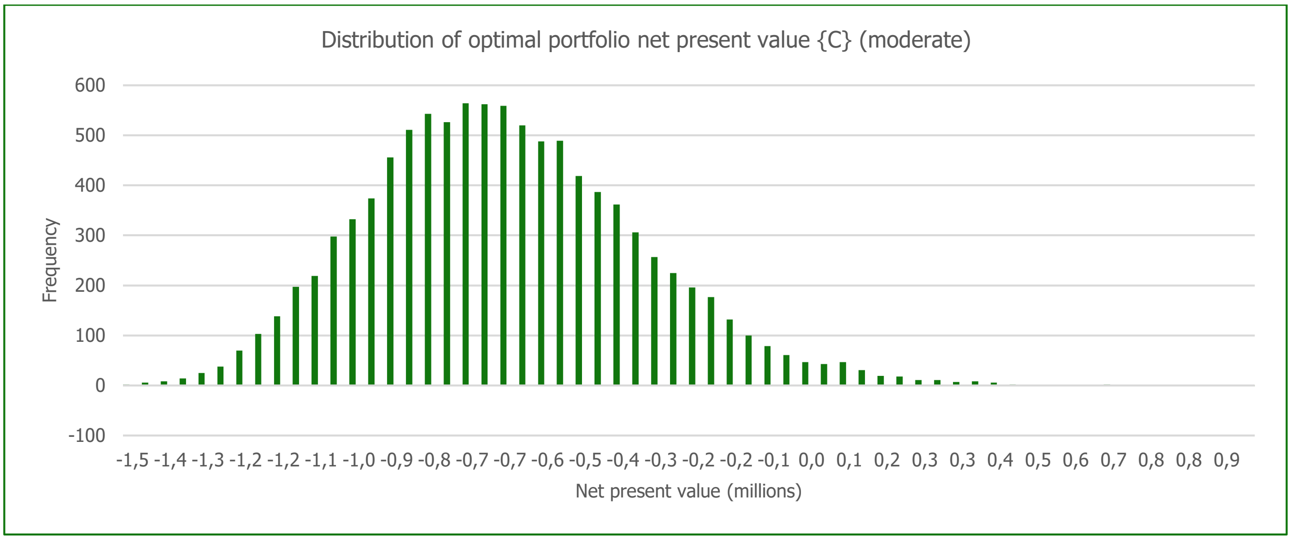

Figure 6. Distribution of optimal portfolio net present value {C} (moderate)

Now, for each of the five projects, we will list specific weaknesses, desired security development goals, a set of controllable parameters for change in both the model (to list risks and expected values) and operational practice, a list of management tools (phasing, real options, partnerships, insurance, contractual mechanisms), as well as direct risk limits and success criteria (Table 6).

Table 6. Action map for optimizing the innovation and investment security management system through project improvement for each project in the HarvEast in the next years.

Project	Current profile and vulnerabilities	The goal of security development	The goal of security development	Expected effect and success criteria	Priority, stages, and resources
EcoTerm (C)	Moderate marginality, relatively low volatility, and lower sensitivity to the external index. In the base case, the best risk-to-expected value ratio is achieved, but the average is still below zero.	Cross zero for expected net present value, while keeping the remaining losses within the set limits. Strengthen the role of the portfolio "anchor" in years of increased dynamism.	Increasing marginal income, optimizing costs, and extending the sales life cycle. In the context of the model, increasing the margin by 2-3 percentage points, reducing index sensitivity, and extending the monetization horizon by one year.	Increase in expected net present value to zero and above in the moderate scenario. Reduction of the notional value at risk by 20-30 percent. Stabilization of cash flows in the years of external shocks.	**Priority 1.** Launch immediately, as the project raises the portfolio level up
AgroSens (E)	Low capital intensity, defensive nature. More modest marginality and short sales cycles. Expected value is close to EcoTerm, but with a smaller range of income.	Make the project a shock absorber of portfolio risk, which provides a quick return even in years of increased dynamism. Increase marginality through service packages.	Packaging of services and subscriptions. Increasing the price due to analytics. Within the model, increasing the margin by 2 points, reducing volatility by 15 percent, and improving the collection speed.	Reduction of the remaining portfolio losses and formation of positive cash flow in the first two years. Growth of expected net present value at the portfolio level.	**Priority 2.** Rapid product iterations
MarketPulse (B)	High growth rates and marginality, but increased volatility and sensitivity to the external index. In the base case, the risk is "pulled" upward.	Transform from a "risk precursor" into "managed growth" through phasing and data. Reduce sensitivity to external shocks.	Managing product-market fit, gradually increasing the customer base. The model emphasizes investment limits by stages, reducing index sensitivity by 20 percent due to customer diversification, and reducing the cost of customer acquisition.	Mitigation of the impact of unsuccessful stages, reaching breakeven in the third year. Increase in expected net present value of the portfolio without excessive growth of risk.	**Priority 3.** Launch after stabilization of EcoTerm and AgroSense
QuantoMat (D)	Average capital intensity, technological risks of providing materials, and dependence on specific clients. Significant contribution to risk in case of unsuccessful tests.	Reduce technology risk and prolong high demand through certifications and developments with clients. Achieve positive expected net present value in a moderate scenario.	Increasing the margin due to premium segments, distributing investments into stages, and increasing the contract horizon. In the structure of the model, certification milestones are conditions for transition between stages, reducing volatility.	Transferring uncertainty from technological to contractual. Growth of expected net present value due to premium prices and longer contracts. Lower sensitivity to the external index.	**Priority 4.** Stage pilots
TitanLine (A)	High capital intensity and breakeven barrier. Sensitivity to the discount rate, risk of "big mistakes" in the base case.	Ensure flexibility through modularity, stretch capital expenditures over time, and tie scaling to market triggers. Minimize the impact of an increase in the discount rate.	Decomposition of investments into modules, linking launches to loading. For the model, the transfer of part of the investment to later years, the deferral option, and an increase in operational efficiency for the margin.	Reduction of capital pressure in the first years, mitigation of the impact of increased dynamism on the discount. Gradually reaching the target productivity.	**Priority 5.** Deployment only after demand is confirmed

Thus, in the baseline scenario of increased dynamism of the external environment, the expected net present value turned out to be negative for all five projects. The best, according to the specified risk limits (restriction on the probability of negative net present value and on the conditional value at risk), was the single-element portfolio "EcoTerm" (C). In the moderate scenario, the expected values improved, but the averages still did not cross zero. The value of the result is that the model quantitatively showed the places and scale of the necessary corrections, namely the establishment of direct risk limits that transform uncertainty into manageable rules for making decisions on maintaining the appropriate level of innovation and investment security.

DISCUSSION

By examining existing empirical and theoretical approaches to managing innovation and investment activities and enterprise security, at least two key provisions can be identified. First of all, innovations are inherently closely related to the dynamics of entrepreneurial growth; however, this relationship is not linear, but depends on the internal management architecture, including commercialization issues and the ability of the enterprise to scale effective innovations (Squicciarini, 2017). Secondly, the intensity of innovations in an enterprise is subject not only to the available resource provision but also to the conditions of the regional innovation ecosystem. In particular, this concerns the development of interaction networks, the availability of information resources, the quality of government agencies, and the effectiveness of government support policies. These parameters are most decisive for less developed regions (Lewandowska, Pater, & Cywiński, 2019).

From the standpoint of sectoral specificity, innovation exhibits distinct heterogeneity of effects. Data on Ukraine's industry show that growth in innovation activity indicators correlates with revenues from industrial sales, but the strength and stability of this relationship depend on the structure of subsectors, technological development, and the specificity of market niches (Ilyash, Dzhadan, & Ostasz, 2018). In our opinion, this explains why small and medium-sized enterprises demonstrate different trajectories. In sectors with shorter product launch cycles, innovations are monetized more rapidly, while capital-intensive sectors require different investment instrument profiles and longer payback horizons. Arguably, aggregated estimates of innovation activity without taking into account distinctive differences conceal critical decision-making modes.

A systematic review demonstrates that investing in digital platforms and knowledge management processes enhances financial innovation, reduces information asymmetry between investors and management, accelerates hypothesis testing cycles, and improves the quality of portfolio decisions (Garad, Riyadh, Al-Ansi et al., 2024). It should be emphasized that this logic is compatible with modern practices of implementing artificial intelligence-based technologies. When real-time analytics supports project selection and phased financing, the investment attractiveness and innovativeness of an enterprise increase due to better verification of effects and predictability of cash flows, which ultimately enables a high level of security.

The assessment of the investment climate in the context of security development underscores that it is the transparency of the regulatory framework, the stability of development policies, and the quality of the financing infrastructure that are decisive in the parameters of the cost of capital, the enterprise's propensity to risk, and the breadth of opportunities for innovative activity (Shaposhnykov & Okayanyuk, 2020). At the same time, existing practices in managing the innovative development of an enterprise demonstrate that organizational mechanisms exert a determining influence on most parameters (from the system of goals and performance indicators to cultural norms and innovation frameworks). This influence can either amplify or neutralize the influence of formal incentives (Dziura & Rojek, 2021).

Research of cases from different sectors of the economy makes it possible to refine the scope of generalized conclusions. Thus, innovative and investment development of security is determined precisely by the imperatives of security, resource rationality, and efficiency of integration with supply chains, wherein technological solutions must account for the specifics of operations and regulatory oversight (Selyutin, 2020). In certain areas of enterprise activity, innovations and investments must pass through a number of conditions and parameters. For example, in the construction sector, they must meet the conditions of project management, take into account the interaction of contractors, and ensure compliance with safety and consistency standards. This, in turn, changes the structure of risks and requirements for information support of the innovation and investment component (Mazur, 2022). It should be noted that it is in these sectors that investments in the information management system and the development of human resources (for example, hiring personnel with the best analytical competencies) will create the most tangible effect on security potential.

The determinants of innovation in regional innovation socio-economic systems point to the importance of a detailed and well-thought-out adjustment of support instruments for less developed regions. The focus in this context will be on network platforms, knowledge transfer, strengthening local interaction nodes, and improving the quality of interactions between universities and enterprises (Lewandowska et al., 2019). In combination with the dynamics of the external environment,

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this means that the same investment volumes generate different trajectories of innovative security development (Squicciarini, 2017).

CONCLUSIONS

The obtained results show that, given the technological and market parameters, the enterprise's portfolio of innovative projects is not attractive enough in a highly dynamic environment. Accordingly, this represents a direct threat to the level of innovation and investment security of the enterprise. The combination of a growing discount rate, volatile cash receipts, and a negative reaction of revenue to the turbulence index causes negative expected values of net present value, even for relatively secure projects.

The practical implications are the need to revise the parameters and architecture of the portfolio for the enterprise we have chosen for the study. We believe that it is necessary to increase marginality through product engineering and operational efficiency, distribute investments into stages with the right of deferment or exit (real options), extend the monetization horizon, reduce initial investments, attract partner funds, apply critical shock insurance, and implement dynamically. The proposed model enables transparent testing of such changes for investment decisions.

Further research should be devoted to a clear definition of the place of innovation and investment security in the general system of ensuring the economic security of an enterprise, including its interrelations with financial, production, personnel, information, and environmental components. It is necessary to determine to what extent new innovation projects are similar to those considered in this article and affect other components of the economic security of an enterprise in current conditions.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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The Authors declare that there is no conflict of interest.

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УПРАВЛІННЯ ІННОВАЦІЙНО-ІНВЕСТИЦІЙНОЮ БЕЗПЕКОЮ ПІДПРИЄМСТВА В УМОВАХ ДИНАМІЧНОСТІ ЗОВНІШНЬОГО СЕРЕДОВИЩА ЧЕРЕЗ ОЦІНЮВАННЯ НАЯВНИХ ПРОЄКТІВ

Метою дослідження є побудова практичного інструментарію для управління інноваційно-інвестиційною безпекою підприємства в умовах динамічності зовнішнього середовища через оцінювання його наявних інноваційних проєктів. Об'єктом дослідження є процес управління інноваційно-інвестиційною безпекою підприємства, що включає формування та реалізацію п'яти інноваційно-інвестиційних проєктів за обраним підприємством. Запропоновано сценарно-стохастичну модель оцінювання, яка поєднує моделювання Монте-Карло, авторегресійний процес для індексу турбулентності зовнішнього середовища та геометричний броунівський рух для грошових надходжень від інноваційних проєктів. Ключовою результативною змінною є чиста приведена вартість, обчислена з урахуванням змінної ставки дисконту, чутливої до індексу турбулентності. Ризик портфеля відображено через імовірність від'ємної чистої приведеної вартості, вартість під ризиком та умовну вартість під ризиком. Вихідні дані складаються з п'яти проєктів одного підприємства з різною маржинальністю, інтенсивністю зростання виручки, волатильністю та чутливістю до зовнішніх шоків за бюджетного обмеження. У межах базового сценарію з підвищеною турбулентністю зовнішнього середовища очікувані значення чистої приведеної вартості виявилися від'ємними, що свідчить про високу ціну невизначеності й потребу в корекції параметрів проєктів. Помірний сценарій із м'якшою динамічністю покращує результати, однак не забезпечує стійкого перевищення нульового порога для очікуваного значення чистої приведеної вартості. Практична користь моделі полягає в можливості перевіряти життєздатність портфеля інновацій з урахуванням мінливості та гіпердинамічності зовнішнього середовища, порівнювати альтернативні склади проєктів і формувати правила ухвалення рішень з обмеженнями ризику з метою забезпечення прийнятного рівня інноваційно-інвестиційної безпеки на підприємстві.

Ключові слова: управління інноваційно-інвестиційною безпекою підприємства, інноваційні проєкти, портфель інновацій, сценарно-стохастичне моделювання, моделювання Монте-Карло, авторегресійний індекс динамічності зовнішнього середовища

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