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THESIS

FORMATION OF THE RISK MANAGEMENT SYSTEM FOR MANUFACTURING ENTERPRISES

073 “Management”
07 “Management and administration”

Applying for a PhD degree

The thesis contains the results of the author’s own research.
Any use of ideas, research findings, or texts of other authors is appropriately cited and referenced to the relevant sources.

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ABSTRACT

Wang Yi. "Formation of the risk management system for manufacturing enterprises".

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The thesis is devoted to the substantiation of theoretical provisions and the development of practical recommendations for the formation of an integrated risk management system capable of ensuring the resilience of manufacturing enterprises to the negative impacts of the macro- and microenvironment using modern digital technologies. Achieving the research goal is based on the analysis and systematization of the theoretical and methodological basis of risk management using such methods as comparison, generalization, cartographic, economic and mathematical modeling, statistical, descriptive statistics, matrix, etc., as well as on diagnosing the current state of risk-oriented management of enterprises in the sector.

The conducted retrospective study of scientific views allowed to identify transformational changes in approaches to determining the nature of risks and to substantiate the author's interpretation of risk management of manufacturing enterprises, which is a multi-level management system that includes the identification, assessment and monitoring of risks. The work proves that under current conditions, risk management cannot be limited only to minimizing negative consequences. Modern risk management should be aimed at identifying and using potential opportunities to strengthen competitive advantages and prevent the negative consequences of the occurrence of risk. Important in the study is a clear distinction between the categories of "risk" and "crisis", where the latter is identified as a consequence of the implementation of a set of threats under the conditions of ineffective management mechanisms. This approach allows to focus on the proactive function of risk management as a key tool for ensuring the viability of manufacturing enterprises and preventing crisis phenomena.

The work systematizes the stages of the risk management process, which made it possible to identify six interrelated stages, the integration of which into the activities of enterprises ensures the transition from reactive response to proactive prevention of destabilizing states. A review of the controversial provisions on the classification of assessment tools made it possible to substantiate the difference between qualitative and quantitative analysis. Thus, qualitative methods focus on identifying connections, sources and potential negative factors of risk events, while quantitative methods are based on mathematical calculations of the probability of their implementation. It was established that the choice of specific methods of influencing risks directly depends on the overall development strategy and industry specifics of the enterprise.

Particular attention is paid to the analysis and systematization of regulatory and legal support, the results of which substantiate the need to continue implementing international standards into domestic practice. This may be reflected in tax incentive mechanisms and the implementation of business continuity strategies.

The analytical part of the study is based on an assessment of the macroenvironment of the functioning of the industrial sector of Ukraine for the period 2014-2024. Using statistical analysis methods and calculations of coefficients of variation, standard deviation and moving average, significant structural imbalances were identified, the cause of which was COVID-19 and military actions in Ukraine. The data obtained indicate the instability of the macroenvironment and fluctuations in important macroeconomic indicators, which has negative consequences for the activities of Ukrainian manufacturing enterprises and necessitates the development of an appropriate risk management model, which will be oriented, among other things, to these dynamics.

In continuation of the study, an analysis of financial performance, calculation of financial stability, liquidity and profitability indicators for 5 manufacturing enterprises of Ukraine was carried out. A differentiated assessment of financial risks was also conducted using discriminant models of Altman, Springate, Tereshchenko, Taffler and Tishaw and calculation of the Beaver coefficient for the same enterprises. The results obtained also reflected fluctuations in financial indicators. The applied approach made

it possible to identify the relationship between the structure of the risk management system and the financial performance of the business entities selected for analysis. Based on the quantitative assessment of financial risks of a representative group of manufacturing enterprises, a direct relationship between the level of hierarchical risk management and indicators of financial resistance of business entities was proven.

Using modern digital analytical tools, a comparative analysis of search activity in Ukraine and the EU countries was carried out. The results confirmed the need to integrate the best European tools into the practice of domestic risk management, namely, the transformation of risk-oriented thinking among Ukrainian entrepreneurs from fragmented perception of terminology to the constant use of risk management methods.

The methodological apparatus of the work was supplemented by the development of an integral indicator of macroeconomic risk, which is based on indicators of gross domestic product, consumer price index and exchange rate. The feasibility of including these indicators was justified by the results of correlation and factor analysis, which were subsequently standardized by the z-score method. This allows us to differentiate the levels of external threats and their impact on the net profit of the enterprise. In combination with the calculated financial insolvency index, an author's matrix of macroeconomic and financial distress risks was proposed, which contains nine quadrants and determines the available risk management vectors depending on the ratio of external and internal risk factors.

In the development of the study, it is recommended to include in the system of the above-mentioned risks also other risks that are typical of manufacturing enterprises and are divided by external and internal characteristics. The proposed risks are differentiated by the levels of probability of occurrence and impact, which allowed developing measures to respond to them, which will significantly enhance the effectiveness and capacity of the risk management system of manufacturing enterprises. It is noted that the list of risks may have its own specifics depending on the industry and the specifics of the enterprise's activities.

The strategic directions and functional capabilities of digitalization of risk management systems were investigated, which allowed to substantiate the feasibility of implementing software products to intensify management processes and improve the quality and efficiency of management decisions. As a result of the analysis, recommendations were developed, which are differentiated by the scale and needs of enterprises. This ensures a high level of adaptability of the proposed toolkit to the specific requirements of Ukrainian manufacturing enterprises.

Particular attention is paid to the identification of specific risks of digital transformation and the development of ways to mitigate them. The need to include digital threats in the overall risk management system of the enterprise is proven, which allows for proactive monitoring of the likelihood of their occurrence and the formation of protective measures.

The final stage of the study was the justification of an integrated complex of organizational-economic and digital mechanisms. As a result, a model of functional allocation of responsibility for risk management was developed. This model takes into account the scale of enterprise activities and integrates modern software products into the overall management system. The proposed approach ensures the formation of a holistic risk management system capable of adapting to the challenges of digitalization, and also allows for the formation of a sustainable trajectory of development of manufacturing enterprises in the future.

The applied significance of the results obtained lies in the possibility of implementing scientific provisions, methodological approaches and practical recommendations in the activities of manufacturing enterprises. The purpose of these measures is to strengthen strategic stability and minimize the impact of negative factors of the external and internal environment of business entities. In particular, the developed macroeconomic risk assessment tool allows enterprises to optimize management decisions and ensure stable functioning in conditions of high market volatility. The implementation of the results of the dissertation research into the real sector of the economy is confirmed by relevant acts and certificates of implementation.

The thesis is an independently completed scientific work in which the author substantiates the conceptual principles of forming an integrated risk management system and proposes a set of organizational-economic and digital mechanisms for proactively responding to threats to the activities of manufacturing enterprises.

Keywords: risk, risk management, manufacturing enterprises, anti-crisis management, proactive management, insolvency risk, financial risk, production risk, logistics risk, macroeconomic risk, digitalization.

АНОТАЦІЯ

Ван Ї. “Формування системи ризик-менеджменту виробничих підприємств”.

Кваліфікаційна наукова праця на правах рукопису.

Дисертація на здобуття наукового ступеня доктора філософії за спеціальністю 073 “Менеджмент” (07 “Управління та адміністрування”). Національний університет біоресурсів і природокористування України, Київ, 2026.

Дисертацію присвячено обґрунтуванню теоретичних положень та розробці практичних рекомендацій щодо формування інтегрованої системи ризик-менеджменту, здатної забезпечити стійкість виробничих підприємств до негативних впливів макро-, мікросередовища з використанням сучасних цифрових технологій. Досягнення мети дослідження базується на аналізі та систематизації теоретико-методологічної бази управління ризиками за допомогою таких методів як порівняння, узагальнення, картографічний, економіко-математичного моделювання, статистичного, описової статистики, матричного тощо, а також на діагностуванні сучасного стану ризик-орієнтованого управління підприємств виробничої сфери.

Проведене дослідження ретроспективи наукових поглядів дозволило виявити трансформаційні зміни у підходах до визначення природи ризиків та обґрунтувати авторське трактування ризик-менеджменту виробничих підприємств, що є багаторівневою системою управління, яка охоплює

ідентифікацію, оцінювання та моніторинг ризиків. У роботі доведено, що в умовах сьогодення управління ризиками не може обмежуватися лише мінімізацією негативних наслідків. Сучасний ризик-менеджмент має бути спрямованим на ідентифікацію та використання потенційних можливостей для зміцнення конкурентних переваг та упередження негативних наслідків настання ризику. Важливим в дослідженні є чітке розмежування категорій «ризик» та «криза», де останню ідентифіковано як наслідок реалізації сукупності загроз за умов неефективності управлінських механізмів. Такий підхід дозволяє акцентувати увагу на проактивній функції ризик-менеджменту як ключового інструменту забезпечення життєздатності виробничих підприємств та попередження кризових явищ.

У роботі систематизовано етапи процесу управління ризиками, що дало змогу виокремити шість взаємопов'язаних стадій, інтеграція яких у діяльність підприємств забезпечує перехід від реактивного реагування до проактивного недопущення дестабілізуючих станів. Перегляд дискусійних положень щодо класифікації інструментарію оцінювання дозволив обґрунтувати відмінність між якісним і кількісним аналізом. Так, якісні методи фокусуються на ідентифікації зв'язків, джерел та потенційного негативного фактору ризикових подій, а кількісні – базуються на математичних розрахунках ймовірності їхньої реалізації. При цьому встановлено, що вибір конкретних методів впливу на ризики безпосередньо залежить від загальної стратегії розвитку та галузевої специфіки підприємства.

Особливу увагу приділено аналізу та систематизації нормативно-правового забезпечення, за результатами чого обґрунтовано необхідність продовження імплементації міжнародних стандартів у вітчизняну практику. Це може відображатися у механізмах податкового стимулювання та впровадження стратегій безперервності бізнесу.

Аналітична частина дослідження базується на оцінюванні макросередовища функціонування промислового сектору України за період 2014-2024 роки. За допомогою методів статистичного аналізу та розрахунків

коефіцієнтів варіації, середнього квадратичного відхилення та ковзного середнього виявлено значні структурні диспропорції, причиною яких стали COVID-19 та воєнні дії на території країни. Отримані дані свідчать про нестабільність макросередовища та коливання важливих макроекономічних показників, що має негативні наслідки для діяльності виробничих підприємств України та обумовлює необхідність розробки відповідної моделі ризик-менеджменту, яка буде орієнтуватись в тому числі й на дану динаміку.

В продовження дослідження здійснено аналіз фінансових результатів діяльності, розрахунок показників фінансової стійкості, ліквідності та рентабельності по 5-х виробничих підприємствах України. А також проведено диференційоване оцінювання фінансових ризиків із застосуванням дискримінантних моделей Альтмана, Спрінгейта, Терещенко, Тафлера та Тішоу та розрахунку коефіцієнту Бівера по тих самих підприємствах. Отримані результати відобразили так само коливання фінансових показників. Застосований підхід дав змогу ідентифікувати зв'язок між структурою системи ризик-менеджменту та фінансовою результативність суб'єктів господарювання, обраних для аналізу. На основі кількісної оцінки фінансових ризиків репрезентативної групи виробничих підприємств доведено пряму залежність між рівнем ієрархічної побудови ризик-менеджменту та показниками фінансової резистентності суб'єктів господарювання.

За допомогою сучасних цифрових аналітичних інструментів здійснено порівняльний аналіз пошукової активності в Україні та країнах ЄС. Отримані результати підтвердили необхідність інтеграції кращого європейського інструментарію у практику вітчизняного ризик-менеджменту, а саме трансформації ризик-орієнтованого мислення у українських підприємців від фрагментарного сприйняття термінології до постійного використання методів управління ризиками.

Методичний апарат роботи доповнено розробкою інтегрального показника макроекономічного ризику, який базується на показниках внутрішнього валового продукту, індексу споживчих цін та курсі валют. Доцільність

включення даних показників було обґрунтовано результатами кореляційного та факторного аналізу й які в подальшому було стандартизовано методом z-score. Це дозволяє диференціювати рівні зовнішніх загроз та їх вплив на чистий прибуток підприємства. У поєднанні із розрахованим індексом фінансової неплатоспроможності запропоновано авторську матрицю макроекономічного та фінансового ризику, що містить дев’ять квадрантів та визначає наявні вектори ризик-менеджменту залежно від співвідношення зовнішніх та внутрішніх факторів ризику.

В розвиток дослідження рекомендовано включення до системи вищезазначених ризиків й інші ризики, які притаманні виробничим підприємствам та які поділено за зовнішньою та внутрішньою ознакою. Запропоновані ризики диференційовано за рівнями ймовірністю настання та впливу, що дозволило розробити заходи із реагування на них, які значно підсилять ефективність та спроможність системи ризик-менеджменту виробничих підприємств. Зауважено, що список ризиків може мати свою специфіку в залежності від галузі та специфіки роботи підприємства.

Досліджено стратегічні напрями та функціональні можливості цифровізації систем управління ризиками, що дозволило обґрунтувати доцільність імплементації програмних продуктів для інтенсифікації управлінських процесів та підвищення якості та ефективності управлінських рішень. В результаті проведеного аналізу розроблено рекомендації, які диференційовано за масштабом та потребами підприємств. Це забезпечує високий рівень адаптивності запропонованого інструментарію до специфічних вимог українських виробничих підприємств.

Особливу увагу в роботі приділено ідентифікації специфічних ризиків цифрової трансформації та розробленню шляхів їх нівелювання. Доведено необхідність включення цифрових загроз у загальну систему ризик-менеджменту підприємства, що дозволяє здійснювати проактивний моніторинг ймовірності їх виникнення та формувати засоби захисту.

Завершальним етапом дослідження стало обґрунтування інтегрованого комплексу організаційно-економічного та цифрового механізмів. В результаті розроблено модель функціонального розподілу відповідальності за управління ризиками. Дана модель враховує масштаби діяльності підприємств та інтегрує сучасні програмні продукти у загальну систему управління. Запропонований підхід забезпечує формування цілісної системи ризик-менеджменту, здатної адаптуватися до викликів цифровізації, а також дозволяє сформувати сталу траєкторію розвитку виробничих підприємств в майбутньому.

Прикладна значущість одержаних результатів полягає у можливості імплементації наукових положень, методичних підходів та практичних рекомендацій у діяльність виробничих підприємств. Метою даних заходів є зміцнення стратегічної стійкості та мінімізація впливу негативних чинників зовнішнього та внутрішнього середовища суб'єктів господарювання. Зокрема, розроблений інструментарій оцінювання макроекономічних ризиків дозволяє підприємствам оптимізувати управлінські рішення та забезпечити стабільність функціонування в умовах високої волатильності ринку. Впровадження результатів дисертаційного дослідження у реальний сектор економіки підтверджується відповідними актами та довідками про впровадження.

Дисертація є самостійно виконаною науковою працею, у якій автором обґрунтовано концептуальні засади формування інтеграційної системи ризик-менеджменту та запропоновано комплекс організаційно-економічного та цифрового механізмів проактивного реагування на загрози діяльності виробничих підприємств.

Ключові слова: ризик, ризик-менеджмент, виробничі підприємства, антикризовий менеджмент, проактивне управління, ризик неплатоспроможності, фінансовий ризик, виробничий ризик, логістичний ризик, макроекономічний ризик, цифровізація.

LIST OF PUBLISHED WORKS ON THE THESIS TOPIC

Articles in scientific publications included in the international scientometric databases Scopus and/or Web of Science Core Collection

1. Dielini M., Nesterova M., **Wang Yi.** Peculiarities of forming an enterprise risk management system in the context of modern transformations: the experience of European countries and Ukraine. *Baltic Journal of Economic Studies.* 2025. Vol. 11, №2, pp. 67-79. https://doi.org/10.30525/2256-0742/2025-11-2-67-79 *(Dielini M. carried out scientific and methodological support for the study, analyzed modern trends in risk management and the emergence of new risks, Nesterova M. investigated the features of the formation of the enterprise risk management system in the conditions of modern transformations in Ukraine, formed the introductory part, Wang Yi conducted a literature search, formed the concept of the study, determined the importance of transforming traditional risk management as reactive into proactive enterprise risk management (ERM), compared the results obtained in EU countries with Ukraine, formed conclusions).*

Articles in scientific publications included in the List of Scientific Professional Publications of Ukraine

1. Дєліні М.М., **Ван Ї**. Теоретичні засади формування системи ризик-менеджменту підприємств. *Інвестиції: практика та досвід.* 2024. №20. С. 40-46. DOI : https://doi.org/10.32702/2306-6814.2024.20.40 *(Delini M.M. carried out scientific and methodological support of the research, formulated interim and final conclusions. Wang Yi carried out an analysis of scientific sources and their generalization, formed a research concept, developed a phasing of the risk management process at the enterprise).*

2. **Ван Ї**, Дєліні М.М. Методи оцінки ризиків виробничих підприємств: методологічні підходи, особливості вибору та використання. *Науково-виробничий журнал "Бізнес-навігатор".* 2025. Випуск 6 (83). С. 343-349. https://doi.org/10.32782/business-navigator.83-56 *(Wang Yi developed a research plan, identified the main methodological approaches to risk assessment. Delini M.M.*

provided scientific and methodological support for the study, formulated general conclusions).

3. Ван Ї. Цифрові інструменти забезпечення ефективності ризик-менеджменту виробничих підприємств. *Цифрова економіка та економічна безпека.* 2025. №6 (21). С. 279-285. https://doi.org/10.32782/dees.21-41

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CONTENT

LIST OF SYMBOLS

WB	–	World Bank
GDP	–	Gross domestic product
ComCU	–	Commercial Code of Ukraine
DSTU	–	National standards of Ukraine
IPI	–	Industrial production index
IMS	–	Integrated management system
CPI	–	Consumer Price Index
PPI	–	Industrial Producer Price Index
LCU	–	Labor Code of Ukraine
CI	–	capital investments of enterprises
CII	–	capital investments of industrial enterprises
MAR		macroeconomic risk
CCU	–	Customs Code of Ukraine
SME	–	small and medium-sized businesses
NBU	–	National Bank of Ukraine
VIPS	–	volume of industrial products sold
TCU	–	Tax Code of Ukraine
CivCU	–	Civil Code of Ukraine
NP	–	net profit
BCMS	–	Business continuity management systems (ISO 22301:2019)
BCRM	–	Best's Credit Rating Methodology
COSO	–	Committee of Sponsoring Organizations of the Treadway Commission
CSDDD	–	Directive on corporate sustainability due diligence
ERM	–	Enterprise Risk Management
FCI	–	Financial Condition Indicator,
FDR	–	Financial Distress Risk
IEF	–	Index of Economic Freedom
ISO	–	International Organization for Standardization
LkSG	–	Lieferkettensorgfaltspflichtengesetz
LPI	–	Logistics Performance Index
RMP	–	Risk Management Program Rule

INTRODUCTION

Relevance of the topic. The current stage of development of the global economic system is characterized by a high level of uncertainty, due to increased geopolitical tension, technological transformations and global economic challenges. These trends are gaining strategic importance for Ukraine. In the presence of global instability, full-scale military aggression has caused significant destabilization of the country's socio-economic environment. Under these conditions, the formation of an effective risk management system at manufacturing enterprises becomes a necessary element of ensuring their viability and resilience to modern challenges. The functioning of manufacturing enterprises in a state of constant uncertainty requires the abandonment of existing risk management models in favor of proactive risk-oriented approaches capable of working in critical conditions.

The relevance of this study is enhanced by Ukraine's strategic course towards integration into the European Union. Adaptation of domestic management systems to EU standards involves the implementation of modern management principles, where risk management plays a central role. This directly correlates with the Sustainable Development Goals adopted by the UN, in particular, in the context of building sustainable infrastructure, ensuring economic resilience to environmental impacts and ensuring responsible production, which corresponds to goals 9, 8 and 12 respectively [108].

An important factor in the modernization of the risk management system is digitalization, which opens up new opportunities for manufacturing enterprises to mitigate threats, i.e. it becomes an alternative tool for optimizing costs and increasing the accuracy of management decisions in conditions of uncertainty and limited financial resources. The need to develop theoretical and applied principles for the formation of a risk management system that meets European development vectors determined the choice of the research topic.

The theoretical and methodological framework of the study is based on the scientific achievements of such Ukrainian scholars as Alekseieva K., Balanovska T., Butenko V., Vakulenko V., Volynets I., Gavryk O., Dedenko L., Dielini M., Dramaretska K., Dudneva Yu., Ostapchuk A., Kovtun O., Kucher A., Mekh K., Pogonchuk A., Polous O., Svinous I., Sosnovska O., Tereshchenko E., Tereshchenko O., Tyurina N., Reshetylo V., Fedotova Yu., Fedulova I., Shynkaruk L. Among foreign authors we can identify Altman E., Aquino Jr. P., Balaji S., Beaver W., Chen Z., Jalagat Jr. R., Kennedyd S., Mehmood W., Mitterbaur P., Mubeen M., Quoc Toan N., Pesendorfer J., Rahman M., Rotinsulu D., Saerang D., Schmidinger E., Shreshta L., Simota J.,Springate G., Steiner F., Sujatha K., Thi Khanh Van H., Tishow J., Tuffler R., Tupa J., Van Tuan L., Zehra B. The works of these scholars highlight the principles of management and sustainable development of manufacturing enterprises in combination with aspects of risk management, methodology for identifying threats and crisis management tools. The scientific achievements of these authors allowed to form a basis for assessing the probability of occurrence of risks in manufacturing enterprises.

Paying tribute to the scientific achievements of the mentioned scientists, it should be noted that the rapid transformation of the environment and the specifics of today's challenges require in-depth research into the mechanisms of forming a risk management system at manufacturing enterprises. This determined the relevance of the topic of the dissertation research, its goal and objectives.

The connection of work with scientific programs, plans, and topics. The dissertation research was carried out in accordance with the scientific research plan of the National University of Life and Environmental Sciences of Ukraine on the research topic “Transformation of public finances in the context of modern challenges” (state registration number 0124U002538). The research materials were used in the preparation of recommendations for assessing the macroeconomic risk of enterprises and the development of measures for managing the risks of manufacturing enterprises, in particular financial risks, based on this toolkit, which will contribute to increasing

the financial stability of enterprises and improving the risk management system of business entities.

Purpose and objectives of the study. The purpose of the thesis is to substantiate theoretical and methodological approaches to the formation of an integrated risk management system for manufacturing enterprises and to develop practical proposals for their implementation.

To achieve the stated purpose, the following objectives were formulated and accomplished:

- to systematize scientific approaches to risk management in order to clarify the essence and characteristics of the basic concepts;

- to propose a phased risk management process, as well as risk assessment methods for building an effective risk management system for a manufacturing enterprise;

- to analyze the regulatory framework for risk management, which will contribute to improving approaches to the formation of enterprise risk management;

- to assess the level of macroenvironmental risks in order to identify potential threats to manufacturing enterprises;

- to analyze the risks of the internal environment and risk management practices of a representative group of enterprises to determine approaches to assessing their viability in a risk environment;

- to conduct a comparative analysis of the specifics and current trends in the formation of enterprise risk management systems in Ukraine and the EU countries, which will allow determining current trends in the formation of risk-oriented thinking among specialists of manufacturing enterprises;

- to model an effective enterprise risk management system taking into account the assessment of external and internal factors;

- to propose a toolkit for assessing and selecting risk management methods for manufacturing enterprises to build an effective risk management system;

- to construct a model of the organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises in order to ensure the comprehensive resilience of the enterprise to negative environmental influences and create a basis for making proactive managerial decisions.

The object of the study is the process of developing directions for the formation of a risk management system for manufacturing enterprises.

The subject of the study is a set of theoretical and methodological foundtions, methodological tools, and practical aspects of forming a risk management system for manufacturing enterprises using modern digital technologies.

Research methods. The scientific research is based on a complex of interconnected general scientific and special methods, approaches and principles of scientific knowledge, which made it possible to analyze the state and prospects for further development of the formation of risk management at manufacturing enterprises. In particular, the following methods were widely used in the work: logical generalization and historical – to determine existing theoretical approaches to the study of risk management; logical-semantic, scientific abstraction and comparison – in the process of clarifying the conceptual and terminological apparatus of scientific research; system analysis – to consider risk management as a complex system consisting of interconnected elements; grouping and classification – in the process of dividing assessment methods into qualitative and quantitative and in the typology of risks by sources of origin; content analysis – in order to generalize and analyze the current legislation on ensuring risk management at manufacturing enterprises, as well as in the study of the results of inquiries from entrepreneurs in the EU countries; analogy and comparative analysis – for studying the risk macroenvironment of manufacturing enterprises; statistical and economic analysis, analysis of dynamic series – when assessing the current state of manufacturing enterprises in Ukraine and the dynamics of their financial indicators; analytical, generalization, cartographic – for visualizing the results of the study, in particular, when conducting a study of the main dynamics and trends in interest in the topic of risk among representatives of business and the

industrial sector of the economy in Ukraine and the EU countries; descriptive statistics – when assessing the volatility of the macroeconomic environment of Ukraine; economic and mathematical modeling – for calculating the macroeconomic risk indicator; matrix method – for constructing a nine-quadrant matrix of macroeconomic risk and internal integral financial distress risk; modeling – for constructing a model of the risk management system for manufacturing enterprises and an integrated complex of organizational-economic and digital mechanisms for forming the risk management system for manufacturing enterprises; statistical and graphical – when determining approaches to constructing tables, graphs, schemes and diagrams to ensure the solution of the general scientific tasks of the study.

The information base of the study is scientific works of leading Ukrainian and foreign scientists on the topic of the study, current legislative and regulatory legal acts of Ukraine, provisions of international standards DSTU ISO and other international legal acts and standards on ensuring risk management, materials of the State Statistics Service of Ukraine, reports of Ukrainian manufacturing enterprises that provide open information on their main activities, results of own research and calculations, and Internet resources.

The scientific novelty of the obtained results, which are submitted for defense, consists in the development of theoretical and methodological principles and practical recommendations for the formation of a risk management system for manufacturing enterprises. The most significant results of the research, which include scientific novelty, are:

first:

- a model of an integrated complex of organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises has been developed, which provides synergy between the functional distribution of responsibility (organizational component) and financial and economic monitoring and assessment of risk parameters of activity (economic component) with the implementation of specialized software (digital component);

improved:

- methodological tools for diagnosing risks in the macroenvironment of manufacturing enterprises through the comprehensive application of descriptive statistics indicators in risk assessment, which allows monitoring dynamics, identifying shock states to predict crisis situations and justifying the need to implement an adaptive risk management model at the enterprise;

- methodological approach to the formation of a conceptual risk management model, which, unlike existing ones, is based on the determination of the integral indicator of macroeconomic risk (MAR), enabling the differentiation of management strategies depending on the level of external threat (moderately acceptable, elevated, high);

- a toolkit for assessing and selecting risk management methods by developing a nine-quadrant matrix of macroeconomic risk (MAR) and internal integral indicator of financial distress risk (FDR), which allows for differentiating risk response methods according to the combination of external and internal determinants and provides the opportunity to promptly adjust the tactics of a manufacturing enterprise in a volatile environment;

further developed:

- conceptual and terminological apparatus of management theory by clarifying, based on the analysis of its main characteristics, the meaning of the concept of risk management in manufacturing enterprises as a comprehensive management system focused not only on minimizing losses, but also on using opportunities to gain competitive advantages;

- systematization of the process of functioning of the hierarchical model of building a risk management system at the enterprise through the definition of six consecutive stages for making optimal managerial decisions;

- streamlining the regulatory framework based on the implementation of proactive risk management systems by shifting the focus from state control to incentive mechanisms, in particular, providing investment tax credits for enterprises certified

according to ISO 22301 and ISO 31000, implementing industry business continuity strategies based on BCMS requirements and harmonizing Ukrainian legislation with international standards;

- an approach to assessing the viability of manufacturing enterprises in a risky environment through the prism of quantitative assessment of the degree of financial risks with the integrated use of discriminant models, which allows determining the connection between the level of stability of the enterprise's risk management system and the instability of the macroenvironment;

- a methodology for analyzing the interest of business and the industrial sector of the economy in risk research issues based on the use of content analysis and comparative monitoring of search activity in Ukraine and EU countries, which allows to substantiate the need for transforming approaches to risk management of manufacturing enterprises on proactive methods taking into account global practices.

Practical significance of the obtained results. The conceptual provisions, conclusions and practical recommendations formulated in the study will contribute to a deeper understanding of the current state of the risk management system formation in manufacturing enterprises. In particular, the results of the scientific research have been used by:

- Private enterprise “Polymet” (Dnipro) has adopted and implemented the proposed methodology for assessing macroeconomic risk and the financial distress risk, as well as the subsequent construction of a risk matrix, into operations of the enterprise, which will enhance the efficiency of risk management in terms of taking into account the real assessment of the probability of occurrence of both external and internal risks (Implementation Certificate No. 2026/3 dated January 12, 2026);

- The non-governmental organization “Community Unity - Prosperous Village” in preparing recommendations and consultations on supporting manufacturing enterprises in local communities, provided to enterprises of a manufacturing profile by the NGO in terms of identifying and assessing risks associated with their operations,

as well as recommendations on the formation of a risk management system for manufacturing enterprises of various levels (Implementation Certificate);

- National University of Life and Environmental Sciences of Ukraine, in the course of improving the scientific and methodological support and teaching of the academic discipline “Crisis Management” for students of the first (bachelor's) degree of higher education in specialty 281 “Public Management and Administration”, specifically regarding identification of risk management methods and strategies as preventive measures to prevent crises (Implementation Certificate).

Personal contribution of the applicant. The thesis is a completed, independently conducted scientific study, which presents the author's original theoretical and practical findings regarding the formation of a risk management system for manufacturing enterprises. The scientific results of the research were developed by the author personally. In scientific publications published in co-authorship, the applicant's contribution is indicated in the list of publications.

Approbation of the results of the thesis. The main theoretical conclusions, proposals and recommendations of the thesis research were presented at one international symposium and six international conferences, in particular at: International Symposium on International Development of Education, Technology and Management 2023 (California, USA, May 17-19, 2023); VII International Scientific and Practical Conference “Inclusive Development of the National Economy: Global Trends, Opportunities of Ukraine and the Role of the Agri-Food Sector” (Kyiv, November 16-17, 2023); VIII International Scientific and Practical Conference “Inclusive Development of the National Economy: Global Trends, Opportunities of Ukraine and the Role of the Agri-Food Sector, Experience and Cooperation with the EU” (Kyiv, October 23-24, 2024); I International Scientific and Practical Conference “Scientific Research: Combining Theory and Practice” (Berlin, Germany, October 14-16, 2024); IX International Scientific and Practical Conference of Higher Education Applicants, Postgraduate Students and Young Scientists “The Role of Youth in the Development of the Agro-Industrial Complex” (Kyiv, April 15-16, 2025); IX

International Scientific and Practical Conference “Inclusive Development of the National Economy: Global Trends, Opportunities of Ukraine and the Role of the Agri-Food Sector, Experience and Cooperation with the EU” (Kyiv, October 21-22, 2025); II International Scientific and Practical Conference “Development of Economic Systems in the Context of Globalization” (Kharkiv, November 20-22, 2025).

Publications. The main findings of the thesis research were published in 12 scientific works, including 1 article in a journal included in the international scientometric database Web of Science Core Collection, 4 articles in Ukrainian academic journals, and 7 abstracts of conference papers.

Structure and scope of the thesis. The total length of the thesis is 281 pages. The work consists of an abstract, an introduction, three chapters containing 9 subsections, conclusions, a bibliography of 254 references and 11 appendices. The work includes 41 tables, and 32 figures.

CHAPTER 1
THEORETICAL FOUNDATIONS OF FORMING A RISK MANAGEMENT SYSTEM IN MANUFACTURING ENTERPRISES

1.1. Evolution of scientific approaches to risk management, essence and characteristics of basic concepts

In today's realities, which dictate constant changes and unpredictable challenges that affect all spheres of life in Ukraine, strengthening resilience is critically important. This task is faced not only by enterprises, but also by state institutions, the public sector and all of civil society, which need to adapt quickly to challenges. The "black swans" of recent years – from the COVID-19 pandemic to a full-scale invasion – have demonstrated the importance of being prepared for sudden shocks. In other words, uncertainty forces us to instantly respond to challenges and adapt to conditions for which we were not prepared.

Under these circumstances, building a risk management system becomes not just necessary, but a critical condition for survival and development. Effective risk management helps not only minimize potential losses but also use instability to identify new opportunities and ensure resilience in the future. This is the foundation that enables to respond quickly to threats and move forward with confidence.

For systematic analysis and justification of approaches to forming risk management, we will first consider the essence of the definition of "risk". In their research, A. Pogonchuk and N. Tyurina prove the existence of two risk theories: neoclassical, according to which risk is considered through the prism of the probability of receiving losses depending on the decisions made, and classical, where risk is defined as the probability of deviation from the goals set in the management process [86].

Complementing and expanding the above-defined concept of risk, V. Reshetylo and Yu. Fedotova within the scope of their study, define risk as the possibility of failing to achieve set goals [109].

An important prerequisite for the formation of an effective risk management system is the analysis of the category of "uncertainty" and its clear distinction from the concept of "risk". Despite the existence of scientific approaches, where these terms sometimes treated as synonymous, the actual nature of these phenomena differs significantly. One of the early researchers of economic phenomena, who differentiated the concepts of risk and uncertainty, is the American economist Frank Knight. According to his approach, risk refers to situations in which the probability of a certain event occurring can be calculated or objectively assessed. His approach, outlined in the work "Risk, Uncertainty and Profit" showed that these two phenomena are fundamentally different. Knight defined risk as a situation where the probability of an event occurring can be objectively calculated, even if its consequences are unknown. Such risk is subject to quantitative analysis and allows the application of mathematical models, that is, decisions are made based on probabilistic calculations. At the same time, uncertainty is a state when future events are completely unpredictable. According to Knight, probabilities cannot be determined due to lack of data or the uniqueness of the situation. In such cases, classical statistical methods do not work. Instead, decision-making under uncertainty requires the Chief Risk Officer to rely on intuition and experience, which have no objective basis. It is precisely on this basis that Knight distinguished between these two concepts. This approach remains relevant today, as it explains why some situations can be insured against, while others cannot [199].

The Ukrainian school of scientific study of the nature of risk is actively investigating the transformation of this concept in the conditions of transitional economies and crises. V. Vitlynsky, who is considered one of the founders of the Ukrainian school, together with S. Nakonechny, consider risk as a multifaceted category that combines both its objective and subjective characteristics, also offering a toolkit for making managerial decisions under conditions of uncertainty [18].

The aforementioned scientists, V. Reshetylo and Yu. Fedotov, also reasonably draw a line between uncertainty and risk. Uncertainty should be understood as a situation when the development of events is ambiguous, and the available indicators of processes cannot be predicted in the future [109]. In conclusion to the analysis, it

should be noted that the main difference between these two concepts is that risk is a controllable process and involves the availability of methods for calculating the probabilities of its occurrence, while uncertainty remains a category that cannot be calculated or predicted [31]. The characteristics of approaches to defining the concept of "risk" are given in Table 1.1.

Table 1.1

Characteristics of approaches to defining the concept of "risk"

Author	The focus in defining the concept of "risk"
Frank Knight [199]	Risk is an objective, measurable probability of events
Vitlinsky V., Velykoivanenko H. [18]	Risk is an inherent category of entrepreneurial activity that arises under conditions of uncertainty and conflict
Reshetylo V., Fedotova Yu. [109]	Defining risk as the possibility of failing to achieve set goals
Pogonchuk A., Tyurina N. [86]	Detailing the classical (deviation from the goal) and neoclassical (threat of loss) theories of risk

Source: compiled by the author based on [18, 86, 109, 199]

In search of an answer to the question of what risk is, let us consider the relationship between phenomena of "crisis" and "risk". These two concepts are central to management. They are often confused, but in fact they are not identical. One of the first to draw a direct line from underestimation of risks to the emergence of large-scale financial and systemic crises is Nassim Nicholas Taleb. According to N. Taleb's concept, a crisis arises where risk management is neglected and then the accumulated or ignored risks are transformed into a phase of acute crisis [122].

Given that the modern environment with a high level of uncertainty is characterized by crisis phenomena, the global crisis, the consequences of the COVID-19 pandemic and the long-term martial law cause new conditions of fragility and uncertainty, under which it is difficult to keep the situation under control, and the consequences of these conditions cannot be predicted. To overcome the existing threats of aggravating crisis situations, the implementation of a risk-based approach to enterprise management is an effective mechanism, the basis of which will be the process of identifying and analyzing risks, taking into account understanding the vulnerability of the enterprise to emerging risks [41, 42].

Among the scientists who establish a causal connection between risk and crisis, there are also Ukrainian researchers. In particular, T. Syvak claims that "crisis management does not arise simultaneously with the crisis, but is a response to the challenges of numerous risks of the potential occurrence of a crisis, and the anti-crisis component must be present in the management system as a whole" [118], and in the works of G. Lihonenko, attention is focused on the fact that the crisis is the logical outcome of unmanaged risk [69].

Rudenko S., Girzheva O., Ryzhykova N. and Nakisko O., in turn, prove that "the presence of risks determines the probability of a crisis and the threat of crisis situations… Risk management within the crisis management system must be flexible and dynamic, able to quickly respond to changing conditions and make optimal decisions promptly" [112].

Based on the above, in Table 1.2 we have formed the main conceptual approaches to the formation of the connection between risk and crisis.

Table 1.2

Main conceptual approaches to forming the connection between risk and crisis

Approach	Essence of connection
Causal	Risk is a probable event, crisis is an actual event (realization of the risk)
Temporal	Risk management operates at the pre-crisis stage (preventive type), crisis management operates during or after a crisis (reactive type)
Transformational	A crisis occurs when a critical number of unmanaged risks exceed the threshold of stability of any system

Source: compiled by the author based on [69, 118, 112, 122]

Thus, the main causal connection between risk and crisis is that the crisis of an enterprise is the result of untimely identification and inadequate response to internal and external risks. Therefore, risk management at the preventive stage is an effective tool for crisis prevention.

Having examined what the definition of the concept of risk depends on, we will consider approaches to the formation of approaches to the definition of risk management.

In the works of O. Sosnovskaya and L. Dedenko, risk management is defined as a risk management system based on the identification, assessment and study of risk. In order to achieve a balance between strategic potential and the degree of risk, it is necessary to correctly choose ways to neutralize their potential consequences [120].

Similar approaches are followed in the works of other authors. For example, K. Mekh and I. Fedulova believe that in order to increase positive and reduce negative consequences, the risk management process should include identification, analysis and decision-making regarding risks [75], and I. Volynets defines risk management as "the management of the enterprise as a whole, taking into account the impact of risks based on the process of their identification, assessment and analysis, as well as the choice of methods for neutralizing their consequences" [20].

Continuing the analysis of views on the concept of risk management, we note that A. Pogonchuk and N. Tyurina offer a classical interpretation of this definition, considering risk management as a sequence of actions to identify, assess and neutralize risks within the operational activities of enterprises [86].

A slightly different emphasis is placed by V. Vasyuta and D. Guz, who link risk management with the implementation of the main functions of the enterprise. They believe that the main task of management is to organize activities in such a way as to minimize the risk impact in order to obtain the greatest profit [15].

The current state of development of the Ukrainian business environment involves a transformation of approaches to the definition of risk management. As O. Rudych notes, in Ukraine there is a transition to a management model in which risk management is no longer about a situational approach, but about its integration into general management. This indicates that risk management is becoming a full-fledged participant in strategic and tactical management, in which decisions are made on the basis of analysis and assessment of the probability of occurrence of risk situations [113].

Summarizing the scientific approaches of Ukrainian researchers, "risk management" is defined as a strategic management system based on proactive assessment of the probability of threats and implementation of actions to minimize

them. The strategic vector in this case is its constant integration into the activities of the enterprise. This ensures stable functioning under conditions of deviations from the planned.

To define the concept of "risk management of manufacturing enterprises", it is first necessary to clarify what underlies the term "manufacturing enterprise".

There are two views: classical (narrow approach) and modern (broad approach).

A manufacturing enterprise in the classical sense is an enterprise that, in the process of its activities, converts raw materials, materials or other resources into finished products. This definition was made because management as a science and field of knowledge began to take shape in the industrial era with the advent of mass production, which led to an increase in the scale of enterprises and, accordingly, the need for effective labor organization. Therefore, this opinion was held by such famous economists as the Scottish economist Adam Smith ("An Inquiry Into The Nature And Causes Of The Wealth Of Nations"), it is his concept of added value that is key to the definition of a "manufacturing enterprise" [228], Karl Marx, a German philosopher and economist, who in his work "Das Kapital. Kritik der politischen Ökonomie" when analyzing the transformation of raw materials into commodities, considered production as a process that results in the creation of added value [208].

Based on the above interpretation, the concept of "manufacturing entrepreneurship" is considered as "activity that is directly related to the production of products, performance of work, provision of services and information regarding this for the purpose of further sale to buyers and consumers for profit" [78].

In other sources, manufacturing enterprises are considered as "a business entity that is created to produce goods for sale" [200], and also "an enterprise that uses equipment and machinery to process goods, allowing it to create a finished product" [207]. That is, under manufacturing enterprises we mean enterprises that directly produce finished products. The difference between the Ukrainian definition and foreign ones is that in Ukraine, manufacturing enterprises also include those that produce services, that is, these are all enterprises that produce not only finished products in tangible form, but also the process of producing services. Foreign sources

suggest a concentration on the production process of finished products that have tangible form.

But it is worth noting that in the modern economy there is no longer a clear boundary between “material goods” and “services”, so the concept of “production” is used more broadly. It can be argued that a “manufacturing enterprise” is an enterprise that, in the process of its activities, creates any good that has value for the consumer. In our study, we will proceed from the position that manufacturing enterprises are enterprises that produce both goods in material form and services, since this approach is more modern.

Thus, when defining the concept of “risk management of manufacturing enterprises” it is not necessary to focus on the “production” components of the enterprise. Therefore, **risk management of manufacturing enterprises** is nothing more than a risk management system that includes the process of identifying, assessing, monitoring, analyzing and controlling risks that are an obstacle to achieving the strategic and tactical goals of the enterprise in order to develop measures to minimize losses and use opportunities to gain competitive advantages.

In the following, we will trace how the attitude towards risk has changed over time. O. Steshenko, in her study of the formation of riskology as a science, identifies four periods of development of approaches to risk definition:

– 1st, covers the years 1970-1980, in which risk management was carried out by specialists in financial departments;

– 2nd, 1981-1990, during which state institutions joined risk management;

– 3rd, 1990-2000. During this period, there is a horizontal growth of organizations under whose control market, credit and operational risks fall, and such a function as “risk management” appears;

– 4th, the beginning of the 21st century is characterized by the complexity of approaches to risk management [121].

We can agree with the periodization indicated by the author under the conditions that riskology as a science is taken as the basis. But the phenomenon of “risk” itself has a longer history, the consideration of which must begin with the development of

production and technologies. Therefore, we agree with A. Pekhnyk, A. Kroitor and Yu. Zavgorodnaya, who, studying the history and modern approaches to risk theory, note that the foundations of the emergence of the risk management system date back to the 17th-18th centuries. [85].

Risk is the subject of many interdisciplinary studies. Thus, based on the study of different approaches to determining the stages of risk management, we believe that the evolution of scientific approaches to risk management occurred from a simple phenomenon to an active management tool, which can be conditionally divided into 5 stages – lack of understanding of the existence of risk – simple understanding of the existence of risk – risk avoidance – its identification – active management of it.

At the 1st stage, "Pre-scientific understanding of risk" (until the 17th century), humanity had a complete lack of understanding of risk. Instead, the development of crafts, and later the emergence of writing, enabled people to record economic transactions, laid the foundations for calculations, analysis and control, and became the first step towards managing uncertainty [85]. At this stage, risk was not a scientific category, but an everyday reality, it was perceived simply as a manifestation of fate, luck, giving a religious accent to the events that occur. Therefore, the first attempts at the so-called "management" were intuitive and reduced to a reactive approach, that is, actions were taken only after the occurrence of a risky event.

At the second stage, "Intuitive perception" (17th-19th centuries), risk was not yet systematically analyzed. It was perceived as an inevitable and often unpredictable part of life and economic activity. Therefore, when people began to realize that some risks could be predicted, the main approach was to avoid them. Because of this, entrepreneurs, for example, refused investments that seemed risky.

During this period, the first scientific achievements in the field of mathematics began to appear, which laid the foundation for understanding risk assessment. The contribution of French mathematicians Blaise Pascal and Pierre de Fermat to risk management is, without exaggeration, fundamental. Their key achievement was the creation of probability theory, which laid the foundation for quantitative risk analysis.

They developed a mathematical model that allowed calculating the probability of certain events occurring [57].

Despite the fact that at the third stage, the “Traditional” (late 19th century - 1970s), risk is still perceived as a negative phenomenon, the policy of its avoidance continues, but the emphasis is shifted from simply avoiding but minimizing the risks that arise. Entrepreneurs, when concluding agreements, began to shift responsibility to the other party. This is how the first forms of insurance appeared, which allowed not to manage risks, but to transfer them.

Moreover, during this period, risk management theories were developing. For example, the English economist Alfred Marshall [3] did not study risk as a separate category, but laid the foundations for its further analysis. The key achievement of the American economist Frank Knight was the clear distinction between the concepts of “risk” and “uncertainty” [199].

The IVth stage, “Systemic” (1970-1990) is characterized by the transition from avoidance to systemic risk analysis. There is already an understanding that risk is part of any system. At this stage, during the development of production and complex business processes, there was a need to systematize risk analysis. And thanks to the development of statistics and analytical observations, it became possible to identify, describe and assess risk. At the same time, management still remained reactive, that is, actions were taken only when the risk had already been identified.

At this stage, the first standards for risk management processes appear. An example is the British standard BS 5760-7:1991 (IEC 61025:1990) Guide to failure mode, effect and criticality analysis (FMECA), which became one of the first documents to systematize the approach to risk management, moving it from an intuitive level to a formalized one [156].

In the current, V-th stage, “Integrated”, starting from the 1990s and up to the present, risk management has become an active process. Risk is no longer perceived as a threat, now it has become a new opportunity. Companies actively integrate risk management into their strategy (Enterprise Risk Management, ERM), for example, through innovation or entering new markets.

The basis for active risk management and the unification of risk management approaches worldwide are documents and basic international standards, such as the standards of the ISO 31000:2018 Risk management – Guidelines, Guide 73:2009 Risk management – Vocabulary and COSO Enterprise Risk Management (ERM) – Integrated Framework [163, 187, 194].

A retrospective of our vision of risk management approaches is presented in Table 1.3.

Table 1.3

Evolution of scientific approaches to risk management in management

Stages	Title	Characteristics	Areas of application	Result
1st to 17th century	Pre-scientific understanding of risk	Lack of understanding of the existence of risk	None	Reactive approach: actions were taken after the occurrence of a risky situation
2nd, 17th-19th centuries	Intuitive perception	Simple understanding of the existence of risk, risk avoidance	Entrepreneurship	The emergence of the first scientific achievements in risk theory (B. Pascal, P. Fermat, A. Marshall, F. Knight)
3rd, late 19th century-1970s	Traditional	Avoidance and minimization of risk	Mainly insurance and financial management	
4th, 1970-1990	Systemic	Risk study and identification	Project management, industrial production	The emergence of the first standards (BS 5760-7:1991)
5th, since 1990	Integrated	Active risk management	All areas of activity (from operational to strategic)	ISO 31000:2018, Guide 73:2009, COSO ERM

Source: compiled by the author based on [3, 57, 85, 156, 163, 187, 194, 199]

Thus, the developed phasing of the evolution of risk management approaches, from a lack of understanding of risk to using it in one's strategies as an opportunity, allows us to assert that the emergence of integrated approaches, such as Enterprise Risk Management and ISO 31000:2018, Guide 73:2009 standards, has transformed risk management into an integral part of corporate governance, which requires constant monitoring and adaptation to changes.

In the modern world, where unpredictable events are the norm, every enterprise operates in conditions of uncertainty and risk. In the realities of a full-scale invasion, this problem has become particularly acute for Ukrainian companies. Risks can come from different sources, have different degrees of impact and management, scale, nature of occurrence and nature of impact, be external or internal depending on the specifics of the enterprise and industry.

Therefore, in order to determine whether an enterprise will be able to independently influence threats, it is necessary to understand the level of the hierarchy at which they can arise. Systematization by the scale of influence distinguishes such types of risks as mega-, macro-, micro- and meso-level risks. Mega-risks are risks of a global scale that do not depend on the activities of a single country or company, but have significant consequences for any enterprise. An example is a sharp increase in energy prices on world markets and an automatic increase in the cost of production of a manufacturing enterprise in response.

Macro risks are similar in structure, but with the difference that they are national in nature and their sphere of influence is all enterprises within the country, regardless of the type of activity. For example, the adoption of amendments to the Tax Code of Ukraine may increase the tax burden on all enterprises without exception.

Next in the hierarchy are meso-risks, which operate at the regional or industry level. An example is the shortage of qualified metallurgical engineers or surveyors in a specific industrial region. In turn, micro-risks are risks inherent in the enterprise itself or its immediate environment, which are formed under the influence of subjective and objective factors. For example, untimely maintenance of equipment can lead to breakdowns, injuries, etc.

According to the possibility of management, managed and unmanaged risks are distinguished. This is one of the important classifications, because it determines how to build risk management: either try to prevent and eliminate the causes of the risk or prepare “backup” measures to minimize the consequences. Managed or controlled risks

are internal micro-level risks that are identified through qualitative analysis with subsequent steps to eliminate or manage them. For example, if there is a risk of producing defective products, the company can control it by implementing a quality control system according to ISO 9001:2015 and performing timely maintenance of equipment.

It is more difficult with unmanaged or uncontrollable risks, which can be conditionally divided into predictable and unpredictable. The sources of these risks lie beyond the influence of the enterprise, so it cannot prevent their occurrence, but can only adapt or insure itself against them. An example would be the risk of power supply interruption due to large-scale accidents in the country's power system. These are predictable macro-level risks, but since the enterprise cannot influence the situation, it can only prepare alternative power sources. An example of unpredictable mega-level risks could be the sudden imposition of an embargo on a certain type of product, which makes it immediately unnecessary.

In the two levels of systematization we have considered, there is a certain relationship in terms of the scale of influence and the possibility of management: micro-risks are usually manageable, and mega-, macro-risks are unmanageable. The multi-level classification of enterprise risks is presented in Fig. 1.1.

In order to understand how to build an effective risk management strategy in any enterprise, in our opinion, it is necessary to take into account three main types of risk, which are extremely important: external, internal and strategic. This division allows not only to classify threats, but also to develop targeted and adequate modern requirements tools for managing them (Fig. 1.2).

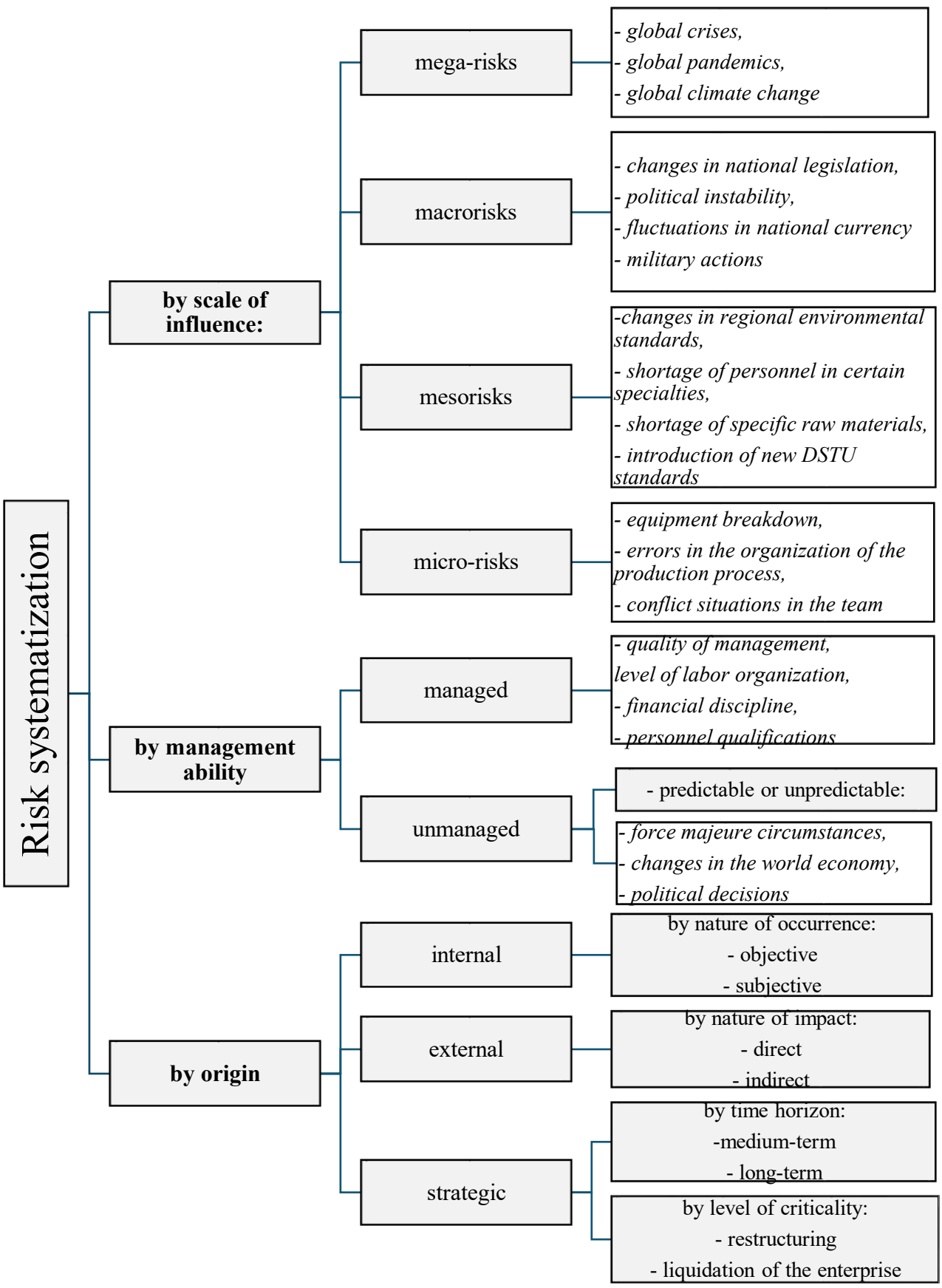


Fig. 1.1. Multilevel classification of enterprise risks

Source: compiled by the author based on [133, 194]

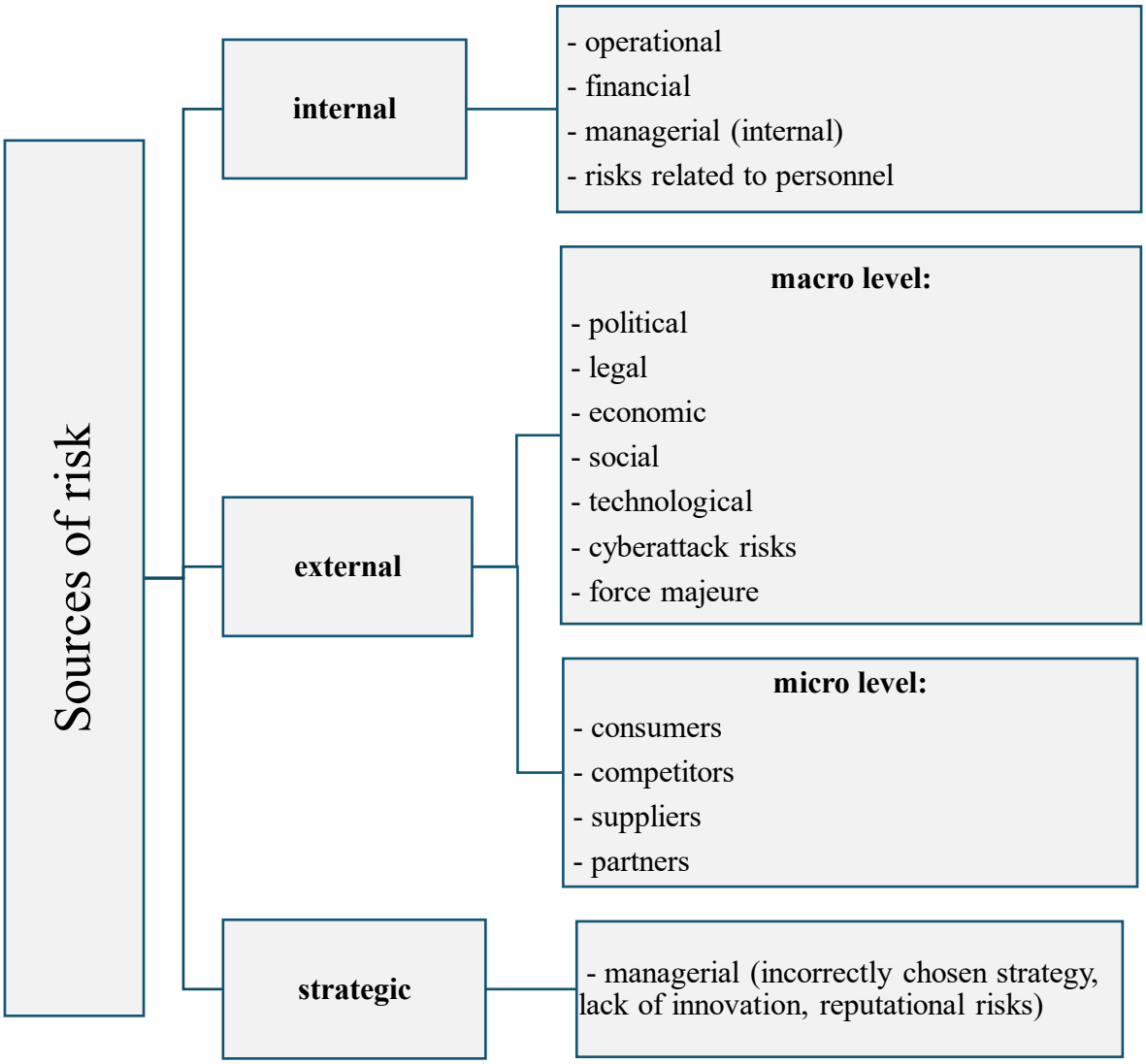


Fig. 1.2. Sources of risk

Source: compiled by the author based on [31, 73]

External risks are those risks that arise outside the enterprise and do not depend on its activities. They cannot be controlled, but they can be predicted and, thanks to a timely developed management strategy, their impact can be adapted and mitigated. External macro-level risks have a global impact, regardless of the industry or enterprise. Thus, political and legal risks arise due to changes in government policy, legislation, political instability or military intervention; economic risks are associated with inflation, currency fluctuations, economic crisis or the state of the economy as a whole and are manifested in rising inflation, falling purchasing power and the onset of financial crises. As for social risks, changes in the demographic structure, public

sentiment, changes in values and priorities significantly affect the activities of the enterprise, since they shape the environment in which it operates. Technological risks, cyberattacks, equipment aging or disruption of technological processes are associated with the rapid development of technologies, which in modern realities have become "companions" of any management system. Natural risks arise due to natural phenomena such as floods, earthquakes and droughts. All of the above macroenvironmental risks are not a consequence of the activities of a particular enterprise, but they affect all market participants.

Also worth noting are those external risks that may come from the immediate environment with which the enterprise interacts on a daily basis. Consumers who sharply change their preferences or decrease their purchasing power, competitors who dump prices or introduce innovative products, suppliers who sharply increase prices or stop work due to their own problems and partners who may violate the terms of cooperation – these micro-level risks are certainly less large-scale than, for example, political or economic, but they can have a negative impact on a particular enterprise. Their peculiarity is that in one way or another they are part of the everyday interaction of the business with the market.

Internal risks – risks that arise within the enterprise and are directly related to its activities, structure, and management system. Unlike external risks, internal risks are fully managed and controlled by the enterprise. They can be conditionally divided into operational risks, which are related to internal processes (failure of production equipment, inefficient logistics); financial risks, which arise due to inefficient financial management (for example, incorrect assessment of an investment project); managerial risks, which are related to the quality of internal management decisions, and risks related to personnel – the emergence of conflicts, staff turnover, the level of employee qualifications, and their motivation. Effective minimization of these risks is the key to successfully overcoming external risks on one's own [31].

Strategic risks are associated with key management decisions that affect the long-term existence of the enterprise. They have a different level of responsibility and, accordingly, require a special approach. Unlike external and internal risks, which are

minimized during tactical planning, strategic risks require a review of the entire business model of the enterprise, flexibility of strategy and constant analysis of the external environment.

Therefore, understanding the classification of risks by source allows management not only to effectively identify threats, but also to focus its efforts, correctly allocate resources, and make decisions in accordance with the scale and nature of threats

When classifying risks, modern expert research on business risks, which are inherent not only to Ukraine, but also to the whole world, is important. Thus, a study by Allianz, a leading insurance company and asset management company for private and corporate clients, which operates in 70 countries around the world, is noteworthy. In 2025, the 14th Allianz Risk Barometer was released, which is the result of a survey of 3,778 respondents from 106 countries around the world. The survey covered companies of all sizes. According to the data of this study, we can present its results in Table. 1.4.

The table presents a summary of the Allianz Group study on the most important business risks in 2024 and 2025. According to the report, the Top 10 most important risks that are inherent in the world, and also, taking into account the geographical location of Ukraine, also in Europe, are given. We also noted the share of respondents who chose one or another risk. It is worth noting that the risks of Europe are not identical to the global risks. Thus, we see certain differences in the places occupied by risks, as well as existing risks that are included in the Top 10 in the world, but do not have such a result in Europe (new technologies). And, in turn, there is the risk of “lack of qualified labor”, which is selected as one of the most important in Europe, but is absent from the survey results worldwide.

In modern conditions, the application of a risk-oriented approach in enterprise management acquires strategic importance as a universal mechanism for identifying and eliminating specific threats of the war period, which allows ensuring the continuity of operational activities and minimizing the negative impact of uncertainty factors on the production potential of business entities, regardless of their industry affiliation [8].

Table 1.4

Key global business risks for 2025

Risk name	Risk characteristic	Risk position in global ranking, 2025 (share of respondents)	Risk position in global ranking, 2024 (share of respondents)	Risk position in European ranking, 2025 (share of respondents)	Risk position in European ranking, 2024 (share of respondents)
Cyber incidents	Cybercrime, data leaks, malware	1 38%	1 36%	1 42%	1 37%
Business interruption	Including supply chain disruptions	2 31%	2 31%	3 33%	2 32%
Natural disasters	Storms, floods, earthquakes, extreme weather events	3 29%	3 26%	2 33%	3 25%
Legislative and regulatory changes	New directives, application of protectionist measures, environmental, social and governance requirements, as well as regarding sustainable development	4 25%	4 19%	4 25%	4 21%
Climate changes	Both physical and financial risks as a result of global warming	5 19%	7 18%	5 19%	7 18%
Fires and explosions		6 17%	6 19%	6 18%	6 19%
Macroeconomic Changes	Inflation, deflation, monetary policy of the state	7 15%	5 19%	8 13%	5 20%
Market Changes	Increased competition, new players, mergers, market fluctuations	8 14%	9 13%	10 12% New	-*
Political risks and violence	Political instability, war, terrorism, etc	9 14%	8 14%	7 18%	10 15%
New technologies	Artificial intelligence and the risks of its use	10 10% New	-*	-	-
Lack of skilled labor	Loss of competitive advantage	-	-	9 12%	8 16%

* - the risk was not among the Top 10 response results in 2024 or is not specific to the region, or is not identified at the global level as the most important

Source: compiled by the author based on [148, 149]

Thus, having systematized the views of scientists on approaches to the concepts of risk, uncertainty, risk management, and having analyzed what the term “manufacturing enterprise” underlies, we have proposed an interpretation of risk management of manufacturing enterprises as a risk management system, which includes the process of identifying, assessing, monitoring, analyzing, and controlling risks that are an obstacle to achieving the strategic and tactical goals of the enterprise in order to develop measures to minimize losses and use opportunities to gain competitive advantages.

The examination of the relationship between risk and crisis has led to the conclusion that these two phenomena are interdependent, which is reflected in the following. Since the emergence of a crisis in an enterprise is often the result of ineffective risk management, preventing crises in the future requires the development and implementation of an effective risk management strategy.

1.2. Stages of risk management and risk assessment methods in manufacturing enterprises

With this in mind, it is important to consider the risk management process, which also justifies an in-depth analysis of risk assessment and management methods.

As already noted, the main goal of forming a risk management system at an enterprise is to maximally neutralize future risk and reduce the negative consequences of its impact on the activities of a given enterprise. To achieve this goal, it is necessary to build a system that would be integrated into the work of the enterprise itself and provide for a constant risk management process.

This process consists of the corresponding stages, which have been the subject of considerable attention from Ukrainian scientists. The number and characteristics of the stages vary depending on the vision of academics and researchers. The analysis of the works made it possible to generalize the stages and propose an author's approach to determining the stages of the risk management process at the enterprise and their characteristics.

The risk management process at enterprises takes place in stages, which are shown in Fig. 1.3.

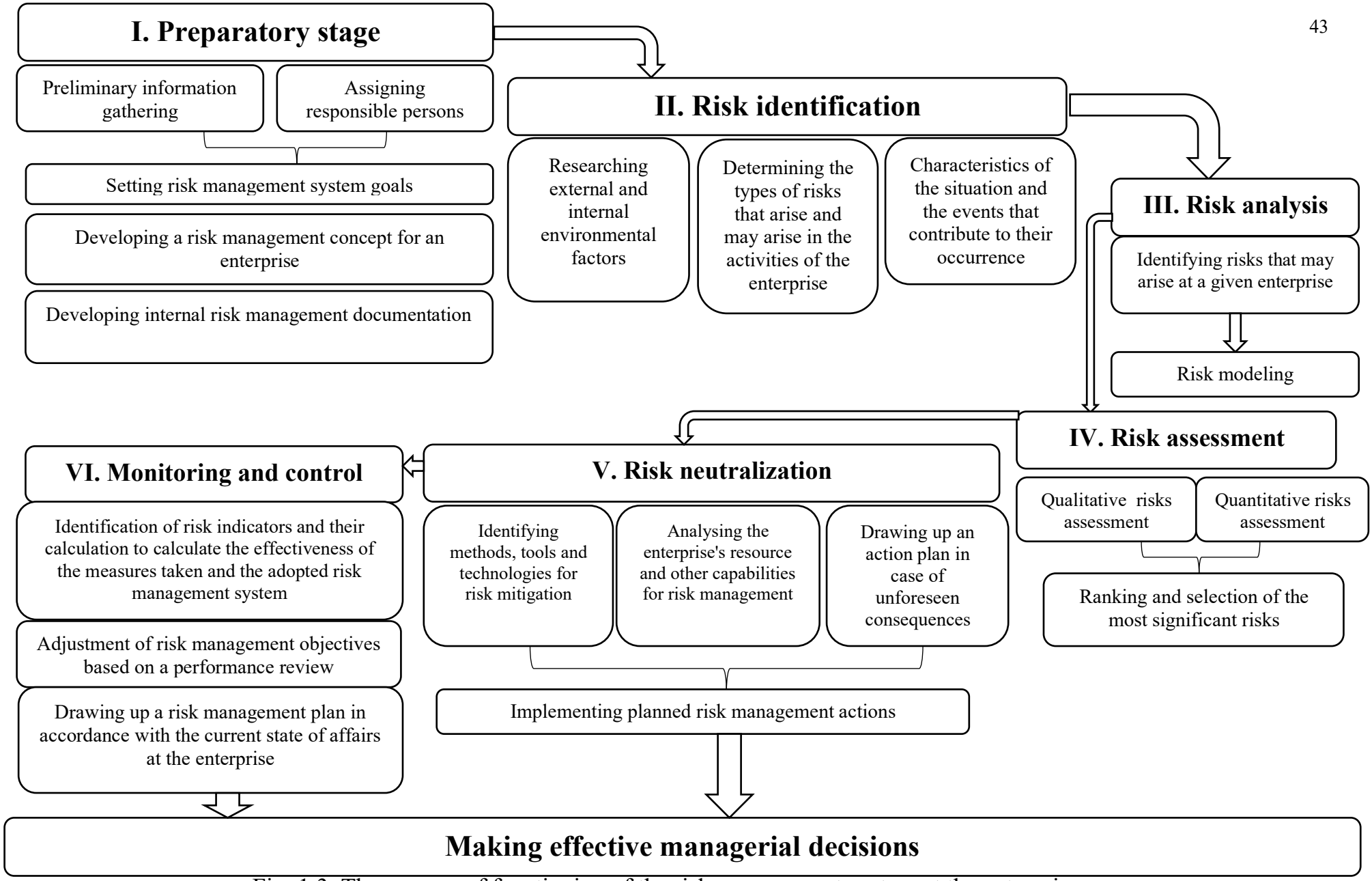


Fig. 1.3. The process of functioning of the risk management system at the enterprise

Source: systematized and developed by the author based on [7, 20, 115, 120]

Ukrainian scientists, studying the stages of risk management at the enterprise, distinguished from 4 stages to 6 stages. Depending on the number of stages, their characteristics and scope of work are given. Summarizing and taking into account the urgent importance of an adequate and timely response to the occurrence of risk and reducing its negative impact, we have identified 6 stages that must be followed when forming and implementing a risk management system at any enterprise. Moreover, they can be applied to enterprises of any size, but will differ in the number of people directly involved in the risk management process, the scale of work performed related to risk management, etc.

The first stage can be defined as preparatory, which is no less important than the others and which is initial and determining for the entire subsequent risk management system. At this stage, work is carried out to determine the purpose of forming a risk management system, the main tasks for its achievement, the necessary information is collected, sources of information are determined, documentation is developed. At this stage, it is necessary to determine the persons responsible for the formation, adjustment and further functioning of the risk management system of a manufacturing enterprise.

At the “Risk Identification” stage, external and internal factors that influence the occurrence of risks are investigated, the types of risks that can potentially arise are determined, their characteristics, etc. Scientists consider the content of this stage differently: some distinguish it as the most extensive, which includes what we have deduced in other stages. We have to understand that the detailing of the management process makes it possible to more carefully approach planning and its implementation, which as a result significantly increases efficiency. Therefore, we have additionally identified the 3rd and 4th stages, which involve the analysis and assessment of risks. Each of them is important, large-scale and necessary for further effective risk management.

The third stage is defined by us as “Risk Analysis”, which, based on what was obtained in the previous stage, already analyzes them in more depth regarding the probability of occurrence at a given enterprise and models the scenario in case of its occurrence.

The next stage, which deserves attention and is worth highlighting, is the risk assessment stage. At this stage, various assessment methods are used, which becomes the basis for further actions of the enterprise. This stage is distinguished by its importance for conducting qualitative calculations and assessments, as this directly affects the effectiveness of the enterprise risk management system.

Based on the results of the previous stage, the next stage should be implemented – Neutralization or minimization or optimization of risks. It determines the methods and tools of risk management in order to reduce their negative impact, analyzes the potential of the enterprise to manage risks by its own forces or use external sources, evaluates the effectiveness of the work carried out, etc. Note that this stage cannot be defined only as the stage of neutralization or minimization of risks. Since each category implies the achievement of different results, it includes a set of certain actions that lead to a positive effect. Neutralization of risks assumes that the applied actions will lead to the fact that the risk will not occur, it will be completely neutralized and leveled. Minimization of risks assumes that the applied actions will lead to the maximum reduction of negative consequences in the event of a risk. Optimization, in turn, can also be defined as minimizing losses in the value of the enterprise [125], and as a way to reduce the negative consequences of risks and maximize the achievement of the initial goals of the enterprise. There are many risk management methods that allow effectively manage this process. We will pay attention to the study of these methods below.

The final – sixth – stage and one of the least represented in the works of scientists is the stage of monitoring and control. We consider it appropriate to highlight it separately, since its importance is significant in the risk management process. This stage involves analyzing the effectiveness of enterprise decisions, monitoring the achievement of risk management goals and their adjustment depending on the changes occurring in the enterprise, determining risk indicators and their constant calculation and analysis, which allows to determine the effectiveness of the created risk management system and the measures taken to neutralize risks. Control is an important

function that significantly increases the efficiency of any process. It is necessary from the point of view of the fact that we have to compare planned indicators with real ones, check whether the adopted norms are observed or decisions are implemented, and how well the risk management system is integrated into the enterprise.

It is worth noting that these stages of the risk management process at enterprises should be systemic in nature and integrated into the activities of the enterprise. This is possible regardless of the scale of the activity, although it is clear that this affects the number of people involved in risk management, their expertise and area of responsibility. However, regardless of the size of the company and the specifics of the activity, the risk management system should be and have to be fully incorporated into the company's activities.

For the complete disclosure of our study, it is necessary to consider the risk assessment methods that should be applied at stage 4. As already noted, risk assessment methods are divided into qualitative and quantitative. The difficulty of assessing risks is justified by the fact that they are hypothetical or difficult to estimate mathematically.

The issue of research into risk assessment methods has received sufficient attention from both Ukrainian and foreign scientists. Among them, Petrova V.F. [84], Shurda K.E. [139], Gritsai O.I., Defir I.V., Kozak O.E. [22], Levchenko M.O. [68], Koretska O.V., Khoteeva N.V., Chyzh L.P. [65], Shvets Yu.O. [138].

Qualitative risk assessment involves identifying risks, their analysis, conditions, sources and causes of occurrence, as well as factors that have a direct impact on the implementation of the enterprise's activities [84]. Levchenko M.O. defines the main tasks of qualitative risk assessment as determining risk factors, as well as identifying stages of an enterprise's activity where risk may arise [68]. The scientist proposes 4 groups of methods for qualitative risk assessment, which we present in Fig. 1.4.

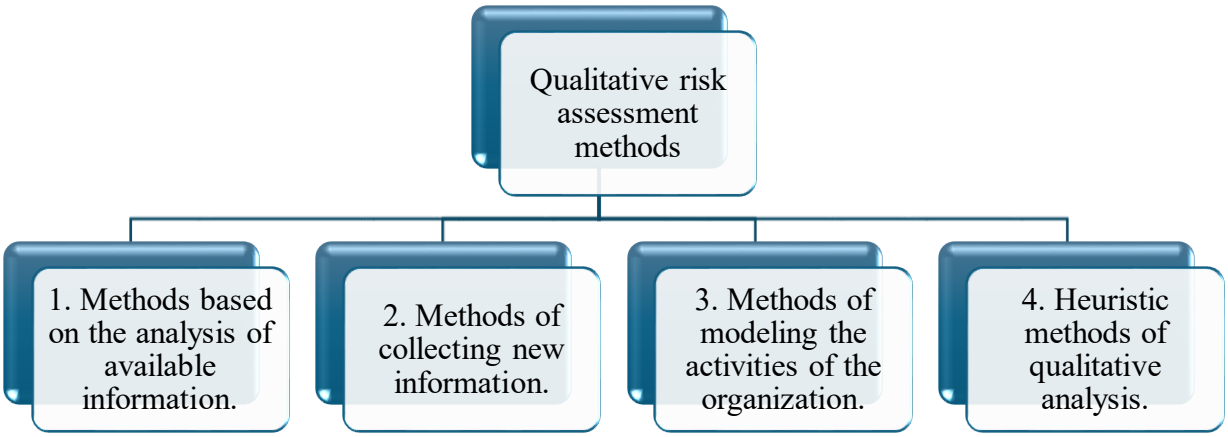


Fig. 1.4. Groups of methods for qualitative risk assessment according to Levchenko M.O.

Source: compiled by the author based on [68].

According to this author, groups of methods related to the processing of information, both existing and new, acquire significant importance. This is justified by the fact that information is the basis for determining possible sources of risk. In the process of risk management, it is important to understand the role of information in it.

Shurda K. E. confirms the above and notes that qualitative risk analysis involves both identifying specific risks that may arise and indicating the sources and causes of their occurrence. Identification of sources and causes gives the opportunity to understand where we can expect the risk to arise and, accordingly, how to respond to it and what management methods to apply [139]. Qualitative risk assessment is focused on both expert assessment and conducting various integrated assessments or applying other expert methods.

Scientists note a different number of methods that can be attributed to qualitative risk assessment. Moreover, there are also disagreements among scientists regarding the attribution of certain methods to qualitative or quantitative risk assessment. Table 1.5 summarizes scientific views on the main methods of qualitative risk assessment.

The results obtained by an enterprise as a result of qualitative risk assessment become the basis for further calculations of enterprises in quantitative risk assessment. Their combination makes it possible to most effectively assess risk and ways to manage

it. But we see that some scientists include in qualitative assessment methods not only those related to the work of experts, but also statistical methods, although for the most part they concern quantitative risk assessment.

Table 1.5

Qualitative risk assessment methods

Author	Method name	Characteristics according to the author(s)
Petrova V.F. [84]	Expert assessment method	It is used when there is not enough information to apply static methods. It consists in processing the opinions of experts in this field (e.g. experienced entrepreneurs). The author distinguishes between individual and group expert assessments.
	Method of collective idea generation (brainstorming method).	Allows to get a large number of ideas; sources and causes of risk; possible consequences of risk occurrence; determination of risk management methods, etc.
Sarana L.A., Bilan O.V., Bityuk I.M. [114]	Statistical method	Allows to assess the degree of impact of a risk that may arise on the enterprise.
	Cost-benefit analysis method	
	Expert assessment method	
Shurda K. E. [139]	Expert method: Questionnaires SWOT analysis Delphi method Score method Ranking Pair comparison Rosie and the risk spiral Project stage risk assessment	Processing of expert assessments from the field of activity of the enterprise. As well as deriving the integral level of risk. This method includes both logical operations and mathematical and statistical methods.
	Cost relevance analysis method	Identifies potential risk areas.
	Method of analogies	Similar projects are analyzed, taking into account the conditions of their implementation.

Source: compiled by the author based on [9, 84, 114, 139].

It is also worth mentioning the methods that Danchenko O. defined as methods of risk identification. The scientist provides methods that should be used in the early

stages of risk occurrence, when various signs begin to appear. To take these signs into account, identify them, and determine possible changes, the following methods are proposed: the “checklist” method, the 6W1H method, the brainstorming method, the analysis tree, expert interviews, the review, the Delphi method [23]. In the following sections, the author explores quantitative methods, therefore, according to the very essence of the stage defined by the author and its characteristics, we can attribute these methods to qualitative ones.

Unlike qualitative assessment, which determines the source, cause and factors of risk occurrence, establishes the significance of the risk, there is also a quantitative risk assessment, which is based on the results of qualitative assessment. Quantitative methods allow to assess the probability of risk occurrence [20, 75].

Table 1.6 presents the main methods of quantitative risk assessment.

Table 1.6

Quantitative risk assessment methods

Author	Method name	Characteristics according to the author(s)
1	2	3
Sarana L.A., Bilan O.V., Bityuk I.M. [114]	Decision tree method	Allows to assess the degree of impact of a risk that may arise on the enterprise.
	Analytical method	
	Method of using analogues	
Danchenko O.B. [23]	Simple quantification	Risk assessment according to certain indicators based on the probability of occurrence and the size of its impact.
	Estimating the monetary value of risk	To assess the risk, the probability of occurrence and the amount of impact in monetary terms are taken into account.
	Statistical methods and modeling: Statistical probability distribution method. Monte Carlo method.	Allows to assess the degree of impact of a risk that may arise on the enterprise.
Levchenko M.O. [68]	Method of analogies	Research on data on similar situations.
	Sensitivity analysis method	Identifying the sensitivity of the indicators being evaluated to changes in the values of the input variables. It determines the new final financial result when each influencing factor changes.

Continuation of Table 1.6

1	2	3
	Normative method	A system of financial ratios is used. Actual values are compared with regulatory values.
	Expert assessment method	Risk is assessed based on the opinion of specialists in a specific field of activity.
	Financial sustainability method	Based on the calculation of financial stability indicators, it allows to determine the financial capabilities and risks of the enterprise.
	Decision tree construction method	A tree is constructed, where the branches represent possible risk management solutions.
	Analytical method	Traditional indicators of investment and innovation project effectiveness are used. Results of alternative projects are compared.
	Statistical method	Quantifying economic risk using mathematical statistics.
Hrytsai O., Defir I., Kozak O. [22]	Cost-benefit analysis method.	Assesses possible losses of the enterprise. Identifies 5 possible financial states (from absolute stability to crisis state). Identifies potential risk zones (from no risk to unacceptable risk).
	Method for assessing financial stability.	Allows to assess the degree of impact of a risk that may arise on the enterprise.
	Sensitivity (vulnerability) analysis method.	
	Method of analogies.	
	Expert assessment method.	
	Simulation modeling method.	
	Statistical methods of risk assessment.	
	Normative method.	
	Decision tree construction method.	
	Scenario method.	Formulation of hypothetical alternatives for possible developments (scenarios).
	Game theory method.	Predicting different levels of risk as a result of the influence of changing factors. A “payoff matrix” is constructed, in which possible alternatives for the development of events are entered and possible risks are assessed.

Continuation of Table 1.6

1	2	3
	Combined method.	A combination of several risk assessment methods, which allows achieving a synergistic effect in assessing risk and minimizing its impact on the enterprise.
Koretska O.V., Khoteeva N.V., Chyzh L.P. [65]	Statistical method: Monte Carlo method Altman Z-model Cheser model Duran model VaR method	Allows to assess the degree of impact of a risk that may arise on the enterprise.
Shurda K.E. [139]	Discount rate adjustment method	Establishing a discount rate that is risk-free or has a minimal level of risk.
	Sensitivity analysis of performance indicators	The dependence of the key indicator on the variation of the values of other indicators taken into account is investigated.
	Scenario method	Forecast of the development of the external environment. “Pessimistic”, “most likely”, “optimistic” scenarios can be developed.
	Simulation modeling (Monte Carlo method)	A series of experiments that allow empirical estimates of the impact of various factors on indicators dependent on them to be obtained.
	Statistical method	Using mathematical probability theory to calculate the probability of risk occurrence.
	Method for estimating the probability of expected loss	The degree of risk is determined as the product of the expected loss and the probability that the loss will occur. The best option is considered to be the one when the result of the obtained indicator is minimal.
	Loss minimization method	Calculates possible losses when choosing a certain solution option. There are two types of losses: study risk (losses due to inaccuracy of the studied model) and action risk (losses due to inaccuracy and ineffective management). Based on these two types of losses, average losses are derived.
	The method of using a probability tree (“decision tree”)	Similar to the scenario method, but has a graphical representation of results and the organization's participation in decision-making.
	Fuzzy multiple analysis	Direct estimation of the uncertainty of the result without conducting a sensitivity analysis.

Source: compiled by the author based on [9, 22, 23, 65, 68, 114, 139].

Shvets Yu. presents methods of risk assessment identical to those we have already considered, without dividing them by qualitative and quantitative characteristics. She proposes the following methods: statistical method, expert method, calculation-analytical method, cost-effectiveness method, analytical method, economic-statistical method, analogue method, sensitivity analysis, “scenario” method, Monte Carlo method [138]. Approximately the same list of quantitative assessment methods is given by Petrova V.F. [84]. They do not differ from those given in Table 1.5 and Table 1.6.

As we can see, these tables show that different scientists do not always clearly distinguish between qualitative and quantitative methods, referring some of them to either qualitative or quantitative. This can be justified by the fact that even when conducting a qualitative risk assessment, the consequences for the enterprise's work are calculated. In this case, the main difference is that quantitative assessment involves calculating the probability of risk occurrence. Qualitative assessment is also more focused on identifying the risks that have the most impact on the results of the enterprise's activities. Although it is assumed that the ranking of risks is carried out on the basis of both assessments.

Each of the selected methods has its own advantages and disadvantages. For example, the method of expert assessments can have a subjective connotation, which is quite difficult to avoid. One way to avoid this is to involve several experts, establish clear assessment criteria, etc. Other methods can also have their own positive and negative sides. The choice of method depends on the capabilities of the enterprise itself in conducting the assessment. Here the difficulty arises in the availability of qualified personnel who can apply different methods and interpret them. Also, of great importance for the choice of method is the information resources of the enterprise and the ability to collect the necessary information, since the information becomes the basis for further risk assessment.

The above-described stages of the risk management process, as well as risk assessment methods, are aimed at making the enterprise's activities as effective as possible, making sound management decisions and minimizing economic losses from the occurrence of risk. This is facilitated by various measures that can be implemented

by enterprises. The study of the works of Ukrainian and foreign scientists reflects a deep study of this issue, but scientists distinguish both strategies and models, methods and ways of risk management, which can lead to some confusion and confusion of concepts. Let us consider the different views of scientists on this issue.

Thus, Shvets Yu. O. also distinguishes active, passive and adaptive approaches to risk management. Where active involves the maximum use of all sources of information and tools for risk management and minimizing risks and their consequences. Passive, on the other hand, involves responding to risk if it occurs. The adaptive approach is manifested in risk management when the environment is already changing and the enterprise is already adapting to the situation, choosing an alternative, etc. [138] Each company independently chooses which approach to apply, that depends on the capabilities of the company itself, the availability of physical, financial and other resources, understanding of the importance of forming a risk management system, etc.

Sarana L.A., Bilan O.V. and Bityuk I.M., in turn, distinguish proactive and reactive risk management strategies, where proactive is considered a strategy of predicting challenges, threats, losses in the event of a risk and planning measures to reduce the negative impact, and reactive is a strategy that resolves the consequences of a risk that has already occurred and the consequences for this enterprise [114]. Proactive can be considered more effective, and reactive – less. Although the choice of one or another strategy can have both pros and cons. But, in our opinion, enterprises should proceed from the proactive approach when forming a risk management system for manufacturing enterprises, although we fully understand that taking into account all factors and predicting all possible risks and the degree of their impact in modern conditions is difficult and almost impossible. However, we must approach the solution of the problem systematically, comprehensively and try to prevent it.

Chernyshova L.I., Bondar K.R., Krasilovska L.O. propose models of enterprise risk management in the conditions of today's Ukraine [135]. The characteristics and models of enterprise risk management are illustrated in Fig. 1.5. The models presented are based on different positions of enterprises regarding risk management and are adapted by the authors to the realities of martial law in Ukraine. They include a different set of tools that can be used in enterprise risk management in modern realities.

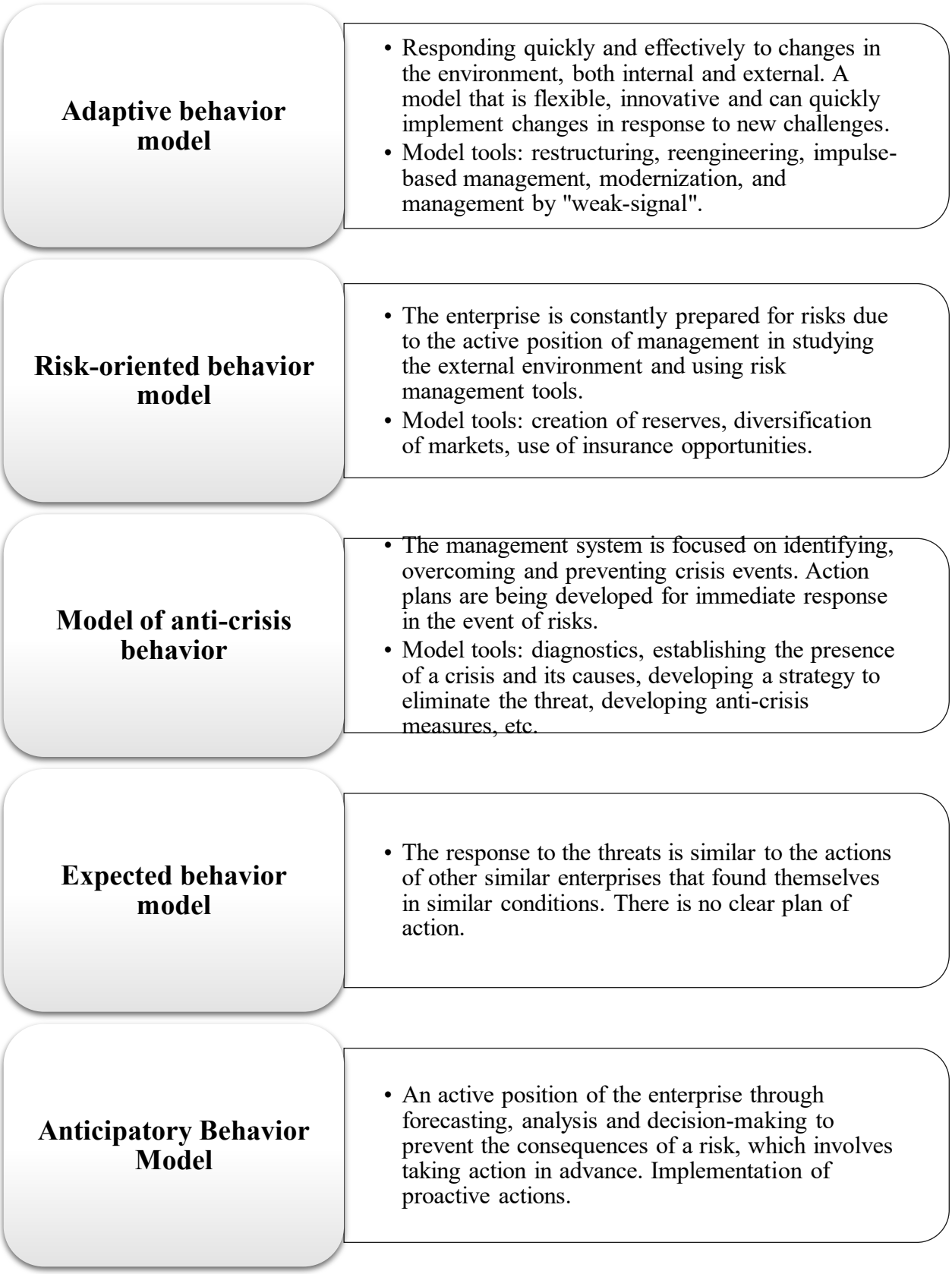


Fig. 1.5. Risk management models of Ukrainian enterprises according to Chernyshova L.I., Bondar K.R. and Krasilovskaya L.O.

Source: compiled by the author based on [135]

Of interest is the approach of Danchenko O.B., which proposes two directions of risk prevention: a risk control plan and risk financing. The risk control plan includes risk avoidance (distribution between participants), risk counteraction (search for countermeasures), risk distribution (creation of a consortium), risk transfer (transfer to stakeholders). Risk financing includes risk transfer (insurance coverage) and risk retention (risk money, self-insurance) [23].

Although our research is aimed at the formation of a risk management system for manufacturing enterprises, approaches to the formation of this system in other areas are also worth noting. Thus, Vovchenko O. studies the development of risk management systems in the banking sector. She believes that in today's unstable conditions, the banking sector is risk-oriented and is based on the concept of “three lines of defense”. The first line of defense concerns the reduction of operational risk, which can be manifested through various fraudulent schemes, cooperation with partners under sanctions, etc. [243].

In such conditions, the institution must have all the means to avoid such a thing. This can be extrapolated to manufacturing enterprises in the conditions of Ukraine's economy during martial law, when the number of fraudulent schemes is increasing, as well as enterprises from the aggressor country or those that are accomplices in aggression. They are under sanctions and cooperation with them is prohibited.

The “second line of defense” involves a clear understanding and awareness of potential risks that an organization may face, a willingness to analyze and make appropriate decisions; setting acceptable limits for different types of risk, which helps to control these risks. This “line of defense” should be worked on not only by those who are directly responsible for risk management at the enterprise, but also by other structures of the organization. The “third line of defense” refers to the active cooperation of the structure responsible for risk management with other organizations and stakeholders in terms of developing internal procedures, documentation, assessment methods or improving and perfecting those that already exist [243]. This risk management model can be adapted to manufacturing enterprises, as they face the same problems as the banking sector, but it may take slightly different forms. But

studying and using cross-sectoral experience can be even more effective in forming any enterprise's own risk management system.

In the development of interdisciplinary research, we will also present the results of a group of scientists on risk management models in economics, finance and accounting. Thus, Kosova T.D., Smerichevsky S.F., Ivashchenko A.I., Radchenko G.A. note that the most promising interdisciplinary risk management models can be reflective, simulation, scenario, Value-at-Risk (VAR), Expected Shortfall (ES), SWOT analysis, gap management [202]. Thus, the reflective model is based on consumer expectations regarding the quality and quantity of goods, changes in their prices. Risk management here occurs in the process of analyzing consumer expectations and making decisions by them and planning and implementing appropriate actions to meet these expectations. Simulation or imitation models allow us to build a simulation of the situation regarding business processes, project management under risk conditions, investment distribution, etc. Based on them, we can look at a possible situation that may occur and predict response scenarios to it. The scenario model involves the development of various scenarios – pessimistic, most likely, optimistic, combined. These scenarios allow to assess the change in various indicators when a risk occurs. VAR models determine the impact of economic, financial, marketing risks on the value of a company's equity, a possible change in NPV, etc. These methods are mainly used in risk management in the banking, stock and financial sectors. The ES model involves determining the probability of credit risk and also applies to transactions with financial instruments. The SWOT analysis model is well-known and involves determining the strengths and weaknesses of an enterprise, as well as the opportunities and threats to its functioning. This method is currently very widespread and is in significant demand in the activities of domestic enterprises of various sizes. Gap management means studying imbalances that can become a source of risk. These imbalances can arise in various areas and are subject to study and analysis in accordance with industry specifics, for example [202].

Yevtushenko G.V. and Berezyuk E.V. in their study provide such risk management methods as the acquisition of new information, diversification of the

enterprise's activities, insurance and self-insurance, accounting and evaluation of the enterprise's funds, risk limitation, etc. [43].

According to scientists such as Sosnovska O., Dedenko L., Mekh K. and Fedulova I., methods (by Sosnovska O. and Dedenko L. they are mentioned as approaches) of risk reduction can be divided into external and internal [75, 120]. That is, depending on what resources and opportunities to use: manage risk at the enterprise itself using your own efforts or turn to third parties, organizations, etc. In Fig. 1.6 we present the risk management methods according to these scientists.

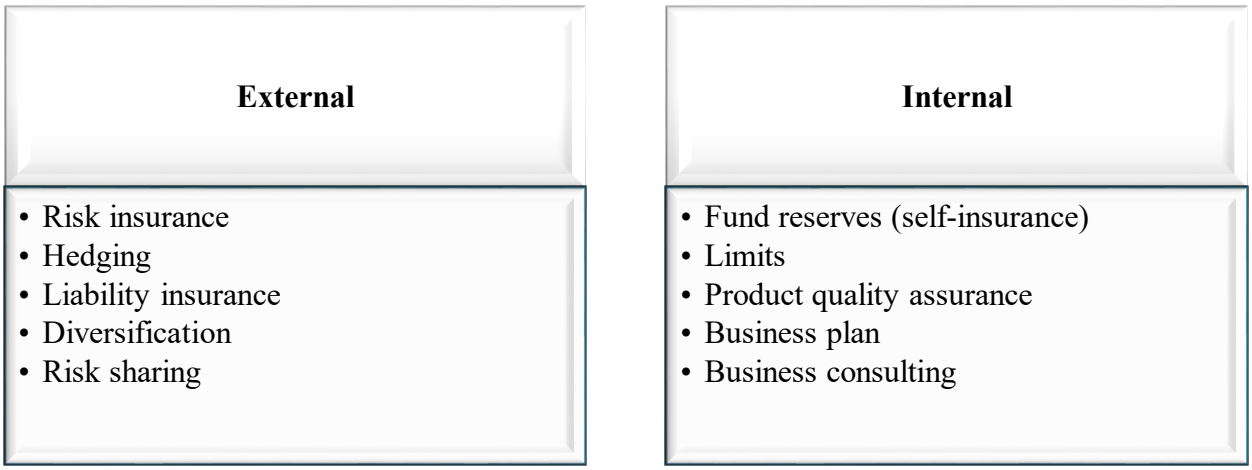


Fig. 1.6. Risk management methods

Source: compiled by the author based on [75, 120]

One of the best-known methods of risk management is the use of insurance. Various types of risks can be insured against, including: commercial, technical, economic, legal and other risks. It is worth noting that the study of literary sources allows to call this one of the most mentioned methods of risk management.

One form of insurance stands out separately as a method of risk management – hedging, which involves insurance against price changes [75, 120].

Liability insurance provides for insurance of the liability of the insured, due to which third parties suffered losses.

Along with insurance, one of the most well-known risk management methods is diversification. Diversification is characterized as investing in different objects. This makes it possible to reduce the likelihood or consequences of the occurrence of risk. This can be both investing in a completely new type of activity and developing

activities related to our main product. This method gives us a significant opportunity to avoid risk or reduce losses from its occurrence if another product or another type of activity has not suffered from this risk or has suffered less.

One interesting method that can be used is risk sharing, which is characterized by transferring a certain share of the responsibility for the risk to another party. This party may be more qualified in managing this particular risk or risks in general, and there is also a possibility that the losses from the occurrence of the risk for this party may not be significant. This party can be either the customer him/herself, or a subcontractor, or another third party [75, 120].

Among the internal methods, one of the most effective and important is the method of forming the company's own funds and reserves. This method acquires all the characteristics of self-insurance, when we create reserves for our own security in the event of a risk. In this case, we can cover our losses with our own resources. Reserves can be both monetary and in the form of stocks of raw materials, materials, etc.

The method of setting limits or limiting risks involves setting upper and lower limits for cash, credit, investment and other flows that are directed to the external environment. The main purpose of limiting is to limit the amount of losses from the possible occurrence of risk [120].

An important internal risk management method is product quality assurance. It involves the production of quality products, which reduces the risk of losing a customer, the risk of reducing demand for products, does not give rise to the risk of terminating contracts with partners and consumers, and also does not give the opportunity to improve competitive positions due to our poor quality. To ensure the implementation of this risk management method, it is important to comply with the production process of a product or service, as well as careful control over it.

Business planning as a management method makes it possible to plan the activities of the enterprise in advance, to study the market, to assess external and internal factors of influence, to calculate the main groups of production, financial,

investment indicators. On this basis, it is assumed that it is possible to assess risks and find opportunities to manage them. Calculation of investment attractiveness indicators will allow to make a decision on the feasibility of opening a new or developing an existing business.

In business consulting, you can contact experts in a certain field to provide appropriate advice. In our specific case, these should be risk management experts. When using this method, it is assumed that the enterprise, the factors of its activity will be analyzed by external specialists and risk management consultations will be provided. But here, a certain discrepancy arises because this method cannot be considered internal, as was noted by scientists, since it involves contacting outsiders if the enterprise itself does not have an appropriate expert. However, this does not change the significance of this method for the entire risk management system.

The above risk management methods are not exhaustive, but only some of them, which are given in the works of scientists. Their study is a necessary component of a full-fledged study on the formation of a risk management system for manufacturing enterprises. The choice of a risk management method depends on many factors: such as the size of the enterprise itself and the number of employees employed in it, as well as the specifics of the enterprise's activities (sector, industry), the type of goods or services produced, the financial capabilities of the enterprise, etc. Risk management methods are important components of the entire risk management system and process, laying the foundation for effective risk management.

Thus, summing up the above, we note that the risk management system can be formed on many principles, but hierarchically the first is the definition of strategy as a general vision of the enterprise's position in relation to risk. The starting point of the strategy will be the model according to which the enterprise builds its risk management system, which, in turn, determines the management methods and risk assessment methods. In Fig. 1.7 we will illustrate this hierarchy.

The choice of strategy, model, and methods of the risk management system depends on the company's capabilities, the market situation, and the qualifications of specialists working in the risk management system at a particular enterprise.

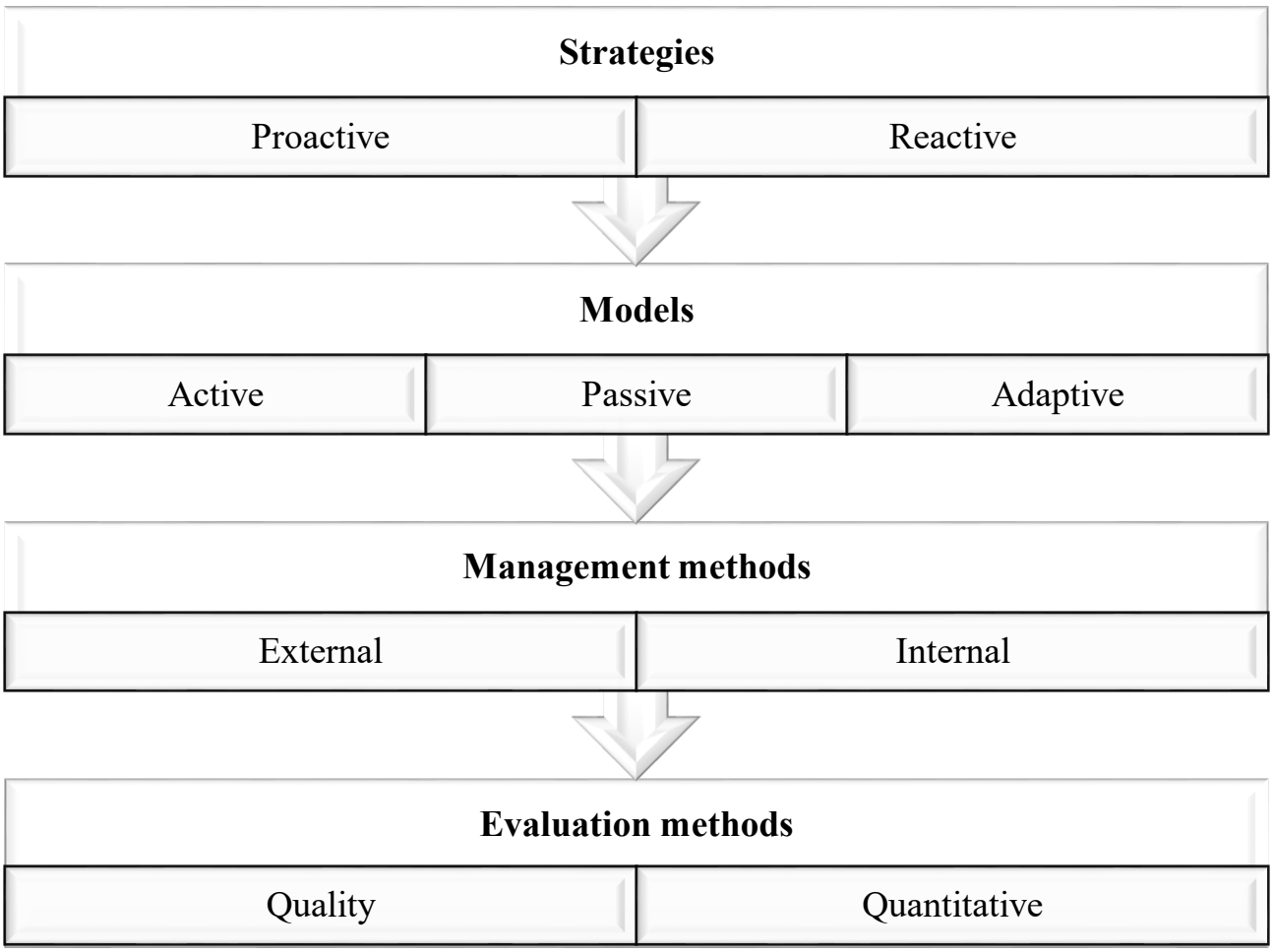


Fig. 1.7. Hierarchy of formation of the risk management system of a manufacturing enterprise

Source: compiled by the author

Thus, the results of the study of the stages of the risk management process, their characteristics, the main methods of qualitative and quantitative risk assessment by groups, as well as existing risk management models made it possible to substantiate the author's vision of the process of functioning of the risk management system at the enterprise (Fig. 1.3) and to develop the Hierarchy of the formation of the risk management system of a manufacturing enterprise (Fig. 1.7).

1.3. Regulatory and legal framework for risk management of Ukrainian enterprises

In the context of globalization challenges, intensive development of science and technology, integration of Ukraine into the European legal space and the need to ensure economic security, enterprises are faced with constantly growing external and internal risks. And it is risk management that becomes a key element of strategic management of the enterprise.

To ensure effective risk management, to form the basis for organizing processes and procedures aimed at identifying, assessing and minimizing risks, regulatory and legal support for risk management is of particular importance.

To systematize the regulatory and legal acts governing risk management, they should be categorized as follows:

– regulatory and legal acts regulating the general legal framework of risk management in Ukraine;

– specific laws relating risk management;

– international and integrated standards and their adaptation in Ukraine;

– industry-specific legislative and regulatory acts;

– subordinate regulatory legal documents.

Given that there is no specific law on risk management in Ukraine, the formation of basic concepts and foundations for understanding these processes is regulated by relevant regulatory legal acts and standards. Explanations are also contained in by-laws aimed at implementing laws and regulating public relations. All this provides a general understanding of the risk management process.

The right to ensure the safety and protection of citizens, safe working conditions, environmental safety, and guarantees of entrepreneurial activity is enshrined in the Constitution of Ukraine [63]. Although the main regulatory legal act of the state does not define specific mechanisms for enterprise risk management, it is the foundation for creating a stable legal framework and guaranteeing property rights. This allows reducing political and legal risks and ensuring equal conditions for free

entrepreneurship, which in turn will allow enterprises to effectively manage internal risks.

In particular, the Constitution of Ukraine ensures the protection of the rights of all subjects of property and business, and also establishes their equality before the law (Article 13), which in turn reduces the risk of illegal seizure of property and creates legal prerequisites for the stable functioning of the enterprise. Article 42 enshrines the right of everyone to entrepreneurial activity that is not prohibited by law, which reduces the risks associated with unequal conditions of competition. The next, Article 43, guarantees the right to safe and healthy working conditions, defines the rights and obligations of employers and employees, which allows avoiding the risks of violation of rights and social norms. Articles 16, 17 and 50 enshrine the right of everyone to a safe environment, ensuring environmental, economic and information security.

Thus, the Constitution of Ukraine is a legislative framework that allows enterprises to apply special risk management methods to identify and analyze risks, manage them, and develop reliable risk strategies depending on the situations.

No less important legislative bases for risk management are codified acts – consolidated regulatory legal acts that provide legal regulation, systematization and generalization of legal norms of individual spheres of social relations, uniting the norms of a certain branch of law [100].

The legal basis for risk management, in our opinion, is the Commercial and Civil Codes of Ukraine

The Commercial Code of Ukraine (hereinafter referred to as the ComCU) until August 28, 2025 was the main regulatory legal act that determined the limits of liability of business entities, regulated the application of economic sanctions, and also contained norms that regulated public relations in the field of economic activity and directly related to the management of business risks [21]. However, due to the duplication of many norms of the aforementioned document, the Civil Code of Ukraine was abolished, and all corporate and economic norms came under the regulation of the Civil Code of Ukraine [102].

Civil Code of Ukraine (hereinafter referred to as the CivCU) [132] in turn, contains a number of provisions directly related to risk management and establishes the legal basis for effective risk management by determining the liability of the parties and regulating contractual obligations. For example, Article 617 of the Code defines the grounds for exempting participants in civil relations from liability for breach of obligation; that is, the party bearing the risk may be exempted from liability if it proves that the accidental destruction of products occurred as a result of force majeure circumstances. The Civil Code of Ukraine also establishes rules for the transfer of risk of accidental damage or destruction of products under a purchase and sale agreement (Article 668), which allows determining at the legislative level which of the participants in the contractual relationship – the buyer or the seller – is liable for the negative consequences if the goods are destroyed or damaged not through their fault, but as a result of any accidental situation.

Thus, the Civil Code of Ukraine establishes rules on liability for non-fulfillment or improper fulfillment of obligations under contracts, which allows the parties to minimize risks from non-fulfillment of the terms of the contract in a timely manner. The Civil Code also defines legal mechanisms that allow counterparties to conclude contracts that contain provisions on the distribution and insurance of risks and determines the means of protecting the rights and interests of participants in civil relations in the event of a particular risk situation.

A summary of the regulatory and legal acts that provide general legal principles for risk management in Ukraine is presented in Table 1.7.

The analysis thus indicates that in Ukraine, currently the regulatory and legal acts regulating the general legal principles of risk management are the Constitution of Ukraine and the Civil Code of Ukraine. Although these documents do not directly define the fundamental principles of risk management, they create a basis for enterprises to manage risks effectively.

Table 1.7

Regulatory and legal acts that provide general legal frameworks for risk management in Ukraine (with changes and additions)

No.	Document name	Year of adoption	Brief description
1	Constitution of Ukraine [64]	1996	guarantees the right to ensure the safety and protection of citizens, the right to safe and healthy working conditions, protection of the rights of all subjects of property and economic activity, environmental safety
2	Commercial Code of Ukraine (expired on 28.08.2025) [21,102]	2003	defines the foundations of economic activity, taking into account risk management and the responsibility of business entities
3	Civil Code of Ukraine [132]	2003	creates a legal framework for the functioning of risk management by establishing liability, regulating contractual relations and protecting the rights of the parties

Source: compiled by the author based on [21, 64, 192, 132]

In Ukraine, there are enterprises of various forms of ownership and management, which conduct their activities in different sectors of the economy. It is quite clear that the risk management of each will have certain characteristics. Therefore, it is advisable to further consider the regulatory and legal framework for risk management in terms of sectors and specifics.

One of the important special laws in the field of risk management is the Tax Code of Ukraine (hereinafter referred to as the TCU) [87]. It, as in the above-mentioned NPAs, does not have a classical understanding of risk management, but focuses on tax risks that may arise to varying degrees in any enterprise, regardless of its form of ownership, size or industry. In particular, Article 14 of the Tax Code defines the concept of “tax risk (compliance risk)”, which is characterized by the probability of a taxpayer failing to fulfill his/her tax obligations, such as declaring, submitting reports, paying taxes, etc. Articles 36, 39 define the risks that may arise from various business transactions.

In general, the risk management system is one of the key tools that helps the State Tax Service to timely identify risky transactions through the analysis of tax reporting, reduce administrative pressure, which allows controlling and preventing

possible violations of tax legislation. Thus, in the TCU, risk management acts as a mechanism of public administration to ensure financial stability and compliance with tax legislation [119].

It is also necessary to highlight the Customs Code of Ukraine (hereinafter referred to as the CCU), which regulates the legal basis for risk management in the field of customs control [76]. The legal basis for risk management is enshrined in Articles 361-363 of the Customs Code, which define the objectives of the risk management system, define such concepts as “risk analysis”, “risk analysis objects” and define the tasks of customs authorities for risk assessment and management using an automated risk management system, in particular.

Also, other articles of the codified act are dedicated to building an effective risk management system, which provide for the categorization of enterprises depending on the type of risk (Articles 14 and 395), the definition of concepts for customs regulation, such as “risk” and “risk management” (Article 4), etc.

It is worth noting that the CCU is the first document that enshrines the application of a risk management system as a key mechanism for ensuring the effectiveness of customs control at the regulatory level. Although the Customs Code concerns risk management of state regulation of foreign economic activity, it has significant practical importance for enterprises, as it enables them to build their own internal risk management system based on the principles of transparency and responsibility, because it is on this that the nature of their risks depends and to optimize relations with the state in the field of customs control.

The next special law we will consider is the Labor Code of Ukraine (hereinafter referred to as the LCU), which, unlike the Tax and Customs Codes, does not use the term “risk”, that is, it does not contain a direct norm on risk management. The LCU creates the legal basis for managing risks related to labor relations and occupational safety, which makes it no less important for effective risk management at any enterprise [60].

In particular, the law establishes the employer's obligation to provide safe working conditions for each employee, which allows avoiding reputational and

operational risks. To minimize financial and legal risks, the Code establishes norms for wages and compensations and regulates the issue of concluding, amending and terminating employment contracts at the enterprise.

Given that the Tax and Customs Codes, the Labor Code are codified laws, at first glance they can be attributed to general laws. However, in our opinion, these are special laws that establish specific rules for individual areas, therefore they have priority over the Civil Code (the rule of "lex specialis") [5].

Another law that establishes the obligation of employers to ensure the functioning of the occupational safety management system and defines the legal basis for the implementation of the right of employees to protection of life and health is the Law of Ukraine "On Labor protection" [104]. The norms of this Law apply to all types of legal relationships that arise between employers and employees and allow minimizing risks in management.

A generalized list of special laws in the field of risk management and their characteristics is presented in Table 1.8.

Before proceeding to the analysis of industry regulations on ensuring risk management of enterprises in Ukraine, in our opinion, it is necessary to consider international and integrated standards. In this case, integrated standards are interpreted by us as standards that can be combined in a single management system (integrated management system, ISM), which allows the enterprise to simultaneously cover the requirements of all standards in its activities and thus manage risks effectively [140].

In international practice, there is no single law that would comprehensively regulate risk management issues for all enterprises, regardless of their field of activity or economic sector. Instead, the basis for the formation of the regulatory and legal framework for risk management is:

– international standards,

– industry laws and regulations,

– laws regulating certain types of risks.

Table 1.8

Special laws in the field of risk management

(with amendments and supplements)

No	Document name	Year of adoption	Key provisions on risk management	Areas of application
1	Customs Code of Ukraine [76]	2012	integration of the modern concept of risk management into the foreign economic activity management system	Enterprises engaged in foreign economic activity
2	Tax Code of Ukraine [87]	2010	Acts as a tool of the state to ensure financial stability and compliance with tax legislation	All areas of application
3	Labor Code of Ukraine [60]	1971	creates a legal framework for managing risks related to labor relations and occupational safety	All areas of application
4	Law of Ukraine "On Labor Protection" [104]	1992		All areas of application/ Enterprises with employees
5	Law of Ukraine “On Amendments to Certain Laws of Ukraine on Information Protection and Cybersecurity of State Information Resources and Critical Information Infrastructure Objects” [91]	2025	Digital asset protection and cyber risk management	Public sector, critical information infrastructure
6	Law of Ukraine “On Protection of Personal Data” [98]	2010	Establishes requirements for information risk management	All areas of application
7	Law of Ukraine “On Accounting and Financial Reporting” [90]	1999	Defines risk assessment in financial management	All areas of application
8	Law of Ukraine “On Audit of Financial Statements and Auditing Activities” [89]	2017	Sets requirements for financial risk assessment and information transparency	All areas of application

Source: compiled by the author based on [60, 76, 87, 89, 90, 91, 98, 104]

The basis for the development and implementation of a risk management system at any enterprise, regardless of its form of ownership or type of activity, are national and international standards. Therefore, the implementation of international risk management standards in Ukraine is of great importance.

The evolution of the development and implementation of international standards shows that many different structures have collaborated on them both at the national and international levels. For example, the Risk Management Standard. This standard was developed by the Federation of European Risk Management Associations (FERMA) in cooperation with three British organizations: the Association of Insurance and Risk Management (AIRMIC), the Institute of Risk Management (IRM) and the Public Risk Management Association (ALARM) in 2002. And although the FERMA Risk Management Standard, unlike other standards, is not certified, it provides a common understanding and approaches to risk management, therefore it is a guide for European companies [173].

The next most influential, but also non-certified, standard in the field of risk management is the Enterprise Risk Management (ERM) – Integrated Framework, developed by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) in 2004. The purpose of this standard is to develop guidelines for risk management and their integration into the strategy of enterprises. The uniqueness of ERM is that, unlike other standards that mainly focused on financial risk management, ERM offers a comprehensive approach to managing all types of risks that can affect the activities of enterprises [163].

Next, we will consider the standards developed by the International Organization for Standardization (ISO), which have been implemented in many countries and a number of UN organizations. It is worth noting that Ukraine has also joined this global harmonization process, starting in 2009.

When working on an effective risk management system, it is necessary to pay special attention to the ISO 31000:2018(en) Risk management – Guidelines “family” of standards, developed by the International Organization for Standardization (ISO).It is fundamental, as it defines the basic principles and tools for building a risk

management system, and also allows enterprises to dynamically respond to changes and identify new risks in the risk management process [194]. This standard is universal, meaning it can be applied by enterprises regardless of ownership, size or type of activity and allows the risk management process to be integrated into all processes of the organization.

Harmonization of international standards with domestic legislation occurs through their implementation at the level of National Standards of Ukraine (DSTU). Thus, DSTU ISO 31000:2018 “Risk Management. Principles and Guidelines” is identical to the international standard, which allows Ukrainian enterprises to apply international norms in practice [36].

International standard ISO 31010:2019 (en,fr) Risk management – Risk assessment techniques [195] in the Ukrainian legal field found an analogy in DSTU IES/ ISO 31010:2013 “Risk management. General risk assessment methods” [37].

The introduction of the next standard, ISO Guide 73:2009 Risk management – Vocabulary (implemented by DSTU ISO Guide 73:2013 Risk management. Vocabulary), was an important step due to the need for unification of terminology and understanding in the field of risk management [40, 187]. Before this standard was introduced, companies used their own terminology for risk management, which created confusion, communication difficulties and misunderstandings. Thus, ISO Guide 73:2009 is a valuable addition to the main ISO 31000:2018 standard.

The following standard, ISO/TR 31004:2013 Risk management – Guidance for the implementation of ISO 31000, is not a stand-alone standard [190]. It helps enterprises that apply ISO 31000 in their practice to move more easily and effectively from theoretical principles to their practical implementation. In other words, it is a manual that provides detailed step-by-step instructions for integrating risk management, recommendations for creating a risk management system, and examples of applying risk management in various areas. This standard corresponds to the Ukrainian DSTU ISO/TR 31004:2018 “Risk management. Guidance on the implementation of ISO 31000” [39].

In the face of constant cyberattacks, information security risk management is vital to protecting critical infrastructure around the world. The ISO/IEC 27005:2022 Information security, cybersecurity and privacy protection – Guidance on managing information security risks standard fills the gap in the information security management system. This standard provides a detailed approach to identifying, assessing, handling and monitoring risks, which helps enterprises make informed decisions after analyzing real risks [189]. ISO/IEC 27005:2022 is a complement and key tool to the main standard ISO/IEC 27001:2022 Information security, cybersecurity and privacy protection – Information security management systems – Requirements, which outlines the requirements for an information security management system [188].

The implementation of ISO/IEC 27005:2022 allows Ukrainian companies to align their risk management process with international practices. The national standard DSTU ISO/IEC 27005:2023 (ISO/IEC 27005:2022, IDT) "Information security, cybersecurity and privacy protection. Information security risk management guidance" has practical significance for Ukraine. This is not just a standard, it is a tool through which we can not only strengthen cyber resilience and protect Ukrainian assets in war conditions, but also build trust on the international stage [38].

No less important in the formation of risk management at the enterprise is the standard ISO 22301:2019 Security and resilience – Business continuity management systems – Requirements (implemented by DSTU EN ISO 22301:2021 Security and stability. Business continuity management systems. Requirements (EN ISO 22301:2019, IDT; ISO 22301:2019, IDT) [33]. This international standard (hereinafter referred to as BCMS) is an applied basis for building an effective business continuity system and enables any enterprise, regardless of size, type or type of activity, to maintain resilience in the event of emergencies, which is especially relevant when managing risks in current conditions [193].

BCMS is aligned with a number of other, equally important international standards for risk management, such as ISO/IEC 27005:2022 Information security, cybersecurity and privacy protection – Guidance on managing information security risks [188], ISO 9001:2015 Quality management systems – Requirements [191],

ISO 14001:2015 Environmental management systems – Requirements with guidance for use [192] etc.

A good example of sectoral laws and regulations in the financial sector is the Basel III series of reforms, which was the response of the Basel Committee on Banking Supervision to the global financial crisis of 2008. In this standard, unlike Basel I and Basel II, the emphasis is placed not only on increasing the quality and volume of capital, but also on greater requirements for risk management, improving their assessment, which in turn will lead to minimizing risks for depositors. In particular, the calculation of capital adequacy requirements has been improved, taking into account credit, market and operational risks [186].

The main countries in which Basel III has been implemented are Canada, China, Japan, Switzerland, the UK, the USA and the EU countries. In Ukraine, these norms are also implemented by the National Bank of Ukraine through its NPA and resolutions in accordance with the requirements of European integration (Resolution of the Board of the National Bank of Ukraine dated 24.12.2019 No. 158 “On the introduction of the net stable funding ratio (NSFR)” [93]).

If Basel III was developed for the financial and banking sector, the purpose of the next standard – Solvency II (or Directive 2009/138/EU) – is to regulate risks in the insurance sector for the financial stability of insurance companies. Solvency II was developed by the European Commission together with the European Insurance and Occupational Pensions Authority (EIOPA) and other institutions of the EU member states in 2009, but its full implementation took place from January 1, 2016 [170].

Ukraine is successfully implementing the main provisions of Solvency II into its legislation. The new Law of Ukraine “On Insurance” dated November 18, 2021 No. 1909-ИХ (entered into force in 2024) is based on the principles of Solvency II and contains more stringent risk management requirements for insurance companies. However, not all institutions have yet managed to develop “secondary” legislation to implement the provisions of the new law, which to one degree or another complicates the work of insurance market participants [107].

Further examples of industry-specific laws include the Risk Management Program (RMP) Rule (USA), which requires businesses that handle hazardous substances to develop risk management plans to ensure environmental safety [224] and Health and Safety at Work etc. Act 1994 (United Kingdom), which requires employers to carry out risk assessments for the health and safety of workers [181]. These regulatory documents have not been directly incorporated into the legislation of Ukraine, as they have specific features of their legislation. However, Ukraine has its own NAPs on the prevention and minimization of risks associated with hazardous chemicals, health and safety of workers, which are based on EU directives. In particular, the analogue of the RMP is The SEVESO III Directive (2012/18/EU) [233], harmonization with which took place through the Law of Ukraine "On High-Hazard Facilities" [101] and the Procedure for identification and registration of high-risk facilities and their registration, approved by the Resolution of the Cabinet of Ministers of Ukraine "Some issues of identification of high-risk facilities" [29].

Some countries have enacted laws to regulate specific types of risks that are of particular importance to their economy or national security. For example, Germany has enacted the Lieferkettensorgfaltsplichtengesetz (LkSG), which requires large companies to manage human rights and environmental risks in their supply chains [203]. Due to the fact that LkSG is a domestic law of Germany, the impact of its action on Ukrainian enterprises is indirect and is expressed in the terms of cooperation with German companies within the framework of this law.

Instead, in the European Union, on July 24, 2024, a similar, but broader-ranging directive came into force – Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on corporate sustainability due diligence (CSDDD) [169].

Since the main provisions of the CSDDD focus not on traditional financial, operational and legal risks, but on risks related to sustainable development and social responsibility, this Directive has a significant impact on risk management. The CSDDD forces all enterprises to include in their analysis such risks as human rights

violations, environmental and reputational risks. The Directive is still new and, in our opinion, harmonization of Ukrainian legislation with it is a matter of time.

Table 1.9 presents generalized information on current international standards and the process of their implementation into Ukrainian legislation.

Table 1.9

International and integrated standards for risk management

No	Document name	Year of adoption	Implementation
1	2	3	4
1	ISO 31000:2018 Risk management – Guidelines [194]	2018	DSTU ISO 31000:2018 (ISO 31000:2018, IDT) Risk Management. Principles and Guidelines [36]
2	ISO 31010:2019(en,fr) Risk management – Risk assessment techniques [195]	2019	DSTU IEC/ ISO 31010:2013 Risk management. General risk assessment methods [37]
3	ISO Guide 73:2009 Risk management – Vocabulary [187]	2009	DSTU ISO Guide 73:2013 Risk management. Vocabulary [40]
4	ISO/TR 31004:2013 Risk management – Guidance for the implementation of ISO 31000 [190]	2013	DSTU ISO/TR 31004:2018 Risk management. Guidance on the implementation of ISO 31000 [39]
5	ISO/IEC 27005:2022 Information security, cybersecurity and privacy protection – Guidance on managing information security risks [189]	2022	DSTU ISO/IEC 27005:2023 (ISO/IEC 27005:2022, IDT) Information security, cybersecurity and privacy protection. Information security risk management guidance [38]
6	ISO 22301:2019 Security and resilience – Business continuity management systems – Requirements [193]	2019	DSTU EN ISO 22301:2021 Security and stability. Business continuity management systems. Requirements (EN ISO 22301:2019, IDT; ISO 22301:2019, IDT) [33]
7	ISO 9001:2015 Quality management systems - Requirements [191]	2015	DSTU ISO 9001:2015 (ISO 9001:2015, IDT) Quality management systems. Requirements [34]
8	ISO 14001:2015 Environmental management systems – Requirements with guidance for use [192]	2015	DSTU ISO 14001:2015 (ISO 14001:2015, IDT) Environmental management systems. Requirements and guidance for use [35]

Continuation of Table 1.9

1	2	3	4
9	Directive on corporate sustainability due diligence (EU) [169]	2024	Implementation work is underway
10	Basel III [186]	2010	The norms are implemented through NPA and NBU resolutions (for example, Resolution of the NBU Board dated 24.12.2019 No. 158 "On the introduction of the net stable funding ratio (NSFR)" [93])
11	Solvency II (or Directive 2009/138/EU) [170]	2009	The norms are implemented through the legislation of Ukraine (for example, the Law of Ukraine "On Insurance" [107])
12	The SEVESO III Directive (2012/18/EU) [233]		Standards are implemented through legislation in the field of environmental safety
13	Risk Management Standard (FERMA) [173]	2002	is not certified
14	Enterprise Risk Management – Integrated Framework (COSO) [163]	2004	is not certified
15	Risk Management Program (RMP) Rule (USA) [224]	1996	have their own NPAs
16	Health and Safety at Work etc. Act 1994 (Great Britain) [181]	1994	have own NPAs (for example, the Law of Ukraine "On Labor Protection" [104])
17	Lieferkettensorgfaltspflichtengesetz (Germany) [203]	2023	German domestic law

Source: compiled by the author based on [163, 169, 170, 173, 181, 186, 187, 189-195, 203, 224, 233]

Thus, international practice shows that the enterprise risk management system is an integrated model of sectoral, corporate and international regulatory legal acts.

Sectoral regulatory legal acts that ensure risk management of enterprises in Ukraine are those acts that provide legal regulation of a certain sphere of social relations. Table 1.10 presents a list indicating the scope of application of a particular NPA.

Table 1.10

Sectoral regulatory legal acts for risk management in Ukraine
(with amendments and supplements)

No	Document name	Year of adoption	Key provisions on risk management	Areas of application
1	Resolution of the NBU Board "On the introduction of the net stable funding ratio (NSFR)" [93]	2019	Regulation, supervision and risk management in the banking system	Finance and banking
2	Law of Ukraine "On Insurance" [107]	2021	Risk management requirements are established	Insurance sector
3	Law of Ukraine "On Standardization" [106]	2014	Regulates risk management and quality control standards	The scope covering the development, adoption and application of standards
4	Law of Ukraine "On Metrology and Metrological Activities" [99]	2014	Regulates risks associated with measurement inaccuracy and inaccuracy	Metrology field
5	Law of Ukraine "On Environmental Protection" [103]	1991	Regulates environmental risks (corporate liability)	Industrial production sector
6	Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine on Improving State Supervision (Control) in the Field of Technogenic and Fire Safety" [92]	2023	Risk management of man-made emergencies and fires	Industrial production sector, critical infrastructure
7	Law of Ukraine "On the Public Health System" [105]	2022	Regulates risks associated with the impact of production on human health	Industrial production sector
8	Resolution "On Approval of the Methodology for Identifying Risks in the Implementation of Public-Private Partnerships, Their Assessment and Determination of the Form of Their Management" [95]	2011	Regulates the allocation and assessment of risks in PPP projects	PPP / Infrastructure and investment projects
9	Resolution of the Cabinet of Ministers of Ukraine "On approval of the methodology for assessing security risks in the education system related to the armed aggression of the Russian Federation against Ukraine" [96]	2024	Methodology for assessing security risks in the education system related to the armed aggression of the Russian Federation against Ukraine	Educational sector

Source: compiled by the author based on [92, 93, 95, 96, 99, 103, 105-107]

It is obvious that the financial sector is the sector with the highest requirements for risk management and the main regulator in this area is the National Bank of Ukraine (hereinafter referred to as the NBU). NBU resolutions based on Basel III principles [186], define requirements for credit, market, and operational risk management. An example is the Resolution of the NBU Board dated 24.12.2019 No. 158 "On the introduction of the net stable funding ratio (NSFR)" [93].

Another example, but already in the insurance sector, is the Law of Ukraine "On Insurance" [107], which implements the requirements of the European Solvency II Directive [170].

In the public health sector, risk management is regulated by the new Law of Ukraine "On the Public Health System" [105]; in the standardization and metrology sector – Laws of Ukraine "On Standardization" [106] and "On metrology and metrological activities" [99]. Also, sectoral regulatory and legal acts regulate risk management issues in the field of information security [38], industrial production and critical infrastructure [92,103], educational sector [96], in the field of public-private partnership [95] etc.

Examples of some subordinate regulatory documents ensuring risk management in Ukraine are given in Table 1.11.

Thus, considering the above-analyzed regulatory framework of Ukraine, international standards and existing Ukrainian ones implemented in relation to risk management, we can conclude that in Ukraine there is an active work on harmonizing domestic legislation with international and European standards. Despite the fact that the application of international standards is voluntary, many large Ukrainian enterprises implement them to increase their competitiveness and improve risk management, in particular.

At the same time, the analysis of the regulatory framework for risk management in Ukraine shows that it is fragmented, sometimes unsystematic and scattered in various documents, which makes it difficult for enterprises to implement effective risk management mechanisms. Thus, the fundamental principles of risk management are partially enshrined in the Constitution of Ukraine, there is no definition of a single

concept of “risk” or a single methodology, and regulatory regulation of risk management largely depends on the industry. As international experience shows, it is the sectoral division that is sufficient for effective management. But in Ukrainian realities, there is a disproportion between regulatory legal acts by industry. For example, the regulation of tax or environmental risks is more “protected” by legislative norms than other sectors of the economy.

Table 1.11

Subordinate regulatory documents for ensuring risk management in Ukraine

No	Document name	Year of adoption	Key provisions on risk management	Areas of application
1	Order of the Ministry of Internal Affairs of Ukraine “On Approval of the Methodology for Assessing the Risks of Emergencies of a Technogenic Nature and Fires” [97]	2023	Risk management of man-made emergencies and fires	Industrial production sector, critical infrastructure
2	Order of the Ministry of Agrarian Policy of Ukraine “On the introduction of a quality management system in accordance with the requirements of DSTU ISO 9001:2001” [94]	2007	Creation of a working group for the implementation of the quality and risk management system	Agricultural sector
3	Orders of the Ministry of Economy, Environment and Agriculture of Ukraine [77]	by year	Implementation of quality and risk management systems	All areas of application
4	Orders of the State Labor Service of Ukraine [28]	by year	Establish a procedure for risk analysis to protect the life and health of employees	All areas of application

Source: compiled by the author based on [28, 77, 94, 97]

Therefore, to fill these gaps, we consider it appropriate to take the following steps to improve regulatory and legal support:

1). At the level of regulatory and legal acts, continue the development of industry-specific risk assessment methodologies, namely, recommend or oblige enterprises in various sectors of the economy, depending on the degree of complexity and criticality of the industry, to develop Business Continuity Management Strategies based on BCMS requirements [33, 193] and obtaining the ISO 22301 certificate. This encourages the company not just to think about risks, but to be prepared for them, which will allow it to avoid a crisis, strengthen its position in the market and improve risk management.

2). In order to stimulate the implementation of certified risk management systems based on the international standard ISO 31000:2018 Risk management – Guidelines [194], it is advisable to make amendments to the Tax Code of Ukraine in terms of introducing a mechanism for granting the right to a temporary reduction in tax liabilities (introduction of an investment tax credit) for business entities that successfully implement the aforementioned systems. The implementation of this initiative will not only be able to compensate for the costs, for example, for the digitalization of risk processes, but will also contribute to the growth of the prestige of enterprises with a developed risk management system, which confirms their self-sufficiency and reliability in terms of fulfilling contractual obligations, product quality and the ability to ensure the continuity of business processes in conditions of macroeconomic instability.

3). In order to harmonize Ukrainian legislation with European standards in terms of critical infrastructure protection, expand the regulatory framework for cyber security of industrial facilities by introducing the mandatory inclusion of digital risks, such as cyber threats and data leaks, in the overall risk mitigation plans manufacturing enterprises.

Conclusions to chapter 1

The generalization of the above material provides grounds for formulating the following conclusions regarding the main theoretical provisions for the formation of a risk management system for manufacturing enterprises:

1. The interpretation of the concept of “risk” is in constant transformation depending on changes in the world economy, the needs of a particular industry and the methods of its assessment. Because of this, it is impossible to single out any one of the above definitions, to choose the best option. Therefore, in our opinion, the most rational is to use the definition that corresponds to the state and needs of a particular industry in a certain period of time. As a result of the analysis of the approaches of Ukrainian and foreign scientists to the interpretation of the concepts of “risk”, “risk management”, “manufacturing enterprise” we have proposed an author's definition of the concept of “risk management of manufacturing enterprises”.

We have proven that risk is the potential possibility of an undesirable event, it is predictable or one that can be identified and assessed. In contrast, a crisis is a consequence of any destabilizing event, a state when a negative event has already occurred and disrupted the normal functioning of the system. Thus, there is a cause-and-effect relationship between the concepts of “risk” and “crisis”, which is as follows: If risk is not managed or is managed ineffectively, it can develop into a crisis. And since risk is a probabilistic characteristic of the possibility of a crisis, risk management is the preventive stage of crisis management.

2. In the course of studying the stages of the risk management process at the enterprise, the author systematized the process of functioning of the risk management system at the enterprises of Ukraine. Thus, we have identified 6 stages: preparatory stage, risk identification, risk analysis, risk assessment, risk neutralization (optimization, minimization), monitoring and control. At each stage, the main content of the work of this stage is indicated and this process is summarized with the main goal - making an effective managerial decision.

In the disclosure of the research objectives, the assessment methods were also analyzed and it was found that scientists have differences in the definition of qualitative

and quantitative methods. Qualitative methods of risk assessment are not always only expert in nature, but are also based on mathematical calculations. Their main difference from quantitative assessment is that they assess the factors, sources of risk occurrence, possible consequences in the event of an occurrence. And quantitative methods are more focused on calculating the probability of occurrence. This is why different scientists classify the methods as both qualitative and quantitative. Moreover, expert methods are also found in both groups, although they are somewhat subjective. That is why, in order to avoid subjectivity, it is worth involving qualified personnel in the risk management system.

Based on the obtained assessment results, we can make decisions about risk management methods, but these methods are also derived from the risk management model and strategy adopted at the enterprise. The methods themselves are also numerous, which can be conditionally divided into external and internal methods. The choice of risk management and assessment methods depends on various factors and may vary at each enterprise. It is important that they should be chosen taking into account the effect that they can bring to a given enterprise. As a result of the research, a hierarchical model of building a risk management system for a manufacturing enterprise was formed, which serves as a tool for early detection of threats and prevention of crises, and the author's vision of the process of its functioning was proposed.

3. It was found that Ukraine is actively adapting international standards into national legislation through the DSTU system, which ensures harmonization with European Union legislation.

The analysis of regulatory and legal support has shown that the application of risk management in Ukraine is regulated by various regulatory and legal acts. It is clear that this is not one law, but a system of regulatory and legal acts in different areas: from general and special laws to sectoral and subordinate legislation. However, there is a certain imbalance between them in terms of functional coverage and sectoral specification.

To overcome this, in our opinion, it is necessary to shift the emphasis from risk prevention to an orientation towards consequences, that is, to stimulate mechanisms for the implementation of proactive risk management systems (benefits for certified enterprises) and to continue the development of industry risk assessment methodologies based on international standards (ISO 22301:2019, ISO 31000:2018, etc.). It is also necessary to strengthen work on harmonizing domestic legislation with international standards, in particular, in terms of digital risks, which will allow creating a stable legal environment that will become a reliable basis for preventively leveling crisis phenomena and strengthening the competitive positions of Ukrainian enterprises in the global economic environment.

CHAPTER 2
DIAGNOSTICS OF THE CURRENT STATE OF RISK MANAGEMENT IN MANUFACTURING ENTERPRISES

2.1. Risk assessment of macroenvironment of manufacturing enterprises

To assess the risk of enterprises, it is important to diagnose the risk environment of their activities at the macro level. It is clear that the activities of enterprises, their risks and, accordingly, the risk management system are influenced not only by micro factors, but also by macro factors, at the country level. For this, it is important to study the enterprise environment at the macro level, the basis for which can be international ratings, assessments, as well as socio-economic indicators of Ukraine and the results of the activities of domestic enterprises, given in official statistical sources.

When studying risks for the further formation of a risk management system, it is worth studying the results of the World Economic Forum CEO Survey, which was conducted in 2024 and involves a survey of executives who identify the 5 main risks that threaten the country in the next 2 years. Executives will choose from 34 risks that fall into one of these categories: economic, environmental, geopolitical, societal and technological [175]. The results of the latest study are shown in Fig. 2.1.

As we can see, the leaders of the organizations identified the 5 biggest threats for Ukraine and enterprises, in particular. Thus, they noted that the possible threats fall into 3 categories: societal, economic and geopolitical. Analysis of the risks included in them makes it possible to see that all risks have one or another relation to the activities of enterprises. The greatest risk for leaders has been the forced displacement of the population. This has a negative impact both on the country from which people leave for other countries and on business, as the outflow of migrants leads to a labour shortage. Next come the risks classified as economic.

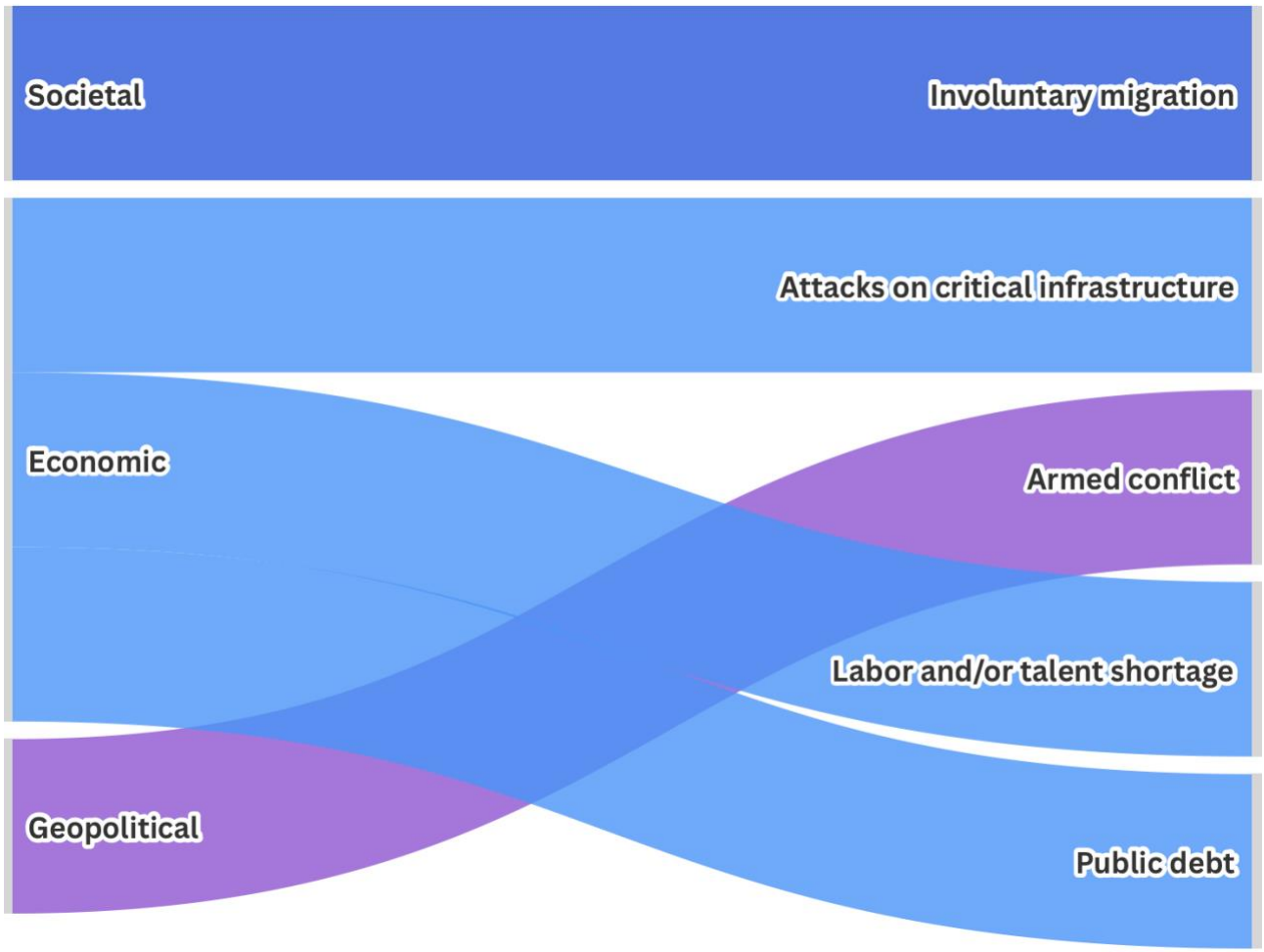


Fig. 2.1. TOP-5 risks according to the results of the Executive Survey (EOS)

Source: compiled by the author based on [175].

Among them, the leaders noted such as attacks on infrastructure, labor shortages and public debt. That is, economic risks make up the largest share of the categories identified by the leaders. We agree with the risks indicated by the leaders, which create real threats to the effective operation of enterprises and the disclosure of their full potential. That is why it is important to take into account these risks when forming a modern risk management system for a manufacturing enterprise.

One of these indicators, which is considered international, is the Logistics Performance Index (LPI). This Index is an international rating calculated by the World Bank (hereinafter referred to as the WB) based on the results of an expert survey [206]. The World Bank assesses more than 100 countries around the world (the number varies each reporting year) on 6 key indicators related to logistics efficiency and derives a weighted average value across these six dimensions:

1) The efficiency of the clearance process – how quickly and simply documents and goods are processed by border authorities. This is important for the implementation of their activities, as it allows enterprises to fulfill their obligations on time or, conversely, slows them down (Customs score);

2) the quality of trade and transport infrastructure, which includes ports, railways, roads, etc. It is clear that for Ukraine under martial law, this dimension is quite problematic and creates real threats to enterprises for production activities (Infrastructure score);

3) Ease and simplicity of organizing transportation at competitive prices (International shipment score);

4) Competence and quality in the organization of logistics services (Logistics competence score). This component of the index is quite important considering what experience there is in the organization of logistics services, whether there is a supply of transport operators, customs brokers, etc.;

5) The ability to track and control cargo (Tracking and tracing score). This is becoming particularly relevant in the context of the spread of digitalization of enterprise activities and the opportunities that arise against this background. Also, taking into account martial law, this dimension is necessary to ensure the implementation of one's activities;

6) Timely delivery of cargo according to the plan and within the delivery terms (Timeliness score). From the point of view of conducting business and assessing its risks, this dimension is an important signifier of trust in the company, creating its image and bearing reputational risks, which justifies the importance of analyzing this dimension [16, 206].

And based on these 6 points, a weighted average indicator of the Logistics Performance Index is derived, which is generalizing and allows to see the logistics risks and threats of domestic enterprises. This index is calculated approximately every 2 years, but with certain exceptions: for example, according to the World Bank, there is data from 2007 with a subsequent calculation in 2010 and subsequent two-year data,

but after 2018, a report for 2023 is provided [206]. The index is calculated on a scale from 1 to 5, where 5 is the highest level [59]. In Appendix A we have provided all the presented results of this Index, which are given by the World Bank, which indicate the main dimensions by which the assessment was carried out, as well as the 3 leading countries according to this Index, the results of Ukraine and the 3 countries with the lowest results. This will allow for a more in-depth analysis of Ukraine's place according to this Index and see what can be improved.

Figure 2.2 illustrates Ukraine's main performance on this indicator during the period of calculation of the Index, as well as the rating of Ukraine in the world. The figure also presents the maximum and minimum result for the corresponding year, which allows us to see the difference between Ukraine and them.

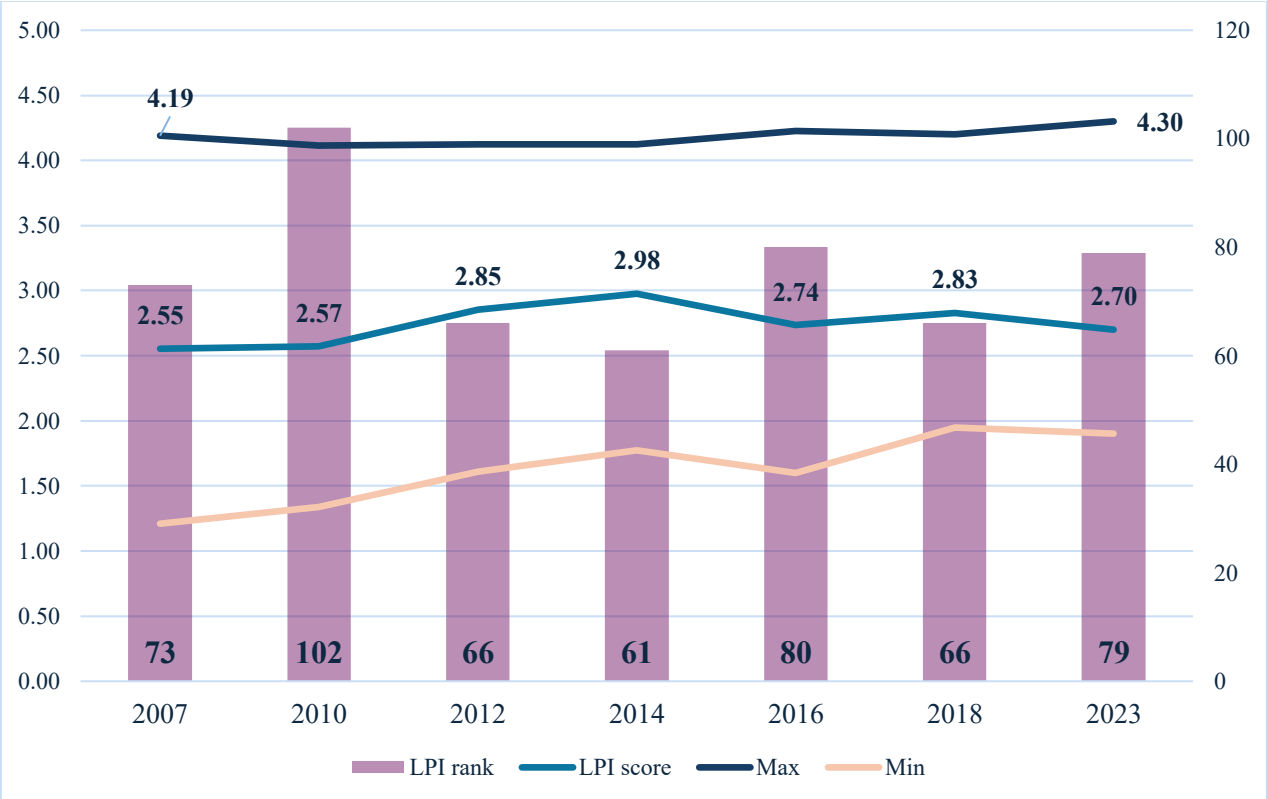


Fig. 2.2. Ukraine in the global Logistics Performance Index, 2007-2023

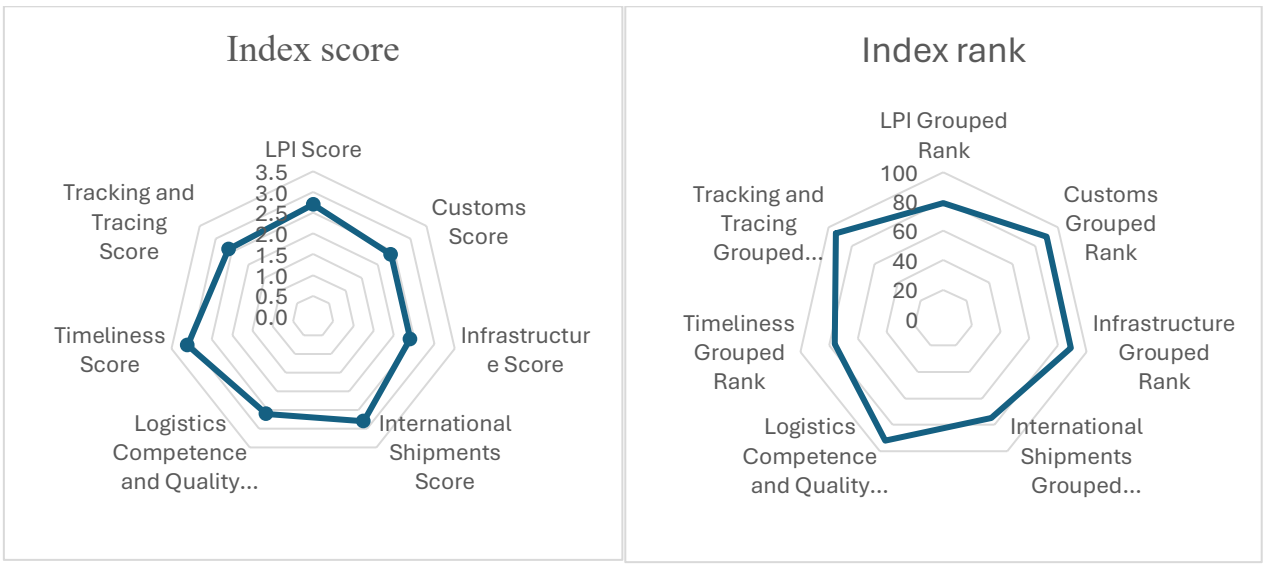
Source: compiled by the author based on [185]

The figure shows Ukraine's score on this index as lines, as well as the maximum and minimum indicators, and the histogram with a secondary axis shows the result of Ukraine's rating in the corresponding year. As we can see, Ukraine's score for the

analyzed period is characterized by certain fluctuations, but does not have an indicator below 2.55. Ukraine's index had a positive growth trend until 2014, including a further decrease in 2016 and another increase in 2018 – to 2.83. According to the result of the score assessment of this Index, Ukraine's score is closer to the maximum level than to the minimum. The result of 2023 is lower than the previous one – 2018 and is equal to 2.70, which is 2.3 below the maximum. The deterioration in 2023 may be the result of martial law and the logistical problems associated with it, military operations on the territory of Ukraine, restrictions on access to certain territories, restrictions on trade routes, blockade of sea routes, etc.

The result of Ukraine's rating according to this Index is notable: its dynamics are characterized by greater fluctuations than the score result, and Ukraine's rating decreased to the 102nd place in the world with further growth and the best indicator - 61st place in 2014. The positive growth of this rating for Ukraine in 2018 to the 66th place was replaced by a decrease to the 79th place. However, this is still better than the result of 2010 (102nd place) and 2016 (80th place).

In Fig. 2.3 we illustrate the score result (a) by the components of this index in Ukraine in 2023, as well as the rating position (b) by these same components.



(a) (b)

Fig. 2.3. Ukraine in the global Logistics Performance Index, 2007-2023

Source: compiled by the author based on [185]

As can be seen from the figure, the best result, namely 3.1 in the component – timely delivery of goods. This is a positive characteristic, because it means that enterprises deliver goods on time and meet their obligations. However, this result is significantly lower than the highest level of 5.0. The worst are the indicators of customs clearance and logistics infrastructure (2.4, respectively). This is fully justified by the wartime conditions in Ukraine. But, as we can see, it does not differ much from other.

Also quite remarkable are the results of Ukraine's ranking position in these components. Thus, the ease of organizing transportation reflects the best result among other components – 75th position, which goes hand in hand with the speed of cargo delivery – 76th place. This characterizes Ukrainian entrepreneurs quite positively, who, in conditions of limited logistics routes, find opportunities to deliver cargo on time.

Worse positions by components – cargo tracking and control (94) and logistics competencies (92).

In our opinion, the deterioration of the indicators according to this Index is fully correlated with the situation that has developed in Ukraine – martial law, active hostilities, destruction of energy infrastructure, which reduces the ability to provide timely and high-quality logistics services, worsens the technological capabilities of cargo tracking due to communication problems during power outages. All this cannot but affect the result according to this Index and indicate that Ukrainian enterprises are facing a real problem in the timely provision of services. This can negatively affect the timely supply of products and raw materials and, accordingly, reduce the ability of enterprises to produce new products and services according to planned indicators. Therefore, when forming a risk management system, it is necessary to take into account the logistical risks that our enterprises are acutely facing.

It is necessary to analyze the country risk, which is determined by the global rating agency AM BEST. Although this company determines the country risk in terms of fulfilling financial obligations, this directly affects the business of Ukrainian enterprises. According to the AM BEST methodology, countries are divided into 1 of 5 levels (from CRT-1 to CRT-5), where countries with the first level of risk are countries with a stable environment and the lowest level of risk, and countries with the

5th level are countries with high risk and a threat to financial stability [165]. This company forms a credit rating that takes into account financial stability, as well as other investment and insurance factors [155].

According to the latest data, as of August 2025, Ukraine's risk level is characterized as having a very high level of economic, political and financial risks. Ukraine is included in CRT - 5. Despite some positive developments in terms of reducing inflation in 2024, its growth is expected in 2025. The financial sector, according to IMF estimates, is characterized by stability, but still requires careful monitoring of increased risks. It is necessary to balance inflation and economic activity through the use of monetary policy [236]. This assessment of the country in these sectors also affects the assessment of risks at the level of enterprises conducting their activities, as they directly depend on the economic, political and financial situation in the country. It is also noteworthy that Ukraine ranks 105th out of 180 countries in the Transparency International's Corruption Perceptions Index [236]. This is a rather negative characteristic and affects the transparency of business operations.

In the development of our research, we will analyze the result of the risk assessment of Ukraine by Coface, an international trade credit risk management company [162]. According to the results of the risk assessment, Ukraine's rating is at level D, as is the business climate assessment [161]. In general, the assessment according to this method varies from A1 to E (A1, A2, A3, A4, B, C, D, E), where D means very high (A1 is very low, E is extraordinary) [174]. Country risk reflects how economic, financial and other factors affect a company's payment behavior. Business climate assessment includes an assessment of the availability of company reporting, creditor protection, easy access to the domestic market, etc. [237]. According to the obtained results, the assessment determines the level of risk and business climate of our country as very high, which is justified by many reasons and is negative from the point of view of risk management. When forming a risk management system for manufacturing enterprises, it is necessary to pay attention to this, as it directly determines both the investment attractiveness of domestic enterprises and the ease of doing business.

Among the strengths, Coface noted the regional location of our country, the Association Agreement and free trade with the EU, the acquisition of the status of candidate for EU membership, the significant potential of agriculture and metallurgy for the country's economy, financial assistance from partners, as well as a qualified workforce. However, they also highlighted the weaknesses of our country, which affect this result and determine the level of risk as very high. Among them, we can highlight the war that is still ongoing in Ukraine, high needs for budget financing, dependence on foreign aid, rather low diversification of the economy, and an important threat is the outflow of population from the country and a significant demographic decline [237]. All this determines both the opportunities for unlocking the potential of our country and the main weaknesses that have a negative impact on the risk environment. The risk management system for manufacturing enterprises must take these points into account when drawing up its risk management plan and policy.

Important in the development of our research are the results of the country risk rating assessment, which is developed by Allianz Trade, a company part of the Allianz Group. This rating measures the risk of default by companies in a country. It consists of two assessments:

- country rating as a medium-term rating, measured from AA (lowest risk) to D (highest risk);

- the country's risk level is measured by a short-term rating from 1 (low risk) to 4 (highest risk)

The medium-term rating assesses economic imbalances, the quality of the business climate, and political threats and risks. It includes a macroeconomic rating, a structural business environment rating, and a political risk rating. While the short-term rating focuses on the direction of economic performance and production over a time horizon of the next 6-12 months. It includes a financing flow indicator and a commercial risk indicator [166].

According to the study, Ukraine has the following results: in 2024, the country's medium-term rating was D, and the short-term rating, which assesses the country's risk level, was 4. Ukraine received the same results in 2025 [150, 167]. This characterizes

the country negatively and as a country with the highest level of risk both at the macroeconomic level and at the business environment level. This can create certain problems in the activities of companies, which is associated with both disruptions in demand and in payment of their obligations. At the country level, this means that there are economic imbalances, instability of the banking system. It indicates the presence of problems in the regulation of the activities of companies, low control of corruption in the country, significant problems in the ease of doing business, etc. This creates obstacles in the activities of companies, reduces the investment attractiveness of the entrepreneurial sector of Ukraine and reduces the efficiency of production activities. To do this, when forming a risk management system, it is necessary to take into account the problems that our entrepreneurs face and build it in such a way as to be able to predict possible disruptions in demand in advance, take into account existing imbalances and at the same time work effectively.

One of the most important indicators by which one can assess the level of risk in a country, including, is the Index of Economic Freedom (hereinafter – IEF). This Index is calculated by the Heritage Foundation and measures the extent to which people have the ability to control their property and work. This Index is measured on the basis of 12 indicators, which are grouped into 4 pillars: Rule of Law (includes property rights, government integrity, and the effectiveness of the judiciary); Size of government (consists of government spending, tax burden, fiscal health); Regulatory effectiveness (business freedom, labor freedom, monetary freedom); Open markets (trade freedom, investment freedom, financial freedom) [231]. The characteristics of the indicators taken into account in the calculation make it possible to see that with low results, the freedom of doing business is violated, there is a problem with property rights, there is a high tax burden, etc. That is, all this is a real threat to the effective conduct of business activities and creates risks in managing the organization.

The index measures each of the 12 indicators on a scale from 0 to 100, where there is the following division: 0 - 50 - repressed, 50 - 60 - mostly unfree, 60 - 70 - moderately free, 70-80 - mostly free, 80 - 100 - free [238]. Regarding Ukraine, data is provided since 1995 and the dynamics of the overall indicator is shown in Fig. 2.4.

However, it should be noted that the Index was fully calculated up to and including 2022, but starting from that date, data were no longer calculated and Ukraine cannot take any position in the world. However, information is available for some indicators after 2022, which we will present in Table 2.1. Appendix B presents available information on changes in the Index of Economic Freedom of Ukraine and the indicators included in it for the period 1995 - 2025

Fig. 2.4 allows to see the dynamics of this Index during the analyzed period. Taking into account the information provided, the dynamics of changes is uneven.

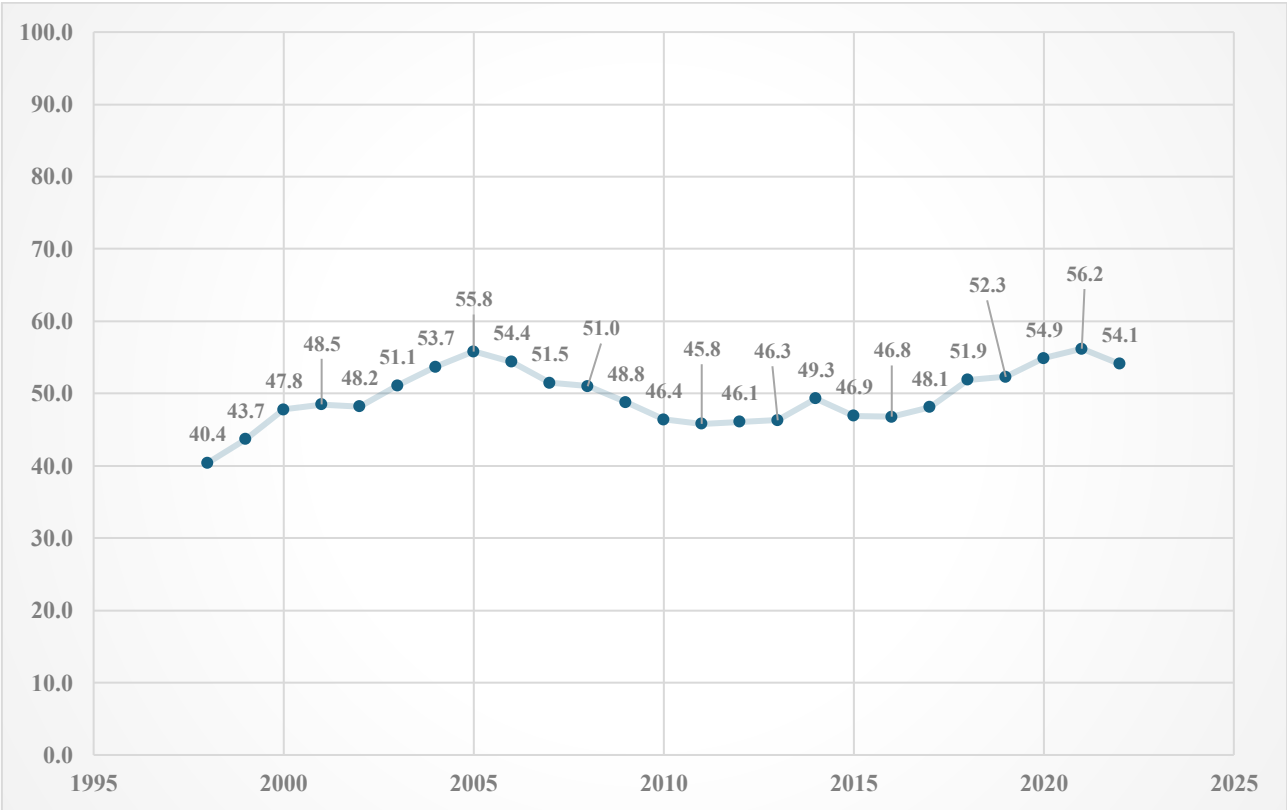


Fig. 2.4. Dynamics of the Index of Economic Freedom of Ukraine, 1995-2022

Source: compiled d by the author based on [238].

The level of freedom had not very positive results during the analyzed period, sometimes improving positions and moving from a repressed level of freedom to a mostly unfree one. All this characterizes doing business in Ukraine as risky, where there are restrictions on property rights, tax burden, etc.

After 2022, the IEF was not calculated for Ukraine in general, which was justified by military actions on the territory of the state and the impossibility of

obtaining various data on the work of enterprises or other important economic indicators. However, for certain indicators, there were still estimates for the period 2024-2025 (data as of December 2025). We illustrate them in Table 2.1.

Table 2.1

Main results of the assessment of the Index of Economic Freedom of Ukraine, 2024-2025

Years	Property rights	Government Integrity	Judicial Efficiency	Trade freedom
2024	23,0	32,5	30,4	73,2
2025	21,5	35,4	29,9	73,2

Source: compiled by the author based on [145, 238].

As can be seen from the results of the table, it is not possible to derive a general Index based on 4 indicators, but we can give a certain characteristic. Thus, the worst indicators are for the “Rule of Law” pillar. There is a low indicator of property rights – the lowest of those presented. The best result demonstrates the honesty of the government, but the indicators of this pillar themselves characterize economic freedom at a repressed level. Corruption in state authorities, which affects the processes and results of their decision-making, also led to this result.

However, we can note a fairly positive result for the “Trade Freedom” indicator, which has the same score of 73.2 in both analyzed years and characterizes the level of economic freedom in relation to it as “mostly free”. However, its analysis over time (see Appendix B) reflects a decline, as it also demonstrated an exit to the “free” zone.

Therefore, we can characterize that, despite certain positive results of economic and market indicators, in Ukraine there is a problem with the legality of actions of the authorities, judicial bodies and protection of property rights. Which cannot but affect the activities of business structures and carries certain risks. And the overall indicator up to 2022 inclusive only confirms our conclusions and indicates a negative indicator of Ukraine.

We summarize the main macroeconomic results of the country-level risk assessment in Table 2.2.

Table 2.2

Ukraine's risk assessment at the macroeconomic level

Rating name	Direction of assessment	Ukraine's position	The highest and the lowest
World Economic Forum CEO Survey, 2025	Company executives identify 5 main risks for the country	Forced Migration Attacks on Critical Infrastructure Armed Conflict Labor Shortage Public Debt	
Logistics Performance Index, 2023	A weighted average indicator that summarizes 6 criteria and allows you to see the logistical risks and threats of domestic enterprises.	Overall score – 2.7 World ranking position – 79	1 – lowest score 5 – highest score
Risk rating from AM BEST, 2025	Determines the country's risk in terms of meeting financial obligations.	CRT-5	CRT-1 - countries with a stable environment and the lowest level of risk; to CRT-5 - countries with high risk and a threat to financial stability.
Country risk assessment from Coface, an international trade credit risk management company, 2025.	Assesses the overall risk of a country by economic, political and financial sectors, as well as the country's business climate.	Country risk rating – D; Business climate rating – D.	A1 – very low, E – extreme
Allianz Trade Country Risk Rating, 2024, 2025	Assesses the country's rating by a medium-term assessment and the country's risk level by maintaining a short-term rating.	Country rating – D, Country risk level – 4.	AA – lowest risk, D – highest risk; 1 – low risk, 4 – highest risk.
Index of Economic Freedom, 2022	Measures the extent to which people have control over their property and labor.	54,1	0 – 50 points – repressed level of freedom, 80 – 100 points – free

Source: compiled by the author based on previous research

Thus, the analysis of global indicators that characterize countries by risk showed that Ukraine currently has mostly negative results in the ratings. Among the ratings that characterize the country by risk on average, we can highlight the Logistics Performance Index, which characterizes the level of risk in relation to logistics activities and the fulfillment of obligations related to logistics.

Other ratings that characterize the country's economic situation, business environment, legal protection of rights, financial condition, etc., have rather low results, sometimes Ukraine has the lowest level or is included in the group of countries with high risk, which indicates problems in the country that affect the business environment and carry certain threats and risks for the production activities of enterprises. When forming a risk management system for manufacturing enterprises, it is necessary to take into account such results in order to build a system that will timely identify those possible risks that may arise taking into account the economic, political, and legal climate in the country.

For further diagnostics of the risk environment of Ukrainian enterprises at the macro level, it is necessary to study the main macroeconomic indicators of Ukraine. When selecting indicators, we rely on the data of official statistics of Ukraine, as provided by the State Statistics Service of Ukraine. Taking into account the possibilities of collecting information for one time period for a thorough analysis of the risk environment of Ukrainian entrepreneurs in order to determine further ways of building a risk management system, we have selected the following indicators:

- The gross domestic product of Ukraine in actual prices (hereinafter referred to as GDP), which reflects the scale of the country's economy and characterizes macroeconomic systemic risk. On its basis and by studying its growth trends, it is possible to generally determine the state of the country's economy. It is measured in natural quantities.

- The Industrial Producer Price Index (PPI) reflects changes over time in industrial production and provides an opportunity to analyze price trends by type of activity [74]. Measured in %. In our study, we use calculation data for the previous year. Characterizes the price risk of production.

- The volume of industrial products sold (hereinafter referred to as the ORPP) characterizes the value of shipped industrial products. It indicates the presence or absence of a risk of demand for industrial products.

- The Industrial Production Index (hereinafter referred to as the IPI) is a weighted average value consisting of data on the distribution of gross value added between industrial activities. In Ukraine, the methodology for its calculation is in accordance with international standards and the base year is 2016 [56]. In our analysis, we use this index to the previous year, calculated in %. We also use an aggregated indicator for the entire industry, which will allow us to see the volatility of this sector as a whole.

- The Consumer Price Index (hereinafter referred to as the CPI) characterizes changes in the general level of prices for goods and services purchased for non-productive consumption [55, 74]. This index is an inflation index and characterizes the purchasing power of potential consumers of products, as its growth leads to a decrease in purchasing power. We analyze the data of the Index calculated to the previous year in %.

- The hryvnia to US dollar exchange rate (UAH/USD) and the hryvnia to euro exchange rate (UAH/EUR) are important indicators of Ukraine's foreign trade, which includes both exports and imports. They characterize currency and foreign economic risk, as the appreciation of foreign currency leads to an increase in the cost of imports, difficulty in meeting obligations, etc. In our study, the exchange rate is given as 1 hryvnia for 100 USD or 100 EUR.

- Capital investments of enterprises (CI) and capital investments of industrial enterprises (CII) are investments of business entities in various forms for the purpose of acquiring, manufacturing or modernizing fixed assets, as well as for other purposes to ensure the production activities of the enterprise [72]. These indicators are important because they are a characteristic of investment risk, technological and reproductive, since a significant part of these investments is directed specifically to machinery and equipment. Appendix C presents capital investments of enterprises by type of

economic activity for the period from 2012 to 2024, which makes it possible to assess these risks.

Table 2.3 presents statistical data on the indicators described above for the period from 2013 to 2024.

Table 2.3

Main macroeconomic indicators characterizing the risk environment of Ukrainian enterprises, 2013-2024*

Years	GDP, mln UAH	PPI	ORPP, mln UAH.	IPI	CPI	UAH/ USD	UAH/ EUR	CI, thousand UAH	CII, thousand UAH
2013	1465198	-0,1	1 322 408,4	95,7	-0,3	799,30	1061,22	222671032	105292801
2014	1586915	17,1	1 428 839,1	89,9	12,1	1188,67	1571,59	183954497	85174872
2015	1988544	36,0	1 776 603,7	87,7	48,7	2184,47	2422,87	218801758	87961431
2016	2385367	20,5	2 158 030,0	104,0	13,9	2555,13	2829,19	288142597	114656763
2017	2981227	26,4	2 625 862,7	101,1	14,4	2659,66	3000,42	366116303	144184086
2018	3560302	17,4	3 045 201,9	103,0	10,9	2720,05	3214,29	480314142	200908467
2019	3977198	4,1	3 019 383,1	99,5	7,9	2584,56	2895,18	533728974	255397386
2020	4222026	-1,6	3 236 369,1	95,5	2,7	2695,75	3078,79	409065379	181513913
2021	5450849	40,8	4 678 908,6	101,9	9,4	2728,62	3230,90	545219654	243855992
2022	5239114	47,3	3 854 040,1	63,3	20,2	3234,23	3398,20	344303239	126146989
2023	6627961	24,2	4 402 949,9	106,8	12,9	3657,38	3955,82	520187646	221130301
2024	7658659	19,7	5 279 813,1	104,6	6,5	4015,21	4345,04	616990761	261502937

* The data does not include the territories temporarily occupied by the Russian Federation and parts of the territories where hostilities are (were) ongoing. By CI and CPI indicators data exclude on and budget organizations.

Source: compiled by the author based on [12, 26, 27]

We have provided data for 2013-2024, which makes it possible to see changes over a sufficiently long period of time, which allows to see the dynamics of their changes.

Thus, the GDP indicator tends to grow during the analyzed period with a slight decrease in 2022 - the year of the beginning of the full-scale war against Ukraine. If we take into account the Indices given in our study, we should note that they are marked by strong fluctuations and have uneven dynamics of development. The exchange rate of the hryvnia to two foreign currencies, which are the main currencies in foreign

economic operations, is constantly changing: it can be noted that the annual growth in the value of foreign currencies is observed with a slight exception in 2019. The trend is somewhat the same when analyzing the capital investment indicator, where it tends to grow during the period, but in 2020 and 2022 it undergoes a decrease. This is justified by the fact that in 2020 the COVID-19 pandemic began in Ukraine, when enterprises were closed for some time and had restrictions on the implementation of their production activities, and 2022 is the beginning of a full-scale Russian invasion of Ukraine, which had an extremely negative impact on various aspects of the country's life. Thus, Shynkaruk L.V. with co-authors, studying the features of the development of enterprises in Ukraine, including in conditions of war and the COVID-19 pandemic, notes the significant influence of external factors on the efficiency of enterprises [184].

But to conduct a qualitative and thorough study of the risk environment of Ukrainian enterprises, it is necessary to make certain transformations with the data for further measurement of volatility and risk. To do this, we need to calculate the standard deviation (STDEV) and the coefficient of variation (V). The coefficient of variation (V) is a relative measure of risk. The lower the coefficient of variation, the smaller the spread of the indicator. This indicator makes it possible to determine the level of the risk environment [126, 136].

To do this, we need to normalize our data. We will calculate the YoY (year-on-year) growth rate and present the result in Table 2.4. We leave the Indices as they are, since they already reflect the growth compared to the previous year.

As we can see from the table, the growth rates are uneven and fluctuate in different years. One of the largest slowdowns in growth and declines in rates is observed in the period 2020 and 2022, which is explained by the reasons already given above. However, we should also note that not all indicators have a positive characteristic when they grow. An example of this is the CPI indicator, which characterizes inflation. Accordingly, the lower its growth rate, the better. Similarly, the growth of currency rates also has the same nature - the lower its growth rate, the better.

Table 2.4

Growth rate of key macroeconomic indicators characterizing the risk environment of Ukrainian enterprises, 2014-2024

Years	GDP	PPI	ORPP	IPI	CPI	UAH/ USD	UAH/ EUR	CI	CII
2014	8,3	17,1	8,0	89,9	12,1	48,7	48,1	-17,4	-19,1
2015	25,3	36,0	24,3	87,7	48,7	83,8	54,2	18,9	3,3
2016	20,0	20,5	21,5	104,0	13,9	17,0	16,8	31,7	30,3
2017	25,0	26,4	21,7	101,1	14,4	4,1	6,1	27,1	25,8
2018	19,4	17,4	16,0	103,0	10,9	2,3	7,1	31,2	39,3
2019	11,7	4,1	-0,8	99,5	7,9	-5,0	-9,9	11,1	27,1
2020	6,2	-1,6	7,2	95,5	2,7	4,3	6,3	-23,4	-28,9
2021	29,1	40,8	44,6	101,9	9,4	1,2	4,9	33,3	34,3
2022	-3,9	47,3	-17,6	63,3	20,2	18,5	5,2	-36,9	-48,3
2023	26,5	24,2	14,2	106,8	12,9	13,1	16,4	51,1	75,3
2024	15,6	19,7	19,9	104,6	6,5	9,8	9,8	18,6	18,3

Source: calculated by the author

Analysis of growth rates indicates the uneven development of these indicators, which characterize both the macroeconomic environment in general and its industrial component, as well as the currency. The dynamics of the GDP growth rate to the previous year is quite uneven with significant growth in 2015, fluctuations at the same level for the next 2-3 years and a significant decrease in 2019-2020. Since 2021, the fluctuations in the growth rates of this indicator have been even greater. The significant growth rates of currency rates against the hryvnia at the beginning of the analyzed period with a subsequent slowdown in these rates are notable. Moreover, in 2022-2024, the growth figures were positive, but not at the level of 2014-2015. This is explained by the rather strict policy of the National Bank of Ukraine, which fixed the exchange rate, which was a forced action in wartime conditions and allowed to preserve Ukraine's gold and foreign exchange reserves and take inflation under control [17].

We see that the environment is characterized by high risk and there are also shock states characterized by large fluctuations. We propose to calculate a moving

average (SMA) for 3 years, which will allow us to smooth our data series and see more evenly the directions of the dynamics of the series and risk. To do this, we calculated this indicator and the results are displayed in Table 2.5.

Taking into account the 3-year calculation period, the formula for calculating the moving average has the following form [182]:

$$SMA = \frac{x_1+x_2+x_3}{n}, \quad (2.1)$$

where x_1, x_2, x_3 – data for the previous two periods and the selected period,

n – the number of periods.

Table 2.5

Moving average of growth rates of indicators

Years	GDP	PPI	ORPP	IPI	CPI	UAH/ USD	UAH/ EUR	CI	CII
2016	17,9	24,5	18,0	93,9	24,9	49,8	39,7	11,1	4,8
2017	23,4	27,6	22,5	97,6	25,7	34,9	25,7	25,9	19,8
2018	21,5	21,4	19,7	102,7	13,1	7,8	10,0	30,0	31,8
2019	18,7	16,0	12,3	101,2	11,1	0,5	1,1	23,1	30,7
2020	12,4	6,6	7,4	99,3	7,2	0,5	1,2	6,3	12,5
2021	15,7	14,4	17,0	99,0	6,7	0,2	0,5	7,0	10,8
2022	10,5	28,8	11,4	86,9	10,8	8,0	5,5	-9,0	-14,3
2023	17,2	37,4	13,7	90,7	14,2	10,9	8,8	15,8	20,5
2024	12,7	30,4	5,5	91,6	13,2	13,8	10,5	10,9	15,1

Source: calculated by the author

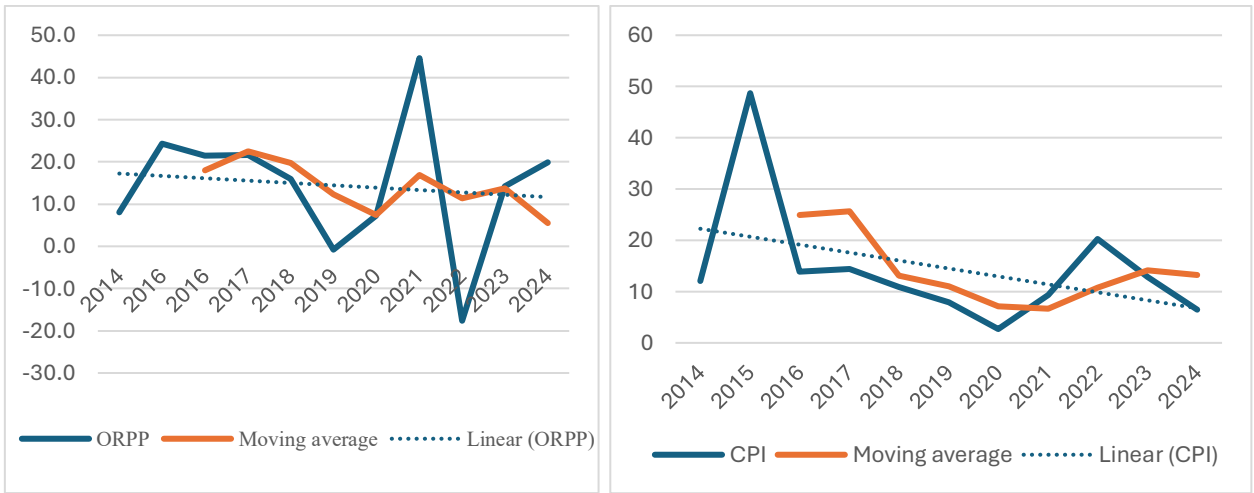
Thus, we calculated a 3-year moving average of our indicators in order to smooth out the results of the dynamics. This will allow us to determine the direction of the indicator's trend without large fluctuations due to shocks. To visualize our calculations and determine trends, we will construct Fig. 2.5 – 2.9.

These figures illustrate the dynamics of the growth of indicators. SMA allows you to see a more smoothed nature of changes. Also, a trend line is added to the figures, which reflects that we do not have a linear relationship in the development of indicators.

(a) (b)

Fig. 2.5. Dynamics of growth rates and moving average GDP (a) and PPI (b)

Source: compiled by the author



(a) (b)

Fig. 2.6. Dynamics of growth rates and moving average of the ORPP (a) and CPI (b)

Source: compiled by the author

Fig. 2.5 – 2.9 show that the growth of all indicators is very uneven, characterized by significant fluctuations, with a market decline (growth of PPI, CPI and exchange rates) in 2022. Some indicators also decreased sharply in 2020, which is confirmed by the figures. The results of the visualization of the moving average reproduce the process of uneven development of the environment and indicate significant volatility

of these indicators. The smoothing that we observe further confirms the variability of the data and sharp fluctuations in the economy, which is a consequence of the activities of both the enterprises themselves, on the one hand, and directly affects these enterprises.

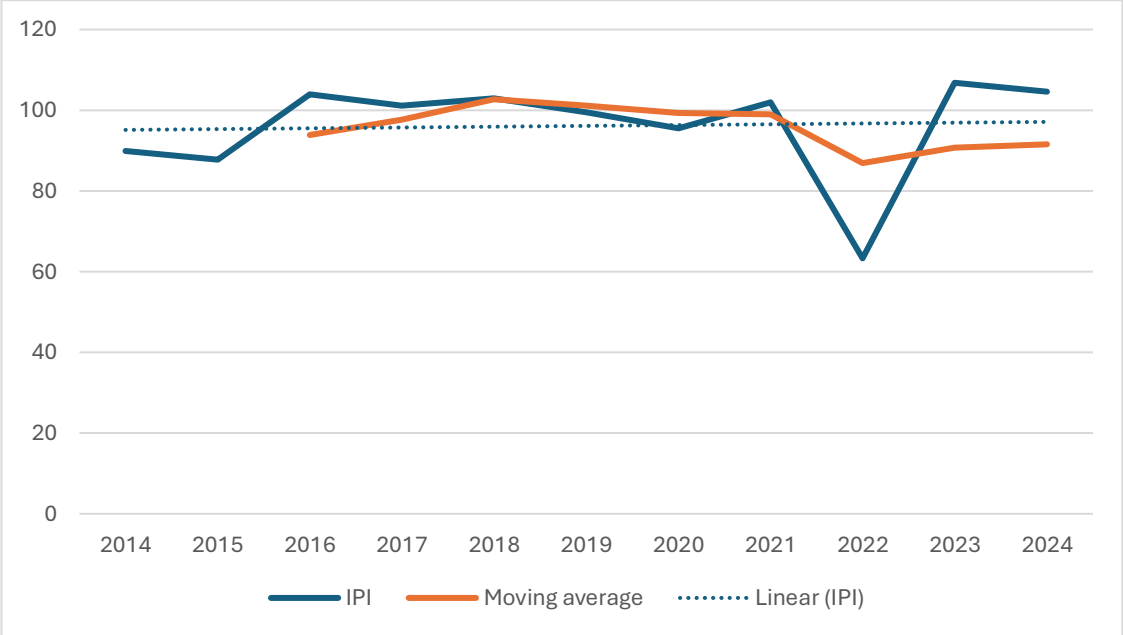
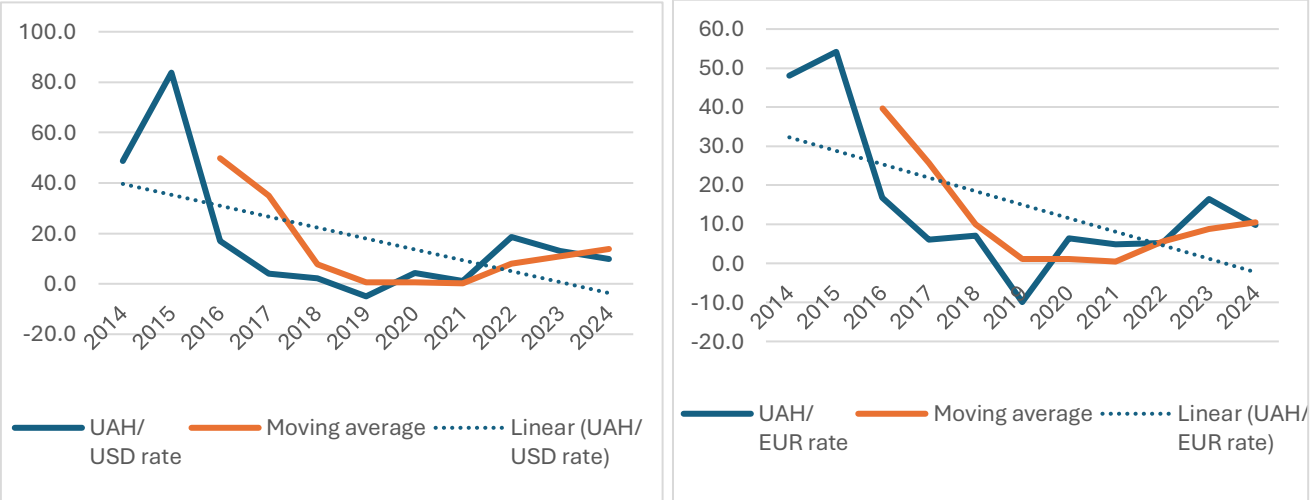


Fig. 2.7. Dynamics of growth rates and moving average of IPI

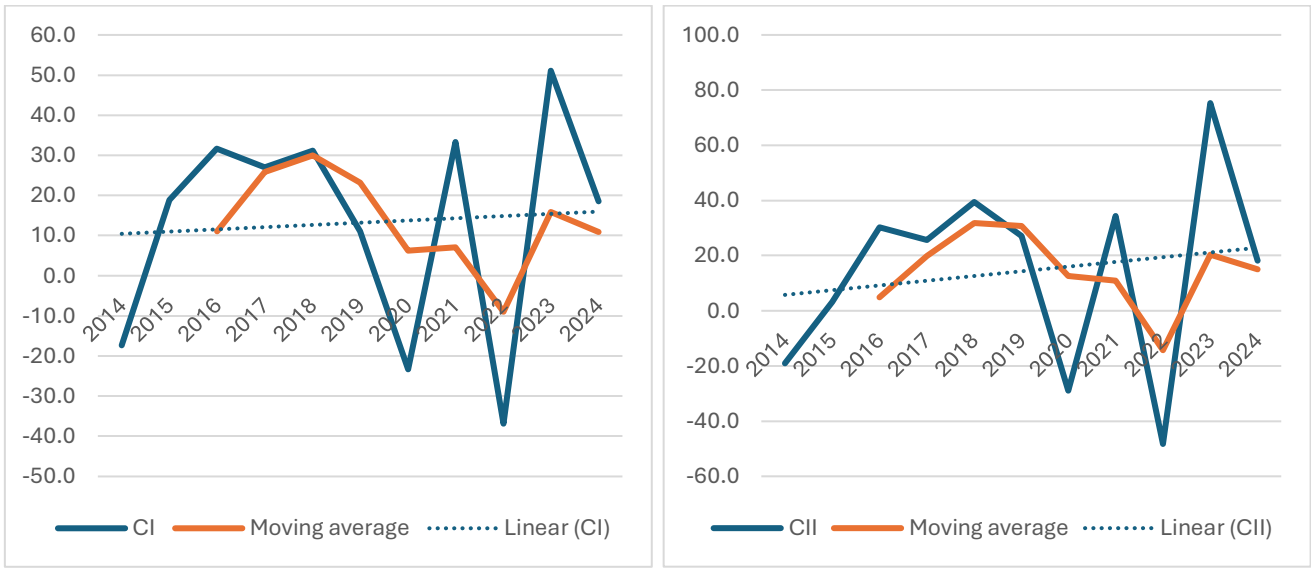
Source: compiled by the author



(a) (b)

Fig. 2.8. Dynamics of growth rates and moving average of UAH/USD (a) and UAH/EUR (b) exchange rate

Source: compiled by the author



(a) (b)

Fig. 2.9. Dynamics of growth rates and moving average of CI (a) and CPI (b)

Source: compiled by the author

Significant fluctuations are noticeable in investment indicators, which is logical given the circumstances, but also indicates the dependence of enterprises on external conditions. During crises, shocks, investments in their own development are reduced, which has a further chain effect. That is why it is necessary to foresee these crises in order to form a risk management policy that will allow the company to continue developing even in the event of a risky situation. Since the cessation of development has significant negative consequences for restoring its market positions and ensuring competitiveness in modern conditions both in Ukraine and abroad.

Based on the obtained data on growth rates, we will proceed to further study of the risky external environment of Ukrainian enterprises. Against the background of already normalized and comparable data, we will calculate the average (Average), median (Median), minimum (MIN), maximum (MAX), standard deviation (STDEV) and coefficient of variation (V). This will allow us to see the spread of indicators that were selected by us for analysis. For this, we will use the MS Excel program. We also note that we will carry out these calculations both for the entire time range (2014-2024), and for the pre-war (2014-2021) and war (2022-2024) periods.

It is worth noting that the coefficient of variation reflects the degree of variability of the studied data in relation to the average of the entire range. It is an indicator of volatility, the nature of changes and the risk of the studied phenomenon [158].

To calculate the coefficient of variation, we use the following formula [241]:

$$V = \frac{\sigma}{\bar{x}} * 100\%, , \quad (2.2)$$

де σ - is the standard deviation,

$\bar{x}$ = average.

Standard deviation measures the dispersion of data in a sample relative to the mean [158].

The mean indicator reflects the average value over the entire sample. If, when measuring the coefficient of variation, the mean is close to or equal to “0”, then the coefficient will show incorrect values [159]. And the median reflects the value that is in the middle of our series. Comparing these values allows to characterize the stability of our data or, conversely, reflect asymmetry.

The minimum and maximum indicators also make it possible to see whether there are extremes in the data under study, whether there are shocks (with a high difference between them).

The results obtained are presented in Table 2.6.

We will also calculate the difference between the coefficient of variation of the two analyzed periods. In formula, it looks like this:

$$\Delta V = V(2014\text{-}2021) – V(2022\text{-}2024), \quad (2.3)$$

This will allow to compare how much the main characteristics of these series have changed and whether the riskiness has increased or decreased.

Table 2.6

Results of calculating the standard deviation and coefficient of variation

Indicator	GDP	PPI	ORPP	IPI	CPI	UAH/ USD	UAH/ EUR	CI	CII
For the entire analyzed period									
Average (14-24)	16,6	22,9	14,4	96,1	14,5	18,0	15,0	13,2	14,3
Median (14-24)	19,4	20,5	16,0	101,1	12,1	9,8	7,1	18,9	25,8
MIN (14-24)	-3,9	-1,6	-17,6	63,3	2,7	-5,0	-9,9	-36,9	-48,3
MAX (14-24)	29,1	47,3	44,6	106,8	48,7	83,8	54,2	51,1	75,3
STDEV (14-24)	10,21	14,61	15,80	12,46	12,23	26,08	19,23	27,46	35,13
V (14-24)	61,3%	63,8%	109,3%	13,0%	84,3%	145,1%	128,2%	207,7%	245,4%
Pre-war period (2014-2021)									
Average (14-21)	18,1	20,1	17,8	97,8	15,0	19,5	16,7	14,1	14,0
Median (14-21)	19,7	19,0	18,7	100,3	11,5	4,2	6,7	23,0	26,4
MIN (14-21)	6,2	-1,6	-0,8	87,7	2,7	-5,0	-9,9	-23,4	-28,9
MAX (14-21)	29,1	40,8	44,6	104,0	48,7	83,8	54,2	33,3	39,3
STDEV (14-21)	8,49	14,46	13,87	6,16	14,12	30,91	22,52	22,57	25,88
V (14-21)	46,9%	72,0%	77,9%	6,3%	94,1%	158,2%	134,9%	160,4%	184,6%
War period (2022-2024)									
Average (22-24)	12,7	30,4	5,5	91,6	13,2	13,8	10,5	10,9	15,1
Median (22-24)	15,6	24,2	14,2	104,6	12,9	13,1	9,8	18,6	18,3
MIN (22-24)	-3,9	19,7	-17,6	63,3	6,5	9,8	5,2	-36,9	-48,3
MAX (22-24)	26,5	47,3	19,9	106,8	20,2	18,5	16,4	51,1	75,3
STDEV (22-24)	15,39	14,81	20,24	24,50	6,85	4,42	5,64	44,47	61,84
V (22-24)	121,0%	48,7%	367,3%	26,8%	51,9%	32,0%	53,9%	406,2%	409,7%
Δ V									
Δ V	74,1%	-23,3%	289,4%	20,5%	-42,2%	-126,2%	-81,0%	245,8%	225,1%

Source: calculated by the author

First, it is worth noting to give a scale of the level of uncertainty and riskiness of the activity for the coefficient of variation:

- minimal risk – up to 10%;
- low risk – from 10% to 25%;
- acceptable risk – 25% - 50%;
- critical risk – 50% - 75%;
- more than 75% - catastrophic risk [71].

It is also noted that there is no general standard for the rate of variation, but analysts suggest this approach:

V < 15% - low variation, when data is clustered around the mean and is predictable;

V – 15-25% - moderate variation that is typical and occurs in a business environment. The data is consistent but takes into account natural fluctuations;

V > 25% - indicates significant dispersion around the mean. Results are less predictable [241].

According to this scale, GDP and PPI indicators characterize the environment as having critical risk, all others as catastrophic. However, we see that there are results with a coefficient of variation higher than 100%, which may be the result of a large scatter of our data, which is confirmed by a rather significant difference between the Average and Median, as well as a distinctive value of the standard deviation.

This table indicates a fairly high risk of the Ukrainian business environment. We see that the coefficient of variation reflects critical risk and catastrophic risk for many analyzed indicators. The exception is the IPI, which demonstrates low risk. This can be explained by the fact that this index does not have large fluctuations, is characterized by low volatility, but is still prone to crisis deviations.

The analysis of the mean, median, minimum and maximum allows us to confirm the obtained results of the coefficient of variation, as they demonstrate the difference between the mean and median indicators, as well as a sufficient difference between the maximum and minimum. This indicates the instability of the environment, the volatility of phenomena, the asymmetric development and the presence of shocks.

If we compare the periods of the pre-war years and wartime, we can see both positive changes in the coefficient of variation and negative (and significant), this can also be justified by the small time period (3 years), which is analyzed and compared with the previous longer period. Although in the second period we calculated the average, median, as well as the minimum and maximum, we understand that it is not sufficiently indicative for such a period of time.

The difference between the coefficient of variation for the two analyzed periods also has positive changes, reflecting the improvement in the level of riskiness in the PPI, CPI and both exchange rates.

But what attracts our attention is that we have obtained quite high variation indicators for all analyzed periods, namely – above 100%. This is acceptable and means that the standard deviation is higher than the average, which is confirmed by the obtained results and indicates a high variability of these indicators. It may also be a result of the fact that the calculation of the coefficient of variation is better done when there is a normal distribution [160], however, the calculations performed, the previously presented graphs of growth rates with a trend, indicate the absence of a normal distribution.

For further research, we added the maximum-minimum indicator (Max – Min, or range of variation), the interquartile range (IQR), as well as the mean absolute deviation (MAD). Let us calculate these indicators and present them in Table 2.7.

The Max-Min indicator reflects the amplitude of fluctuations in the values of the indicators we selected.

The interquartile range (IQR) is a measure that defines the portion of a sample that contains 50% of the values of the sample elements, excluding the 25% of the smallest and largest values [32]. The median represents Q2. The magnitude of the value reflects the clustering of the sample around the median. The smaller the value, the more tightly clustered it is [2]. This indicator is also important because it shows typical variability, that is, what is inherent in a particular series.

The mean absolute deviation (MAD) is a measure that reflects the average deviation of individual values from the mean (Average). The latter two measures are

also important in that they are less sensitive to outliers and extreme values. This is done by discarding the 25% of the smallest and largest values when calculating the IQR, when an outlier simply happens to be in those 25%. And the MAD indicator is also less sensitive to outliers because it is based on absolute deviations of values from the mean.

Table 2.7

Results of calculating the variability of indicators

Indicator	GDP	PPI	ORPP	IPI	CPI	UAH/ USD	UAH/ EUR	CI	CII
For the entire analyzed period									
Average (14-24)	16,6	22,9	14,4	96,1	14,5	18,0	15,0	13,2	14,3
Median (14-24)	19,4	20,5	16,0	101,1	12,1	9,8	7,1	18,9	25,8
MIN (14-24)	-3,9	-1,6	-17,6	63,3	2,7	-5,0	-9,9	-36,9	-48,3
MAX (14-24)	29,1	47,3	44,6	106,8	48,7	83,8	54,2	51,1	75,3
Max- Min (14-24)	33,0	48,9	62,2	43,5	46,0	88,8	64,1	87,9	123,6
STDEV (14-24)	10,21	14,61	15,80	12,46	12,23	26,08	19,23	27,46	35,13
MAD (14-24)	8,3	10,9	11,1	8,7	7,3	17,7	13,7	21,7	27,3
IQR (14-24)	15,1	14,0	14,0	10,8	5,5	14,6	11,0	34,6	40,3
V (14-24)	61,3%	63,8%	109,3%	13,0%	84,3%	145,1%	128,2%	207,7%	245,4%

Source: calculated by the author

Therefore, the calculations carried out further show that our data has a high amplitude of fluctuations, which results in such an indicator of the coefficient of variation and indicates the variability of the data. And for variation indicators above 100%, the Max-Min indicator is noticeably high, although for other indicators its result also reflects a high range.

For correct conclusions about the interquartile range and standard deviation, their values should be analyzed in relation to the median and mean.

The interquartile range (IQR) has a different result relative to the median for our indicators. It is significantly smaller for the Consumer Price Index, which also shows a low result for the mean linear deviation indicator, but the high amplitude of fluctuations (Max-Min) results in such a coefficient of variation result. Indicators that have an IQR above the median are also characterized by a large amplitude, as well as a relatively high MAD indicator, which correlates with the result of the coefficient of variation.

The result of MAD reflects the average fluctuation of possible changes when oriented to the average. That is, in addition to the fact that there is asymmetry and skewness in one direction or another (with the difference between the median and the average), there is also a deviation from the average indicator itself. It is worth adding that these deviations are distinctive, since this variability is additional to our averages. Therefore, it is important to take this into account when forming the risk management system of enterprises, that changes can also be made taking this into account.

Appendix D contains histograms of indicators and box plots, which make it possible to assess the distribution of indicator values over certain intervals (histogram), as well as the stability of the indicator and the presence of extreme indicators (box plot).

In general, in conclusion, we can say that the risk environment of Ukraine is characterized by a high level of volatility, instability, and the presence of shock states. This is confirmed by international ratings, according to which Ukraine has the lowest values almost everywhere. Of course, the main period when the environment significantly deteriorated was the COVID-19 pandemic, as well as the war on the territory of Ukraine. The instability is evidenced by the calculations that were carried out and substantiated.

The values of the coefficients of variation obtained by us indicate the presence of shock fluctuations and structural changes in the risk environment of the functioning of enterprises. In our study, the coefficient became an indicator of the instability of the

environment. To determine the trends of the selected indicators, we calculated a moving average for 3 years, which confirmed the uneven development of indicators and negative changes in moments of crisis. Indicators that are resistant to emissions also reflected that the environment is unstable, although they had low values for some indicators. But the additional calculations performed correlated with the coefficient of variation. In the future, we will propose a mechanism for taking into account the calculations performed when building a risk management system for manufacturing enterprises.

2.2. Analysis of the internal environmental risks and risk management practices at manufacturing enterprises in Ukraine

After analyzing the volatility of the macro environment of Ukrainian enterprises, it is advisable to study the results of enterprises' activities due to an unstable environment. First, it is worth to analyze the financial indicators at the country level. We present them in Table. 2.8.

From Table 2.8 we can see that net income, which is all revenue of enterprises less indirect taxes, as well as discounts and refunds, increases every year, with the only exception being 2022, when the volume of net income decreased. The growth rates are uneven, but stable.

The result of the activities of enterprises before taxation is not so positive, as it demonstrates both negative results, that is, when enterprises are unprofitable, and further positive dynamics and profit of enterprises before taxes. But in 2020 there is a significant decrease in this indicator, although the result is positive. From 2023, the financial result before taxation is growing again.

Table 2.8

Main financial indicators of Ukrainian enterprises *

Years	Net income from sales of products (goods, works, services), thousand UAH	Financial result (balance before tax), thousand UAH	Net profit (loss), thousand UAH	Level of profitability of all activities of enterprises, %	Level of profitability of operating activities of enterprises, %
2014	-**	-523587000	-590066945	-14,2	-4,1
2015	5164124288	-348471649	-373516013	-7,3	1
2016	6226583191	69887807,3	29705020,1	0,6	7,4
2017	7621974799	236952071	168752793	3	8,8
2018	9092539797	369212262	288305468	4,5	8,1
2019	9659409675	613044036	523779002	7,6	10,2
2020	9884573566	134734313	68054905,5	0,9	6,2
2021	12807404568	-	885276480	10,1	12,6
2022	10681887363	-	-276277743	-3,2	3,3
2023	13472989530	563114685	427672584	4,5	8
2024	16022601490	819802108	665011112	5,8	5,7

* The data does not include the territories temporarily occupied by the Russian Federation and parts of the territories where hostilities are (were) ongoing. Data exclude on banks.

** - – data missing

Source: compiled by the author based on [26, 27]

The net profit or loss indicator is also characterized by loss-making indicators at the beginning of the analyzed period with a subsequent decrease before transitioning to a profitable result. However, in the main crisis years of 2020 and 2022, there is a significant decrease in this indicator. And a return to a loss-making result in 2022. In the future, starting from 2023, the positive dynamics are restored again. Which indicates the positive results of the activities of Ukrainian enterprises.

Also noteworthy is the indicator of the level of profitability of the entire enterprise's activities, which reflects the efficiency of the enterprise's activities, namely the share of profit in the enterprise's expenses. The change in this indicator during 2014 - 2024 is also uneven: from negative indicators at the beginning of the period, 2014 - 2015 to steady growth until 2020. In the year of the onset of the COVID-19 pandemic, profitability decreased significantly, although it did not reach a negative result.

Significant growth in 2021 – up to 10,1% was replaced by a significant decrease to – 3,2% in the year of the full-scale invasion. The results of subsequent years demonstrate the restoration of positive dynamics.

We will also examine the indicator of the level of profitability of operating activities, which characterizes the effectiveness of the main activity of the enterprise for which it was created, how profitable the costs of production and sale of goods are. The results of this indicator and the dynamics are somewhat different from the previous one: although there is a negative value, it is only in 2014, and subsequently all the results are positive. Fluctuations are also present, but their rates are not so high. There is a decrease in the level of profitability in 2020 and 2022 with further growth. However, in 2024 the indicator decreases again, although the profitability of all activities demonstrates growth. The results of the two levels of profitability in 2024 have almost the same indicators (5,8% – the level of profitability of all activities of enterprises, 5,7% – the level of profitability of operating activities of enterprises). This indicates an increase in the part of operating activities in the profit of the enterprise. Although, in general, the profitability of operating activities has decreased.

Thus, we see that the financial results of Ukrainian enterprises are characterized by instability due to the risky macro environment, the volatility of macroeconomic indicators. The greatest decrease occurs in 2020 and 2022 – the years of crisis. In such conditions, enterprises need to form a risk management system that would quickly respond to possible changes, assess the situation and the main threats that arise before it. That is why it is necessary to study Ukrainian manufacturing enterprises from the perspective of studying their risk analysis and their risk management practices.

To do this, we will examine the main manufacturing enterprises that provide open information about their main activities. We have selected the following 5 enterprises that are manufacturing and based on the analysis of their reporting, it is possible to conduct a risk assessment:

1. PJSC “ArcelorMittal Kryvyi Rih” (hereinafter referred to as ArcelorMittal), which is the largest mining and metallurgical enterprise in Ukraine. This company is part of an international company and is one of the largest investors in Ukraine. This company is an enterprise with a full metallurgical cycle, which includes coke chemical

production, mining production and metallurgical production. Within the framework of our study, the company represents the mining and metallurgical complex of Ukraine (MMC), which is one of the most important for the industrial and economic development of the country [81].

2. Metinvest is an international mining and metallurgical group of companies (Metinvest Holding LLC is the management company and a subsidiary of Metinvest B.V.). This company also produces mining and metallurgical products [128].

3. Public company «Interpipe Holdings» (hereinafter – Interpipe) is a leading manufacturer and exporter of pipe and railway products. Represents the metallurgical and mechanical engineering industry in our study [130].

4. PJSC “Kryukiv Carriage Building Plant” (hereinafter referred to as KVBZ) produces both freight and passenger railcar products, products for subways, mechanical engineering and metal construction products. The plant's industry is mechanical engineering (transport) [82].

5. Private Joint-Stock Company “AZOT” (hereinafter – AZOT). It is a chemical industry manufacturer and is part of the OSTCHEM holding, being its main asset. The company's industry is the chemical industry [80].

Thus, we analyzed the data of 5 manufacturing enterprises belonging to different branches of industry in Ukraine. The study of their financial statements allowed us to analyze the period 2019-2023 and provide the main indicators of financial activity, calculate the coefficients of financial stability and liquidity, which characterize the risk of the enterprise (financial, insolvency), and also further analyze the financial risk of these enterprises in terms of possible bankruptcy, inability to secure their obligations, etc. For this, we used 5 methods of assessing the risk of insolvency, which we will describe below.

First, we will present the main financial and accounting indicators of the activities of these manufacturing enterprises (Table 2.9) and analyze their absolute and relative changes (Table 2.10), which will allow us to make a general overview of the development of these enterprises and assess the dynamics of their development, determine how much it corresponds to trends at the macro level.

Table 2.9

Main performance indicators of selected manufacturing enterprises, 2019 - 2023, thousand UAH

		Arcelor Mittal	Metinvest	Interpipe	KVBZ	AZOT
Assets	**2019**	97436408	327745949	30037583	4562362	18175657
	2020	88251664	380406468	26236850	3998600	22855418
	2021	105631044	435905636	31940917	4909653	20943683
	2022	52637474	321255151	29254441	4532293	24865504
	2023	47006610	346893259	42060950	5315658	23153570
Equity	**2019**	60627742	164145366	10640031	3295240	-11485030
	2020	60867996	183671802	14716533	3391492	-14262101
	2021	76544616	217407254	11877419	3230533	-18305916
	2022	28197740	104951882	7523880	3288098	-25730887
	2023	15912044	99627835	20152208	3199414	-22547700
Stocks	**2019**	10097927	28068147	4618809	1973970	635771
	2020	7575431	26493300	4350358	1290541	581450
	2021	14700484	42090263	5848392	1738446	686688
	2022	14166798	33350563	6345749	1406722	644846
	2023	11029613	30044078	7007487	1317834	893834
Net income	**2019**	62423831	254792453	26584491	8218515	4269053
	2020	63517295	295554394	24461233	3336667	3387932
	2021	109302319	491143991	30903473	2550219	3597294
	2022	43819882	303080557	35885864	3543812	3087958
	2023	41873521	280955813	37553427	2086944	4723250
Operating profit	**2019**	-2744139	7698015	1966191	1040935	1950843
	2020	2073425	23948586	6016835	92842	-2267961
	2021	31047537	134563361	4001057	-226514	91585
	2022	-50262969	-52146824	10143289	74418	-7443595
	2023	-10304134	16902168	13615095	-205781	-1465120
Net profit	**2019**	-2263623	8076994	19627712	842314	2120313
	2020	742292	14872440	5516827	69016	-2796384
	2021	25220003	129980623	2490936	-228517	74780
	2022	-49054174	-80194940	7476121	41288	-7605386
	2023	-11875974	-7368586	9605483	-143897	3207499
Acquisition of fixed assets	**2019**	7036911	21199149	1417548	79552	20012
	2020	5608640	19170179	1244931	49790	-*
	2021	8522466	27741929	1709688	33593	-
	2022	2367453	13932637	775474	4441	-
	2023	4087584	11584632	1170428	2653	-

* - – this cost item was not applied during this period

Source: compiled by the author based on a study of reporting forms of selected enterprises [48-52]

The indicators selected for presentation in the table are important for the first step of risk analysis of Ukrainian manufacturing enterprises, as they allow to assess the scale of the companies' activities. It is worth noting that the figures are given in thousand UAH according to the financial reporting forms of Ukraine. Metinvest and Interpipe in their consolidated reports provided figures in US dollars. For clarity in this table, they were calculated at the NBU exchange rate as of December 31 of the corresponding year. Further calculations of liquidity, stability and other ratios were carried out by reporting units, which does not affect the result of the ratios.

The asset indicator is important from the point of view of further assessment of the asset structure and the scale of the company in general. Equity allows to analyze the systemic risk of the enterprise. These two indicators are one of the most important in further calculations of risk assessment models. Inventories are an indicator of the state of the production cycle. It is important to maintain a balance of inventories, because their excess or deficiency directly affects the production process or cash flow. In both cases, this is negative for operational activities.

The income and profit indicators that we analyze in the table and in the subsequent dynamics reflect the stability of the company, the demand for products. Net income directly depends on production and is an indicator for it, because its decrease will mean a decrease in demand for products, the risk of losing customers and the need to reduce capacity utilization. Operating profit is important in the analysis of manufacturing enterprises, because it is an indicator of production efficiency. It reflects production and operational risks. The net profit indicator is one of the most important in the activities of any enterprises and is a signifier of the profitability of the enterprise. If the enterprise's activities are characterized by unprofitability over a certain period of time, then this is a signal to management about the crisis at the enterprise and the need to revise the production model or reorient to other types of activities or changes in company management.

We also consider it important for manufacturing enterprises to characterize such an indicator as "acquisition of fixed assets", since it means capital investment in the assets of the enterprise for the purpose of conducting economic activity. This

contributes to technological development or, conversely, causes it to stop in the absence of this expense item.

For a full analysis of these indicators, we calculated the absolute deviation of these indicators and the relative deviation year-on-year (YoY) (Table 2.10), which will allow to see the dynamics of changes in the main financial and production indicators.

Table 2.10

Dynamics of changes in the main performance indicators of selected manufacturing enterprises, 2019-2023

		Arcelor Mittal	Metinvest	Interpipe	KVBZ	AZOT
1	2	3	4	5	6	7
Assets	**Absolute deviation, thousand UAH**					
	2020/2019	-9184744	52660519	-3800734	-563762	4679761
	2021/2020	17379380	55499168	5704068	911053	-1911735
	2022/2021	-52993570	-114650485	-2686476	-377360	3921821
	2023/2022	-5630864	25638108	12806509	783365	-1711934
	Relative deviation YoY					
	2020/2019	-9,4%	16,1%	-12,7%	-12,4%	25,7%
	2021/2020	19,7%	14,6%	21,7%	22,8%	-8,4%
	2022/2021	-50,2%	-26,3%	-8,4%	-7,7%	18,7%
	2023/2022	-10,7%	8,0%	43,8%	17,3%	-6,9%
Equity	**Absolute deviation, thousand UAH**					
	2020/2019	240254	19526436	4076503	96252	-2777071
	2021/2020	15676620	33735452	-2839114	-160959	-4043815
	2022/2021	-48346876	-112455372	-4353540	57565	-7424971
	2023/2022	-12285696	-5324047	12628328	-88684	3183187
	Relative deviation YoY					
	2020/2019	0,4%	11,9%	38,3%	2,9%	24,2%
	2021/2020	25,8%	18,4%	-19,3%	-4,7%	28,4%
	2022/2021	-63,2%	-51,7%	-36,7%	1,8%	40,6%
	2023/2022	-43,6%	-5,1%	167,8%	-2,7%	-12,4%
Stocks	**Absolute deviation, thousand UAH**					
	2020/2019	-2522496	-1574847	-268451	-683429	-54321
	2021/2020	7125053	15596962	1498033	447905	105238
	2022/2021	-533686	-8739699	497358	-331724	-41842
	2023/2022	-3137185	-3306485	661738	-88888	248988
	Relative deviation YoY					
	2020/2019	-25,0%	-5,6%	-5,8%	-34,6%	-8,5%
	2021/2020	94,1%	58,9%	34,4%	34,7%	18,1%
	2022/2021	-3,6%	-20,8%	8,5%	-19,1%	-6,1%
	2023/2022	-22,1%	-9,9%	10,4%	-6,3%	38,6%

Continuation of Table 2.10

1	2	3	4	5	6	7
Net income	**Absolute deviation, thousand UAH**					
	2020/2019	1093464	40761940	-2123258	-4881848	-881121
	2021/2020	45785024	195589597	6442240	-786448	209362
	2022/2021	-65482437	-188063434	4982391	993593	-509336
	2023/2022	-1946361	-22124744	1667563	-1456868	1635292
	Relative deviation YoY					
	2020/2019	1,8%	16,0%	-8,0%	-59,4%	-20,6%
	2021/2020	72,1%	66,2%	26,3%	-23,6%	6,2%
	2022/2021	-59,9%	-38,3%	16,1%	39,0%	-14,2%
	2023/2022	-4,4%	-7,3%	4,6%	-41,1%	53,0%
Operating profit	**Absolute deviation, thousand UAH**					
	2020/2019	4817564	16250571	4050643	-948093	-4218804
	2021/2020	28974112	110614774	-2015778	-319356	2359546
	2022/2021	-81310506	-186710184	6142231	300932	-7535180
	2023/2022	39958835	69048992	3471807	-280199	5978475
	Relative deviation YoY					
	2020/2019	-175,6%	211,1%	206,0%	-91,1%	-216,3%
	2021/2020	1397,4%	461,9%	-33,5%	-344,0%	-104,0%
	2022/2021	-261,9%	-138,8%	153,5%	-132,9%	-8227,5%
	2023/2022	-79,5%	-132,4%	34,2%	-376,5%	-80,3%
Net profit	**Absolute deviation, thousand UAH**					
	2020/2019	3005915	6795445	-14110885	-773298	-4916697
	2021/2020	24477711	115108183	-3025891	-297533	2871164
	2022/2021	-74274177	-210175563	4985185	269805	-7680166
	2023/2022	37178200	72826354	2129362	-185185	10812885
	Relative deviation YoY					
	2020/2019	-132,8%	84,1%	-71,9%	-91,8%	-231,9%
	2021/2020	3297,6%	774,0%	-54,8%	-431,1%	-102,7%
	2022/2021	-294,5%	-161,7%	200,1%	-118,1%	-10270,3%
	2023/2022	-75,8%	-90,8%	28,5%	-448,5%	-142,2%
Acquisition of fixed assets	**Absolute deviation, thousand UAH**					
	2020/2019	-1428271	-2028970	-172617	-29762	-20012
	2021/2020	2913826	8571751	464758	-16197	-
	2022/2021	-6155013	-13809293	-934215	-29152	-
	2023/2022	1720131	-2348005	394954	-1788	-
	Relative deviation YoY					
	2020/2019	-20,3%	-9,6%	-12,2%	-37,4%	-100%
	2021/2020	52,0%	44,7%	37,3%	-32,5%	-
	2022/2021	-72,2%	-49,8%	-54,6%	-86,8%	-
	2023/2022	72,7%	-16,9%	50,9%	-40,3%	-

Source: compiled by the author based on a study of reporting forms of selected enterprises [48-52]

The analysis of the two previous tables allows us to obtain primary conclusions regarding the dynamics of the selected indicators of the enterprise's activity. We see that the dynamics of assets is uneven and with rather high actual indicators of the first 3 companies (ArcelorMittal, Metinvest, Interpipe), their dynamics are uneven and sometimes negative. All the companies presented experience both positive and negative changes in assets during the study period. This indicates the influence of negative factors at this moment. The decrease is mainly observed in 2020 compared to 2019 and in 2022 – the year of the beginning of the full-scale war in Ukraine. This is fully correlated with the previous study of the macro environment. Enterprises confirm the crisis conditions at these moments. However, it is worth noting that the dynamics of changes is uneven by year, depending on the companies. For example, AZOT, on the contrary, will experience a decrease in the years following the crisis states (2021 and 2023).

The volume of equity in these companies did not change evenly compared to the previous indicator. For example, in ArcelorMittal during 2019-2021 there was an increase in equity, however, since 2022 the dynamics became negative and equity decreased significantly. In Metinvest the same dynamics. Moreover, the figures for 2022 are quite high (-63.2% in ArcelorMittal and -51,7% in Metinvest). Negative dynamics were also observed in them in 2023, although Interpipe demonstrates a significant increase in equity in 2023 (by 167,8%).

The dynamics of changes in inventories of selected manufacturing enterprises also differs in both negative (mostly) and positive values. A decrease in inventories can be a consequence of incorrect warehouse logistics of the enterprise, as well as a consequence of a decrease in demand and the need to reduce production. If we analyze this indicator simultaneously with net income, we can see a certain connection in them. Although there is not always a direct relationship. However, we can see that a decrease in income occurs in some periods (mainly 2022 and 2023) simultaneously with a decrease in inventories. Perhaps this is an effective policy of the enterprise, when in

the case of demand decrease, inventories are automatically reduced so that the volume of frozen funds does not increase, or, perhaps, ineffective inventory logistics led to a decrease in production volumes and, accordingly, to a decrease in sales. But, taking into account the years of the greatest decrease in both indicators (2022 and 2023), this is most likely a consequence of many factors, one of which is the decrease in demand due to hostilities in Ukraine, problems with delivering products to potential consumers (i.e., there is still a logistical risk, but it has a different form) and a decrease in the solvency of product buyers. Although there are exceptions. Thus, KVBZ experienced the greatest decrease in inventories and income in 2020 and 2023.

The operating profit of enterprises undergoes even greater fluctuations, ranging from – 175,6% in 2020 at ArcelorMittal to 1397,4% in 2021 at the same company. Negative values during all analyzed years are shown by such enterprises as KVBZ and AZOT. Interpipe had only one negative year of growth (2021), demonstrating stable and effective operating activities of the enterprise. Metinvest experienced the largest decreases in 2022 and 2023. Thus, the results can be an indicator of various risks: from operational to macro risk, when the enterprise depends on external factors. This does not indicate the unprofitability of the enterprise, but the existing problems in the production model of the enterprise and its significant dependence on external factors, when it is difficult to make forecasts of the enterprise's activities.

The dynamics of net profit has approximately the same dynamics as the previous indicator, demonstrating significant negative results in 2022 and 2023. Although KVBZ and AZOT also have negative growth rates compared to the previous year during 2019-2023, in relative growth rates, when absolute changes are noted, positive dynamics.

Capital investments in fixed assets develop unevenly depending on the period and the enterprise. At AZOT, this expense item last occurred in 2019, after which the purchase of fixed assets did not take place. This may cause the risk of technological lag. In other companies, this item is present, although the dynamics vary for each enterprise. That is, enterprises continue to purchase fixed assets, but the amount of

expenses fluctuates quite significantly. Among the positive changes in 2023, the indicator of ArcelorMittal (72,7%) and Interpipe (50,9%) is noted, although in the previous year they experienced a significant decrease in expenses for the purchase of fixed assets.

In conclusion, we can say that the main financial and production indicators of the activities of these enterprises indicate high volatility during the implemented period, which is fully consistent with the results of the study in the previous paragraph. It is worth noting that the sensitivity of these indicators to external factors and vulnerability is notable. This has a negative effect on the main financial indicators of activity, which ensure the financial stability of the enterprise. In addition, there may be a risk of technological lag, since investments in fixed assets react negatively to external shocks. That is, all this requires the construction of such a risk management system that could protect the enterprise from the occurrence of risk and its negative consequences.

The next stage of our research and determination of the risk status of the selected enterprise will be the calculation and presentation of the main financial ratios that characterize various risks. This is justified by the fact that one of the methods of assessing the risk of enterprises is the analysis of indicators of financial stability, liquidity and profitability. They make it possible to assess the solvency of the enterprise, its ability to meet its obligations, and the effectiveness of its activities. And this also embodies the risk management of the enterprises themselves, how effectively the company works in this direction. In table. 2.11 we present the results of the research and calculation.

Appendix E presents the dynamics of these indicators over time, carried out using the method of calculating the absolute deviation.

Table 2.11

Results of coefficient analysis of the activities of manufacturing enterprises

		Arcelor Mittal	Metinvest	Interpipe	KVBZ	AZOT
1	2	3	4	5	6	7
Current liquidity ratio	2019	1,38	1,33	1,47	4,08	0,52
	2020	1,69	1,46	2,37	9,78	0,56
	2021	2,10	1,12	2,70	2,88	0,47
	2022	1,62	0,89	2,38	3,82	0,45
	2023	0,88	0,93	2,71	2,48	0,47
	Normative	1,5-2,0 (1-2); if <1 – a warning sign; >3 – sign of inefficient asset structure.				
Quick liquidity ratio	2019	1,00	0,98	1,01	1,98	0,50
	2020	1,26	1,19	1,48	5,93	0,54
	2021	1,42	0,80	1,77	1,69	0,45
	2022	0,84	0,64	1,59	2,45	0,43
	2023	0,43	0,74	1,87	1,79	0,45
	Normative	0,6 (0,7) -1 and above (however, 1-1.5 is also indicated), but not higher than 2				
Absolute liquidity ratio	2019	0,04	0,08	0,60	0,89	0,0004
	2020	0,05	0,23	0,56	4,73	0,0001
	2021	0,06	0,24	0,69	1,04	0,0001
	2022	0,05	0,10	0,70	0,59	0,0001
	2023	0,02	0,15	1,13	1,55	0,0001
	Normative	0,1-0,2 (0,2-0,5; 0,2 - 1)				
Financial leverage ratio	2019	1,61	2,00	2,82	1,38	-1,58
	2020	1,45	2,07	1,78	1,18	-1,60
	2021	1,38	2,01	2,69	1,52	-1,14
	2022	1,87	3,06	3,89	1,38	-0,97
	2023	2,95	3,48	2,09	1,66	-1,03
	Normative	1 – the company has no debts, everything is financed by equity; 1.5 – equity is used, along with a smaller amount of borrowed funds				
Financial dependency ratio	2019	0,38	0,50	0,65	0,28	1,63
	2020	0,31	0,52	0,44	0,15	1,62
	2021	0,28	0,50	0,63	0,34	1,87
	2022	0,46	0,67	0,74	0,27	2,03
	2023	0,66	0,71	0,52	0,40	1,97
	Normative	< 0,5				

Continuation of Table 2.11

1	2	3	4	5	6	7
Financial independence (autonomy)	2019	0,62	0,50	0,35	0,72	-0,63
	2020	0,69	0,48	0,56	0,85	-0,62
	2021	0,72	0,50	0,37	0,66	-0,87
	2022	0,54	0,33	0,26	0,73	-1,03
	2023	0,34	0,29	0,48	0,60	-0,97
	Normative	> 0,5 and above				
Financial risk ratio	2019	0,61	1,00	1,82	0,38	-2,58
	2020	0,45	1,07	0,78	0,18	-2,60
	2021	0,38	1,01	1,69	0,52	-2,14
	2022	0,87	2,06	2,89	0,38	-1,97
	2023	1,95	2,48	1,09	0,66	-2,03
	Normative	< 1				
Operating margin	2019	-4,4%	3,0%	7,4%	12,7%	45,7%
	2020	3,3%	8,1%	24,6%	2,8%	-66,9%
	2021	28,4%	27,4%	12,9%	-8,9%	2,5%
	2022	-114,7%	-17,2%	28,3%	2,1%	-241,1%
	2023	-24,6%	6,0%	36,3%	-9,9%	-31,0%
	Normative	10-15% and above, industry-specific				
Net profit margin	2019	-3,6%	3,2%	73,8%	10,2%	49,7%
	2020	1,2%	5,0%	22,6%	2,1%	-82,5%
	2021	23,1%	26,5%	8,1%	-9,0%	2,1%
	2022	-111,9%	-26,5%	20,8%	1,2%	-246,3%
	2023	-28,4%	-2,6%	25,6%	-6,9%	67,9%
	Normative	depends on the industry, 5% is low, 10% is healthy, 20% is strong				
Return on assets	2019	-2,3%	2,7%	73,8%	20,2%	14,1%
	2020	0,8%	3,9%	17,8%	1,6%	-13,6%
	2021	26,0%	32,4%	8,7%	-5,1%	0,3%
	2022	-62,0%	-17,7%	20,7%	0,9%	-33,2%
	2023	-23,7%	-2,2%	26,5%	-2,9%	13,4%
	Normative	depends on the industry, 5-10% - average indicators, 10-20% - high indicators.				
Capital investment to revenue ratio	2019	0,11	0,08	0,05	0,010	0,005
	2020	0,09	0,06	0,05	0,015	
	2021	0,08	0,06	0,06	0,013	
	2022	0,05	0,05	0,02	0,001	
	2023	0,10	0,04	0,03	0,001	
	Normative	depends on the industry, 5-10%, 10%-20% - potential overinvestment				

Source: calculated by the author based on [19, 70, 134, 157, 176, 204, 205, 222, 240, 248, 249, 250]

The importance of calculating liquidity group ratios when assessing risks is justified by the fact that liquidity refers to the ability of assets to quickly turn into

money without losing their value [239]. That is, it is the ability of the enterprise to meet its obligations. This is a characteristic of the solvency of the enterprise and its ability to fulfill current obligations and provides for the payment of wages, timely payment to suppliers, the ability to independently cover unforeseen expenses [204]. From a risk perspective, there is a liquidity risk for the enterprise, which means that the enterprise is unable to meet its short-term obligations. This is a threat to the financial stability of the enterprise [205]. This group of indicators includes indicators of current liquidity, quick liquidity and absolute liquidity.

Let us proceed to the analysis of the obtained research results. Thus, the current liquidity ratio, which reflects the general liquidity status of the enterprise, received different values at the analyzed enterprises. The main guideline for this indicator is the range from 1-1,5 to 2. The company that had indicators in this range is Interpipe, its indicators vary from 1,47 in 2019 to a maximum of 2,71 in 2023. However, the latter indicator is approaching 3, which may also indicate an increase in the probability of the risk of forming an inefficient asset structure. Other companies - ArcelorMittal, Metinvest at the beginning of the analyzed period demonstrated indicators within the regulatory framework, but Metinvest has experienced a decrease in the current liquidity ratio since 2022, maintaining this trend in 2023. ArcelorMittal reduced its indicator in 2023. AZOT throughout the period had an indicator in the range from 0,45 to 0,56, which is an alarming indicator, but its fluctuation is not high. The result of KVBZ is noteworthy, where they are too high, which may indicate problems in the management of the company's current assets.

The quick liquidity ratio characterizes the extent to which a company can meet its obligations in the event of an unforeseen situation. Scientists note industry differences in regulatory values [134, с. 903; 219]. According to the results of our study, we found that almost all indicators are within the normative value, but with minor exceptions. Also, the analysis of this indicator should be carried out together with the previous one. We see that the difference between them is not large, maintaining the same trend. The indicators of only KVBZ are notable, where the

difference between these two indicators is noticeable, which may indicate the company's dependence on inventories [134, c. 903].

Absolute liquidity implies the ability of the enterprise to quickly respond to short-term obligations with its cash and current financial investments. Analysis of the results shows that almost Metinvest and Interpipe fall under the normative value (0,2-0,5) with a small deviation. This is a positive characteristic of these enterprises. Others have other indicators that indicate both insufficiently effective cash management (with a value above 1) and insufficient current assets (less than 0,2, according to some sources 0,1). However, scientists note that there is a different view of this indicator from the side of company management and investors, who are interested in the result above 1 [134, c. 904]. But in our case, we analyze from the point of view of the management of the company, its assets, cash and liquidity risk. We can say that the situation is quite threatening for AZOT and KVBZ, although it has different directions.

Thus, the analysis of this group of ratios showed that at some enterprises – Interpipe and with a slight deviation Metinvest – the liquidity situation is more or less favorable and the enterprises can potentially meet their obligations, even in critical situations. However, at other enterprises we see that there is a certain problem with solvency.

For further analysis, let us move on to the study of indicators that characterize the financial stability of enterprises. The calculation of this group of indicators is justified by the fact that it makes it possible to assess the financial risk of the enterprise, its investment attractiveness, and dependence on external financing.

The financial leverage ratio has several forms of calculation. In our study, we used the formula for calculating the asset-to-equity ratio, which is also referred to as the capital multiplier. This indicator is very important, because it shows what proportion of assets is financed by equity compared to debt obligations [240, 248, 250]. Our results indicate different dynamics of this indicator by companies. However, the closest to the maximum use of equity is KVBZ and for a certain period ArcelorMittal. Other companies and ArcelorMittal, starting from 2022, demonstrate a situation when equity capital is used with the involvement of debt. AZOT company has negative

indicators, which is justified by the negative indicators of the company's equity and retained earnings during the analyzed period. This may indicate a real threat to the financial stability of this enterprise.

To confirm or refute our research, we will turn to the following indicators – financial dependence and financial independence (autonomy). These two indicators are inverse to each other. The financial dependence indicator indicates the presence of dependence on borrowed funds, and the independence coefficient, on the contrary, characterizes the extent to which the enterprise is independent, i.e. autonomous from external debt sources of financing [58, c.748]. Despite the fact that these two indicators are inverse and their result is the difference of one and 1, we decided to use them in this study, because the autonomy coefficient indicates the potential for stability and resilience of the enterprise, and the second indicates the potential risk of dependence on debt obligations. Our results show that the selected manufacturing enterprises have different potential for financial stability at the beginning of the analyzed period and at its end. For example, ArcelorMittal, which in 2019 demonstrated a good result of financial independence with its positive dynamics until 2021 inclusive and a further decrease and exit from the optimal zone (to 0,34), can be an example. Metinvest in 2019 had an even distribution of these two indicators, but gradually dependence on borrowed funds increased and went outside the zone of favorable optimality. A positive result throughout the analyzed period is demonstrated by KVBZ, in which the autonomy coefficient did not drop below 0,5. We see a high dependence on debt funds in AZOT enterprises, which is fully correlated with the financial leverage indicator. It should be noted that the increase in dependence at enterprises mainly occurred in 2022 and the following 2023.

The calculated financial risk ratio reflects the ratio of borrowed capital to equity, demonstrating the dependence on borrowed funds. The results obtained show indicators that exceed the optimal value in 2023 in ArcelorMittal, at the end of the analyzed period in Metinvest, a significant period of time in Interpipe and negative large values in AZOT. But these values do not mean that the risk is low, but, on the contrary, indicate that the equity indicator is negative, which is confirmed by

preliminary data and calculations. This company has a significant dependence on borrowed capital and its financial risk is also high. In general, we see the negative impact of the crisis years 2022 and 2023 in companies with stable positions before that. The exception is KVBZ, the financial risk ratio of which does not exceed the optimal value. Moreover, it is worth noting the significant range before its achievement.

Thus, in conclusion, we can say about the uneven development of the financial stability of Ukrainian manufacturing enterprises. The main years of negative impact were 2022 and 2023. However, there are enterprises that were in the risk zone throughout the period (AZOT), but there are also enterprises that are distinguished by positive results, although they did not have such positive signs in terms of liquidity indicators (KVBZ).

Important are indicators of the profitability of the enterprise, such as operating margin, net profit margin and return on assets. They reflect the efficiency of the activities of manufacturing enterprises. Operating margin characterizes how effectively the company manages its operating activities and what profit remains in the enterprise after covering all operating expenses [249]. Our research has shown that companies are exposed to significant external fluctuations and some of them demonstrate a high level of operational risk (ArcelorMittal, AZOT and Metinvest indicators in 2022 and KVBZ in 2021 and 2023 experienced a significant drop below 0). Although there are no established standards for this indicator, as it is highly industry-dependent, its growth is desirable. We see that only Interpipe has demonstrated it and is characterized by positive results of the company's profitability after paying operating expenses.

Net profit margin reflects how much profit remains at the enterprise after paying all expenses, including taxes, loans. 2022 was characterized by negative values at almost all enterprises, except for Interpipe, which maintains positive results throughout the period. The indicators of ArcelorMittal in 2022 and AZOT in 2020 and 2022 are supercritical and indicate the onset of financial risk at these enterprises, as they incur significant losses.

The return on assets indicator characterizes the efficiency of using the company's assets, both its own and borrowed resources [222, 223]. The analysis of selected

companies indicates the presence of inefficient use of assets during crisis conditions. ArcelorMittal and Metinvest have been showing a negative result since 2022. The best indicator of return on assets is Interpipe, which has positive figures throughout the period with the lowest indicator in 2021. AZOT again has negative values, but its result improves in 2023. We see that large manufacturing enterprises are vulnerable to shock conditions, which results in indicators of operating margin, profitability of net profit and assets.

The analysis of the macro environment showed that during crisis situations, capital investments of enterprises fluctuate significantly. Let us analyze the ratio of capital investments to revenue as one that reflects how much revenue is directed to the renewal of fixed assets. This ratio characterizes the investment risk (in the case of low indicators) and the risk of technological obsolescence. The results we obtained indicate the preservation of regulatory values at ArcelorMittal even during crisis periods and regardless of other negative performance indicators. Metinvest demonstrates a gradual reduction in expenses for the renewal of fixed assets. Interpipe had stable indicators until 2022, after which it significantly reduced capital expenditures. KVBZ has very low investment indicators. And AZOT stopped investing altogether after 2019. All this indicates a different approach and capabilities of the enterprise to investing in the renewal of fixed assets. And although the indicators of some enterprises are not negative, they are nevertheless insufficient to improve the technological component of the enterprise's activities, which creates corresponding risks.

In general, we can say that the enterprises demonstrated different results according to the analyzed indicators. However, we see the impact of shocks on their activities and their performance. The exception is Interpipe, which demonstrates a fairly strong position according to many indicators. Although in terms of financial stability, it exceeds the regulatory indicators. Thus, all companies face the probability of financial risk, a certain number of companies are exposed to liquidity risk, and the profitability results indicate the presence of real problems with effective revenue management at enterprises.

In the development of our research, we will apply appropriate methods for assessing the financial condition of enterprises and assessing their solvency. These methods involve the use of discriminant analysis. The models we have chosen and their main characteristics are given in Table 2.12.

Table 2.12

Characteristics of models for assessing the risk of insolvency and bankruptcy of enterprises

Model	Normative value	Characteristic
1	2	3
Modified 5-factor model of Altman 1983 (A) (Altman Z-score model)		
X_1 – Working capital / Assets X_2 – Retained earnings / Assets X_3 – EBIT / Assets X_4 – Equity / Liabilities X_5 – Net Income / Assets	$Z < 1,23$ – "distress zone", $1,23 < Z < 2,99$ – "gray" zone, $Z > 2,99$ – "safe" zone	It is a classic model, simple enough to calculate, but built on the basis of research by Western companies and should be interpreted taking into account Ukrainian specifics.
$Z = 0,717X_1+0,847X_2+3,107X_3+0,42X_4+0,998X_5$		
Springate Model (S)		
X_1 – Working capital/Total assets; X_2 – Profit before interest/Total assets; X_3 – Profit before tax/Current liabilities X_4 – Net income/Total assets.	$S < 0,862$ = "distress" zone – high risk; $0,862 < S < 1,062$ = "gray" zone – state of financial insolvency; $S > 1,062$ = "safe" zone – minimal risk.	Sufficiently high reliability of risk forecasting (error does not exceed 10%). But it was also focused on the economies of Western countries.
$S = 1,03X_1 + 3,07X_2 + 0,66X_3 + 0,4X_4$		
Tereshchenko's model (T)		
X_1 – cash flow to liabilities ratio X_2 – balance sheet currency to liabilities ratio X_3 – ratio of net profit to average annual assets X_4 – profit to revenue ratio X_5 – inventory to revenue ratio X_6 – revenue to fixed capital ratio.	$0 < Z < 1$ – there is a threat of bankruptcy; $1 < Z < 2$ – financial stability is violated; $Z > 2$ – there is no risk of bankruptcy.	It is a national Ukrainian model developed at Ukrainian enterprises taking into account international practice.
$Z = 1,5X_1 +0,08X_2 + 10X_3 + 5X_4 + 0,3X_5 + 0,1X_6$		

Continuation of Table 2.12

1	2	3
Taffler and Tishaw model (TT)		
X_1 – operating profit / current liabilities X_2 – current assets / liabilities X_3 – current liabilities / total assets X_4 – net income/total assets.	*Z* < 0,2 – the probability of bankruptcy is quite high; 0,2 < Z < 0,3 – possible bankruptcy; *Z* > 0,3 – the probability of bankruptcy is low, a company is considered healthy.	Simplicity of calculations, but it was developed for companies that went public. However, the practice of using the methodology is now widespread and can be chosen for all companies.
T-Score = $0,53X_1 + 0,13X_2 + 0,18X_3 + 0,16X_4$		
Beaver coefficient (B)		
K_B= (Net income + Depreciation) / (Long-term liabilities + Current liabilities)	$0,17<K_Б< 0,4$ – 5 years before bankruptcy; $K_Б> 0,4\text{-}0,45$ – does not threaten; $-0,15<K_Б< 0,17$ – 1 year before bankruptcy.	

Source: compiled by the author based on [6, 54, 67, 117, 129, 137, 141, 154, 172, 197, 225, 232, 234]

Models are focused on determining the risk of bankruptcy, but if we consider bankruptcy from the point of view of uncertainty regarding the ability of a company to conduct its current and operational activities and as a result of ineffective management, then we can approach this as a study of the risk of solvency and the effectiveness of company management. Since the financial component is one of the most important for the implementation of all company activities

For this purpose, we chose the Altman 1983 methodology, which was modified and adapted to all types of enterprises, both public and private. Other methodologies, which also have different variations, were chosen by us based on the calculation of the most effective use in relation to the manufacturing enterprises we selected.

There are several possible options for calculating the Beaver Coefficient, but based on the classical approach, we included depreciation in the numerator, since this

is the company's internal own resource. The results of the research are presented in Table 2.13.

Table 2.13

Assessment of the insolvency risk of manufacturing enterprises in Ukraine

Enterprises	Risk assessment models	Years									
		2019		2020		2021		2022		2023	
		R	**P**	**R**	**P**	**R**	**P**	**R**	**P**	**R**	**P**
1	2	3	4	5	6	7	8	9	10	11	12
ArcelorMittal	**A**	1,57	gray zone	2,11	gray zone	3,58	low	-1,55	high	0,10	high
	S	0,21	high	0,534	high	2,483	low	-4,225	high	-0,697	high
	T	0,12	threat	0,97	threat	5,86	no risk	-14,08	catastrophic	-3,89	catastrophic
	TT	0,23	possible	0,36	low	1,17	low	-1,10	high	0,11	high
	B	0,14	1 year before	0,31	5 years before	1,11	no	-1,75	1 year before	-0,27	1 year before
Metinvest	**A**	1,84	gray zone	2,03	gray zone	3,10	low	1,55	gray zone	2,01	gray zone
	S	0,541	high	0,745	high	2,213	low	-0,544	high	0,437	high
	T	0,93	threat	1,19	stability is violated	5,93	no risk	-3,25	catastrophic	-0,07	catastrophic
	TT	0,30	low	0,40	low	0,87	low	0,08	high	0,35	low
	B	0,15	1 year before	0,19	5 years before	0,72	no	-0,27	1 year before	0,03	1 year before
Interpipe	**A**	2,12	gray zone	3,50	low	2,66	gray zone	4,11	low	3,73	low
	S	1,986	low	2,208	low	1,433	low	2,608	low	2,578	low
	T	12,98	no risk	4,16	no risk	1,86	stability is violated	4,01	no risk	4,95	no risk
	TT	0,40	low	0,97	low	0,64	low	1,03	low	1,18	low
	B	1,09	no	0,61	no	0,20	5 years before	0,40	no	0,48	no
KVBZ	**A**	4,21	low	3,81	low	1,56	gray zone	2,39	gray zone	1,26	gray zone
	S	2,818	low	1,331	low	0,536	high	1,07	low	0,543	high
	T	4,19	no risk	1,39	stability is violated	-0,60	catastrophic	0,78	threat	-0,26	catastrophic

Continuation of Table 2.13

	2	3	4	5	6	7	8	9	10	11	12
	TT	1,31	low	1,00	low	0,38	low	0,61	low	0,36	low
	B	0,74	no	0,27	5 years before	-0,09	1 year before	0,10	1 year before	-0,03	1 year before
AZOT	**A**	-0,78	high	-1,43	high	-1,53	high	-2,75	high	-1,80	high
	S	-0,315	high	-1,006	high	-0,913	high	-2,093	high	-1,056	high
	T	4,12	no risk	-5,48	catastrophic	0,26	threat	-15,74	catastrophic	4,96	no risk
	TT	0,43	low	0,34	low	0,42	low	0,35	low	0,40	low
	B	0,08	1 year before	-0,07	1 year before	0,01	1 year before	-0,15	1 year before	0,07	1 year before

where: R is the obtained value of the indicator, P is the probability of risk according to the normative value

Source: compiled by the author

If we conduct a qualitative analysis of the obtained results of the assessment of the risk of bankruptcy, insolvency and the ability to conduct their operational activities, we can see the following: Enterprises have different dynamics of the risk state. But it is obvious that the greatest negative impact on their activities was in 2022 – the year of the beginning of the full-scale invasion of Ukraine. Such large enterprises as ArcelorMittal and Metinvest, which are leaders in their industry, significantly worsened their results according to many models and reached the lowest level according to the Tereshchenko's model. Note that the characteristic "catastrophic" was introduced by us, since in the model itself the smallest value indicated is equal to 0, but the obtained data are with a negative sign and sometimes significantly below "0". Therefore, we marked such a state as catastrophic. In general, if we characterize ArcelorMittal according to this assessment, we can see that the risk state of this enterprise in 2019-2021 could be called satisfactory (although some indicators had high values). However, since 2022, this situation has deteriorated and the financial situation has worsened, which poses a direct threat to the company's activities. Important in this is the use of a risk management system that not only foresees risk, but also applies crisis management mechanisms.

Metinvest is characterized by approximately the same dynamics, with a slightly more positive result. But after 2022, the situation worsens significantly, although the

gray zone remains according to the Altman Z-score model, and in 2023 the indicator according to Taffler and Tishaw indicates a low level of risk. The results obtained for these two enterprises are fully correlated with the indicators that we analyzed above and complement each other, confirming the correctness of the calculations made.

One of the best positions in terms of risk assessment is demonstrated by Interpipe, which has very low results according to many models and during the analyzed period. According to the Beaver model, the probability of bankruptcy risk is estimated as absent, and only in 2021 the situation worsened slightly with the subsequent restoration of the absence of a probable risk forecast. The same trend is observed according to the Tereshchenko's model and the Altman Z-score model, but the return to the previous positions indicates the effective work of the analytical service of the enterprise and the entire management of the company. Since maintaining such positions requires great effort.

KVBZ has results that correspond to the conclusions based on the previously considered indicators: a sufficiently high probability of insolvency risk according to the Tereshchenko's model, which correlates with profitability and liquidity indicators. But, in general, the degree of probability of the risk of the inability of this enterprise to implement its operating activities is not too high, if we take into account other models. Although it tends to a significant probability. In this case, it is the work of the enterprise's management apparatus, its focus on results, that is important. Taking into account all problem points and forming a management policy on the basis of proactivity, and not just reacting to those problems that have already occurred.

The company "AZOT" has a slightly different characteristic, different from the previous enterprises, which is justified by the financial indicators that we have provided and analyzed. The enterprise has a problem with liquidity, financial stability and profitability, which poses a direct threat to the existence of the enterprise. In such conditions, we are not talking about a risk, but about a crisis, to overcome which an

appropriate policy must be formed. It is clear that the situation is not catastrophic, but, given the prolonged negative dynamics, it requires an immediate response.

In conclusion, we note that the most negative significance and impact on manufacturing enterprises was 2022, which turned out to be a shock for them. This suggests that the risk management system must be ready for such situations that may pose a real threat to the main financial indicators of the enterprise. The studied experience shows that enterprises have different results and the speed of restoration of previous positions, but even the deterioration of financial indicators does not always mean that the probability of risk has increased significantly. Sometimes, positive results of previous years make it possible to balance the situation and not get into high or catastrophic risk. This is what the risk management system of enterprises should be aimed at, because it is not always possible to avoid risk, but it is possible to prevent it and prepare for it.

It is also necessary to analyze the risk management systems of these enterprises in order to study relevant practices at Ukrainian manufacturing enterprises.

ArcelorMittal implements various risk management practices in its activities. An important emphasis is placed on financial risk management, which is manifested in monitoring the liquidity of the enterprise and forecasting cash flows in order to analyze the possibility of fulfilling its obligations. Credit risk is managed in terms of studying the creditworthiness of customers and concluding agreements with already known partners. The image of those companies and a positive business reputation play an important role in conducting business and cooperating with other parties. Financial risk management is carried out by the treasury department of the financial service of the Group of companies (PJSC “ArcelorMittal Kryvyi Rih” and its subsidiaries [62, c.7].

The main principles of ArcelorMittal risk management are the principle of an effective risk management process; the principle of targeted responsibility; the principle of proactive leadership; the principle of risk culture; the principle of transparency and compliance [47, c. 3-4].

In Metinvest in 2013, the Code of Ethics stated that the company's internal control system includes, in addition to regular monitoring of financial and operational activities, also risk management analysis [61]. Currently, the Internal Audit Policy, which is formulated in accordance with the requirements of the ISO 31000:2018 Standard “Risk Management”, also defines the main principles of Metinvest’s risk management. In general, the management process takes place through the Supervisory Board and its committees, which constantly monitor the functioning of risk management systems, the General Director, who actively promotes the risk management philosophy and, in accordance with the company’s strategy, determines the priorities of Metinvest’s risk management system. This structure also includes the Economics and Business Systems Development Directorate, the Internal Audit Directorate, and Functional Management [111]. It should be noted that Metinvest conducts an internal classification of risks, distinguishing between commercial and non-commercial. Commercial risks are assessed based on EBITDA analysis, while non-commercial risks are assessed using a corporate scale, which determines the probability of risk occurrence [110]. Risk management at Metinvest is based on sustainable development paradigms. The main risks that are described and taken into account by the company for management purposes are listed in Table 2.14.

Interpipe also pays a great attention to risk management. There are quite a few types of risk that are influenced and taken into account when conducting business. Organizational, risk management is assigned to the following services: financial and economic service (financial risks), legal support service (legal risks), PR service (reputational), financial and economic service and division sales service (credit risks of counterparties), ecology and industrial safety service (ecology, labor protection and technogenic risks), corporate affairs service (human rights), economic security service (fraud, corruption). The company develops a list of key risks of the Interpipe group of companies, which describes the risk itself, its potential impact and the main measures to manage it. Based on this list, a matrix of the materiality of key risks is developed.

The methodology for its construction consists in ranking all identified risks on a scoreboard of up to 10 from the point of view of assessing the impact in the year of assessment and in 3-5 years [147].

KVBZ also applies risk management practices in its activities, but they are not as widely covered as in previous companies. The main information is provided in the company's Consolidated Annual Report, which lists the company's main risks and measures to manage them [63]. Also, conclusions can be drawn about the management of the risk of product quality decline, which is confirmed by the creation of an enterprise management system based on the requirements of international standards ISO 22163 and ISO 9001 and DSTU ISO 9001 [218]. The Ukrainian version of the site also contains information about unreliable buyers and suppliers, which indicates attention to reputational risks and the risks of cooperation with unreliable partners [82]. Overall, it is worth noting that despite the work on risk management, there is not enough information about it.

AZOT relies on risk-based thinking in its activities and has implemented an Integrated Management System, which was created in accordance with the requirements of ISO 9001, ISO 14001, ISO 45001 standards, which provide for the management of relevant areas, including taking into account risk [88]. It is worth noting that the company has not disseminated sufficient information about risk management. However, in the report, the audit company highlights certain risks of this company, and also notes that there is no practice of reviewing the report on risk management. When analyzing the information materials, we came to the conclusion that the company places more emphasis on managing labor protection, safety technology, and product quality. But no information is provided on other risk management measures.

Table 2.14 summarizes the main risks that are paid attention to at enterprises.

Table 2.14

Summary of the main risks managed by manufacturing enterprises

	Financial risk	Credit risk	Operational risks	Environmental risk	Risk of staff turnover, occupational health and safety	Inherent risks
ArcelorMittal	+ Emphasis on liquidity analysis.	+ Cooperation with permanent partners.	+	+ Taking appropriate measures to reduce the negative impact of its activities on the environment. Environmental management in accordance with ISO 14001:2015 standards.	+ Considerable attention to workplace safety.	Market (including currency). Tax. Logistics and others.
Metinvest	+		+	+ Monitoring compliance. Technical measures to reduce environmental impact. Initiatives to increase energy efficiency.	+ Safe Workplace Program. Training and encouragement in the field of OSH.	ESG risk rating, Business ethics and compliance, Sanctions risks, Information security risks. Tax risk.
Interpipe	+	+	+	+	+	Information risks. Reputational risks. Currency risk. ESG risks. Logistics risk.
KVBZ	+	+	+	+ Through quality standards and product certification	+ Corporate Culture Code	Tax risk. Currency risk. Political and macroeconomic risks.
AZOT	+ (identified by the audit firm)		+ (identified by the audit firm)	+	+	Market risks.

Source: compiled by the author based on [47, 48, 62, 63, 88, 111, 147, 218]

Thus, we can conclude that Ukrainian manufacturing enterprises are under the influence of both macroeconomic risks that have an external impact on them and internal risks that depend directly on their activities. The analysis made it possible to assess the risks of the activities of the manufacturing enterprises that we selected. We conducted a quantitative assessment of financial risks (risk of liquidity, bankruptcy, financial stability, inefficiency of the enterprise's activities). The results obtained indicate a significant impact of external factors and the instability of the macroenvironment on the activities of the selected manufacturing enterprises. Even the leaders of the metallurgical industry are experiencing problems in the conditions of a full-scale invasion. The indicators indicate insufficient efficiency of capital allocation of companies, problems with the solvency of some of them, as well as with the efficiency of profit and operating activities. The assessment of bankruptcy risk, which we considered from the perspective of the probability of insolvency for the enterprise, the inability to meet its obligations, and pay wages, also has results that indicate dependence on shock states and an increase in the probability of risk in war conditions. Our analysis of risk management practices indicates a sufficient level of attention from ArcelorMittal, Metinvest, Interpipe to risk management and a slight coverage of information from KVBZ and AZOT. The volume of risk management measures taken is fully correlated with the results of financial indicators. This makes it possible to make assumptions about the need to build a risk management system based on balance and orientation to real needs.

2.3. Identifying the specifics and prerequisites for the formation of an enterprise risk management system: comparative characteristics

In the development of our research, it is necessary to study the trends of developed countries in relation to risk. Under modern conditions of world development, the threats of risk occurrence are changing and possible risks are increasing. It is important here to determine the possible risk, its identification. This will allow us to analyze and assess the possible consequences of the impact in the event of its occurrence and, accordingly, take measures to manage it. We assume that the

attention paid to risk issues by entrepreneurs directly affects the effectiveness of its management. This is confirmed by the research conducted above and the coverage of the main practices in risk management.

As we wrote above, scientists note that the risk of an enterprise is directly related to the specifics of the work of this enterprise, which is quite logical and justified, and, accordingly, risk assessment and management tools should also be industry-oriented [66, 123]. However, the risk is also associated with the region where the enterprise is located. For example, an enterprise located in Ukraine may currently face the risks of shelling, lack of electricity and Internet connection, as a result of this, a decrease in sales due to the outflow of the population, etc. It is worth noting that even in Ukraine there is a certain difference by region in the probability and scale of the occurrence of these risks. European enterprises suffer less from the possible risk of war by Russia, which also exists, but it is very low. But their risks are now more related to the environmental initiatives of the EU government and the adoption of the “Green Deal”. In the context of the implementation of the Sustainable Development Goals (SDGs) in all areas of activity in the EU, the requirements for the production of goods, production that is more environmentally friendly and focused on improving the environment are becoming higher. The EU has set a goal to achieve climate neutrality, which affects all processes in this integration formation. Under such conditions, the main risks that may arise in EU enterprises may be environmental risks, when their production standards do not have time to reorient to new requirements and will not meet them, which will affect the possibility of functioning. Also, Ukrainian enterprises currently have a problem with finding personnel, which is explained by the outflow of labor in the first years of a full-scale war, as well as the mobilization of the population at present. The number of male laborers is decreasing, and female representatives cannot always perform all the same types of work. In the EU, on the contrary, there is currently a large number of migrants from Ukraine, who are a potential labor force. However, there is a language issue if displaced persons have not yet sufficiently mastered the language of the state in which they are located and, accordingly, cannot communicate at the proper level in the work process, in particular. This may affect the quality of production of

goods or services. Therefore, EU countries that have granted asylum to our fellow citizens also have risks related to the labor market, but these risks, characteristics and consequences are of different nature and differ from each other. Also, one of the sources of risks in modern enterprises is the digitalization of enterprises, their activities in the context of digital transformation and the threats that arise against this background (for example, information leakage, cyber threats) [46, 230, 235].

In accordance with this, the risk management system will be formed at enterprises in Ukraine or the EU, or enterprises in other countries of the world. To summarize, in Ukraine the risk management system will now be focused on maintaining the production of goods or services, effectively balancing the company's asset structure, maintaining market positions in the conditions of the need to preserve the life and health of personnel, as well as ensuring the uninterrupted operation of the enterprise. And in the EU, enterprises will be more focused on the production of more technological and environmentally friendly goods and the risks that arise as a result of this. Scientists note that using European risk management experience in Ukraine is difficult to implement, as the operating conditions of enterprises vary [127]. However, it is necessary to study their experience, as one that demonstrates positive results.

In this case, we can talk about the importance of forming a risk management system, which is the result of understanding by business owners of the orientation to risk-oriented thinking, the importance of identifying risk and managing it. This is the main impetus for the development of risk management in enterprises. It should be noted that building a risk management system is possible at an enterprise of any size and industry. However, this will affect the risks themselves being analyzed, the scale and measures to manage them. But what is important in modern conditions is conducting one's activities from a risk management perspective, building a management system that would provide for constant monitoring and assessment of enterprise risks. In conditions of uncertainty, this becomes even more important, because when preparing for those risks that we can influence, we free up a resource that we may need in the event of an unforeseen situation that we cannot influence [46, 215].

Taking this into account, we consider it necessary to study the interest in the topic of risk among representatives of entrepreneurship both in Ukraine and the EU to compare the main dynamics and trends. Using the analytical method, generalization methods, graphic, cartographic, dynamics analysis, content analysis and comparative, we can conduct an analytical study of representatives of business and the industrial sector of the economy in terms of studying risk and other related issues. The choice of the category "Business and the industrial sector of the economy" is justified by the topic of the dissertation research, where we study manufacturing enterprises. This category most closely corresponds to the selected type of enterprise.

To collect analytical data, we used Google Trends, which provides data on queries, their zoning, and related search words and phrases.

In the development of our research, we analyzed the queries of the category "Business and industrial sector of the economy" using Google Trends. The study of queries from business and production is important for understanding the interests of their representatives, for predicting the occurrence of possible risks, and, accordingly, responding to them, forming an effective, proactive risk management system for enterprises. The importance of the principle of proactivity is of particular importance in our time, as it involves warning and taking action in advance, which reduces the likely negative impact. Foreign scholars identify the significant role of ERM in building a holistic risk management system that will ensure proactive risk management principles [151, 152, 168, 210, 220].

For comparison, we chose two periods that are crisis periods for our country and EU countries: 2020-2021 (COVID-19 pandemic) and 2022-2024 (full-scale war in Ukraine). For the analysis, we used the search word "risk" in the study of search queries in Poland, Germany and France and "risk" in Ukraine. An additional regional analysis will also be conducted for Ukraine by region, which will allow us to see more specifically the regions that are more interested in this topic. The results of this analysis are presented in Fig. 2.10 and 2.11 according to the analyzed period.

To compare the trends of interest of entrepreneurs in the category of "business and industrial sector of the economy", we analyzed data on the main trends in searching

for information about risk and related words in 3 EU countries with which Ukraine has long-standing and stable diplomatic and economic ties. For this, we chose Poland, Germany and France. The choice of EU countries for comparing results is also justified by the level of development of these countries and their leadership positions in the EU. An interesting example is Poland, which had historical and economic roots with Ukraine, but has been a member of the EU since 2004 and has demonstrated positive results in its development. This is important given Ukraine's European integration path.

Figures 2.10 – 2.11 illustrate the trends in the search for information on risk by entrepreneurs in these countries during the periods indicated (2020-2021 and 2022 - 2024). The selection of information was carried out using the query "risk", since the results for other search queries, which will be further analyzed in the indicators of Ukraine, reflected only small numbers or their absence. We also note that the search for trends in these countries was carried out in English so that their results could be compared with each other. Note that the Google Trends algorithms determine the maximum value (100%) based on the selected research period and other periods or search trends are calculated relative to it. That is, in the analyzed period, the period with the highest relative level of queries receives the greatest value – 100%. And other results will already be calculated from this 100%.

As we can see, the trends in the search for information on risk in these countries are high and intense during the two analyzed periods. There are also declines and increases, but the figures almost never fall below 40% (with the exception of the 3rd quarter of 2021 and the beginning and also the 3rd quarter of 2023). The orientation towards maximum results makes it possible to see an active position in the study of risk. These results indicate an active interest of European entrepreneurs in the study of risk, issues related to it and, it can be assumed, in the effective implementation and implementation of the risk management system in their enterprises.

The greatest intensity of searches was during the COVID-19 pandemic, reaching its maximum in the 3rd quarter of 2020. After that, interest was not so pronounced, but a resurgence was noted at the end of the first period of the study, especially in Poland.

We can assume that this is due to warnings about possible military aggression against Ukraine. Enterprises, analyzing the security situation, studied information about risks more actively. The prevalence of the search indicator for Poland at the end of the first analyzed period is justified by its territorial proximity to Ukraine, as a potential country (at that time) against which military aggression could be launched [168].

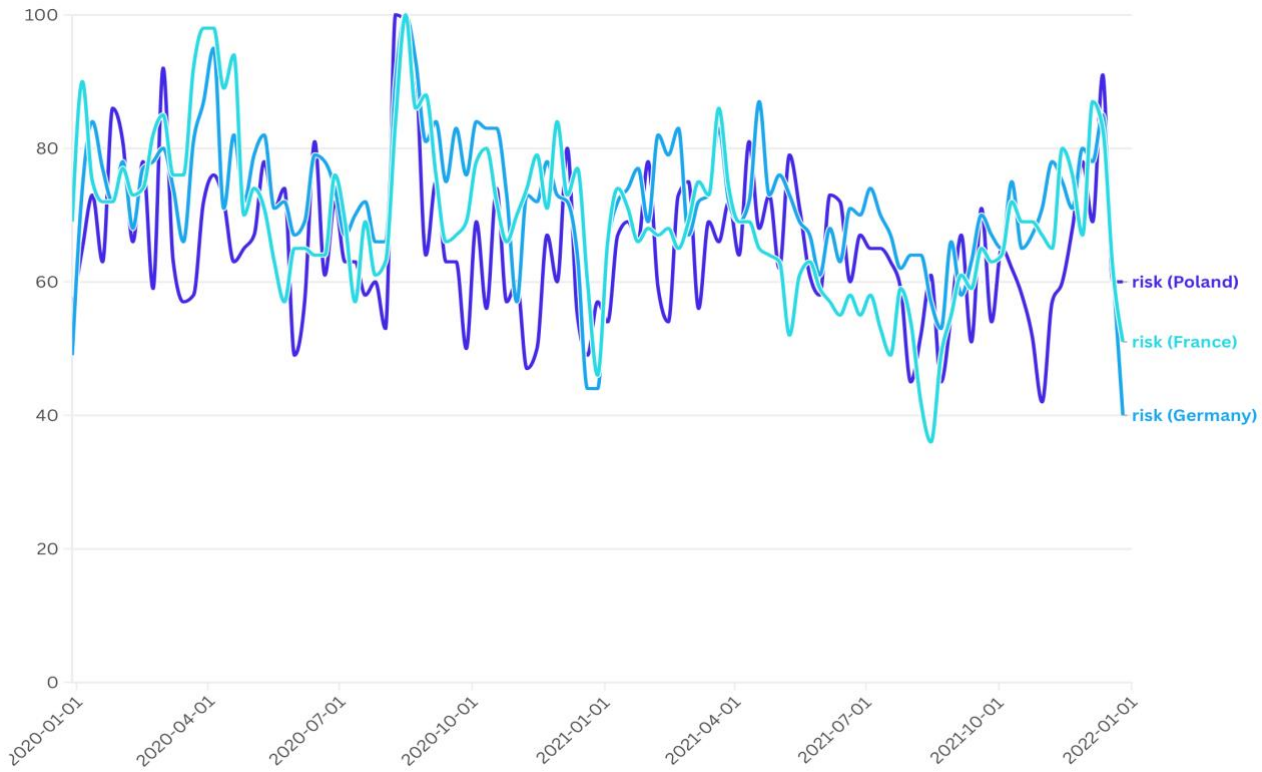


Fig. 2.10. Search dynamics for risk queries in 2020-2021, Poland, Germany, France

Source: compiled by the author based on [168, 177]

In the second analyzed period, the search intensity was even higher, although the maximum was not in the 1st quarter, when the full-scale war in Ukraine began. The highest intensity of requests is observed in the period from the end of 2023 to the end of the second analyzed period. Perhaps this is also due to the potential military threat for these countries as well.

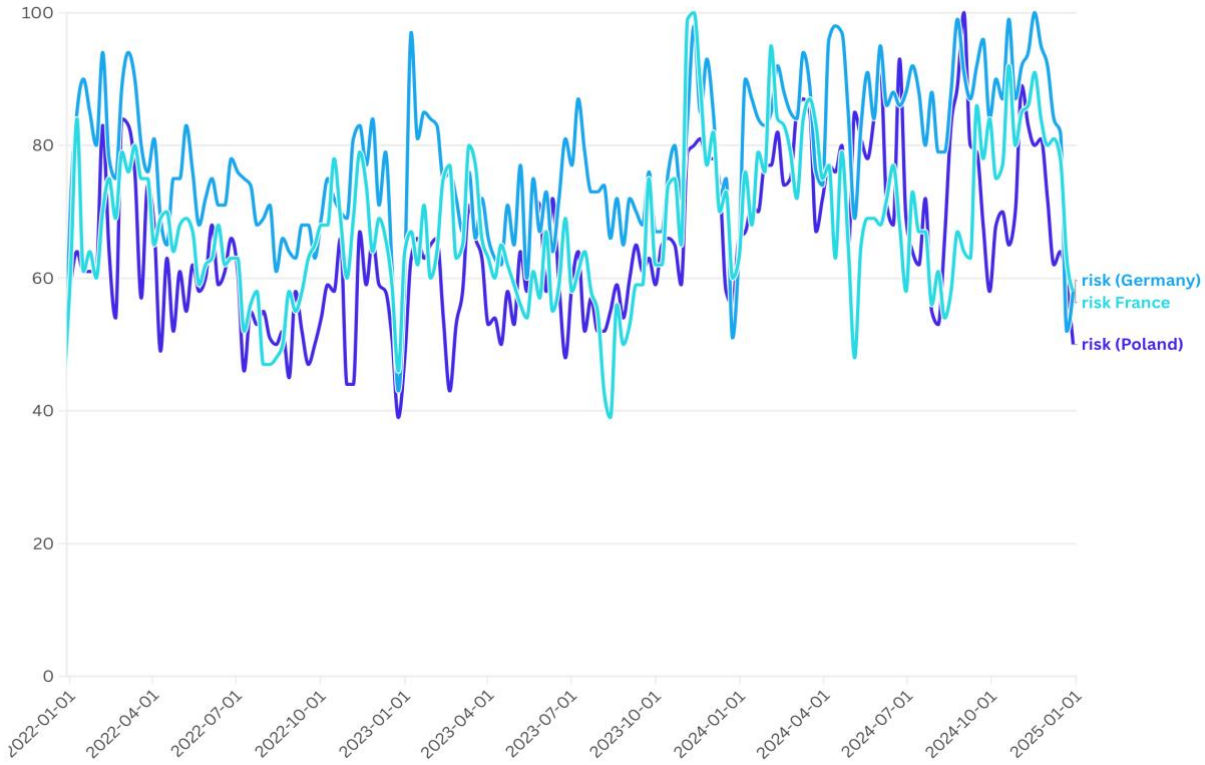
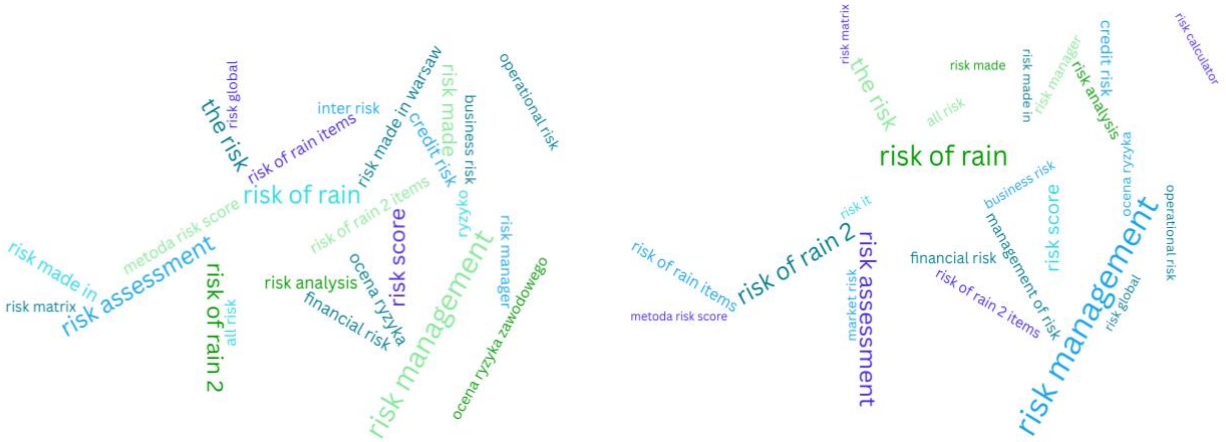


Fig. 2.11. Dynamics of search queries related to risk in 2022-2024, Poland, Germany, France

Source: compiled by the author based on [168, 177]

Comparing the dynamics of trends by country allows to see that there are differences, although within the general trend. Sometimes some countries experience significant growth. Such as, for example, Germany at the beginning of 2023, while other countries, on the contrary, do not increase their activity. For the most part, Germany's indicators differ most in the intensity of the corresponding request. But, in general, there is an intense interest on the part of entrepreneurs in the topic of risk.

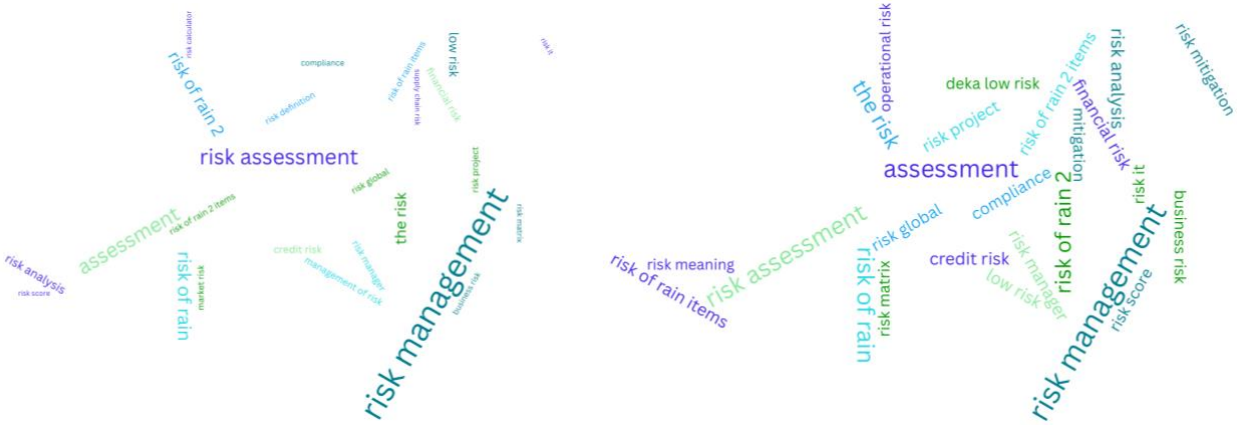
Below is a content analysis of related words for these countries in the same periods (Fig. 2.12 – 2.14, where (a) – 2020-2021, (b) – 2022-2024). It is worth noting that the search capabilities of Google Trends provide data on related words – up to 25 words. The feasibility of conducting content analysis is justified by the fact that it can indicate the main directions where entrepreneurs are headed when researching risk topics, what risk they are focused on, whether there is an understanding of the availability of methods for managing them, assessing them, etc.



(a) (b)

Fig. 2.12. Searches for words related to the word “risk” by representatives of the business and industrial sector of the economy in Poland in 2020-2024

Source: compiled by the author based on [168, 177]



(a) (b)

Fig. 2.12. Searches for words related to the word “risk” by representatives of the business and industrial sector of the economy in Germany in 2020-2024

Source: compiled by the author based on [168, 177]

(а) (б)

Fig. 2.14. Searches for words related to the word “risk” by representatives of the business and industrial sector of the economy in France in 2020-2024

Source: compiled by the author based on [168, 177]

As it is seen, in Poland, related searches in both analyzed periods did not differ much. Most of all, risk management and risk assessment were searched. The searches also included studying information on the risk matrix – an assessment method used in risk management, and on various types of risk. Among the types of risk, information on credit risk was searched. In general, this result indicates the orientation of Polish entrepreneurs precisely on risk assessment and management.

The German results also show a slight difference in the words associated with this search: there is a search for risk management, risk assessment, financial risk, as well as a risk matrix, how to mitigate risk, etc.

In France, we got roughly the same results. The main search terms besides risk were: risk management, risk assessment, risk analysis, risk manager, capital risk, etc.

That is, we can see that the scope of related words is wide and includes many important points for effective risk management. Entrepreneurs explore different types of risks and how they can be managed, what methods to use to influence it.

In the development of our research, let us move on to the analysis of the results for Ukraine. First, we analyze the results of searches for the word “risk” by representatives of the business and industrial sector of Ukraine by region in both analyzed periods (Fig. 2.15 - 2.16).

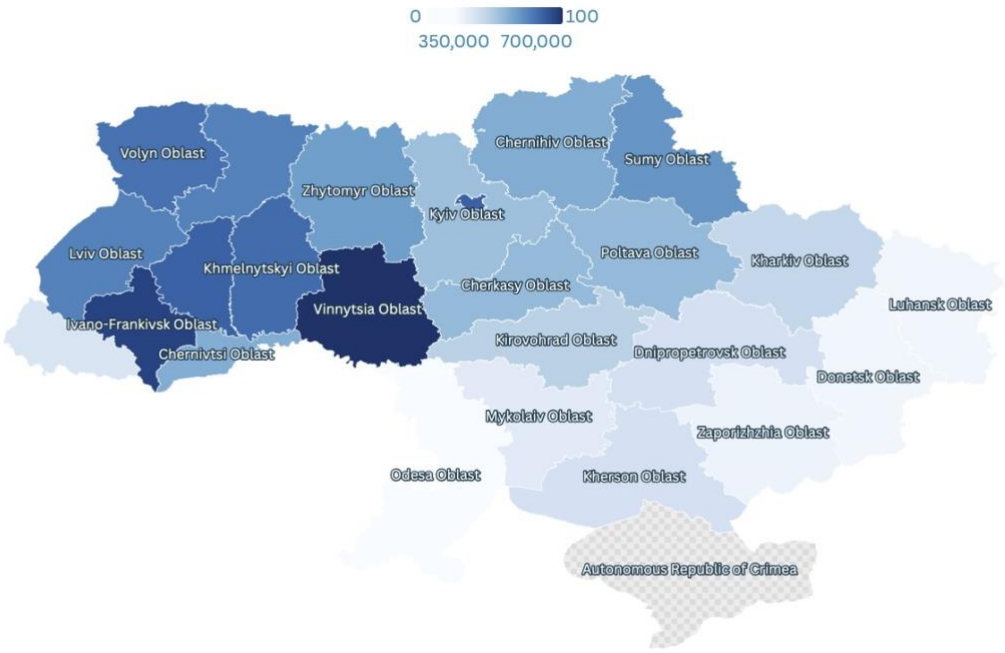


Fig. 2.15. Searches for the word "risk" by representatives of the business and industrial sector of the economy of Ukraine in 2020-2021 by region

Source: compiled by the author based on [168, 177]

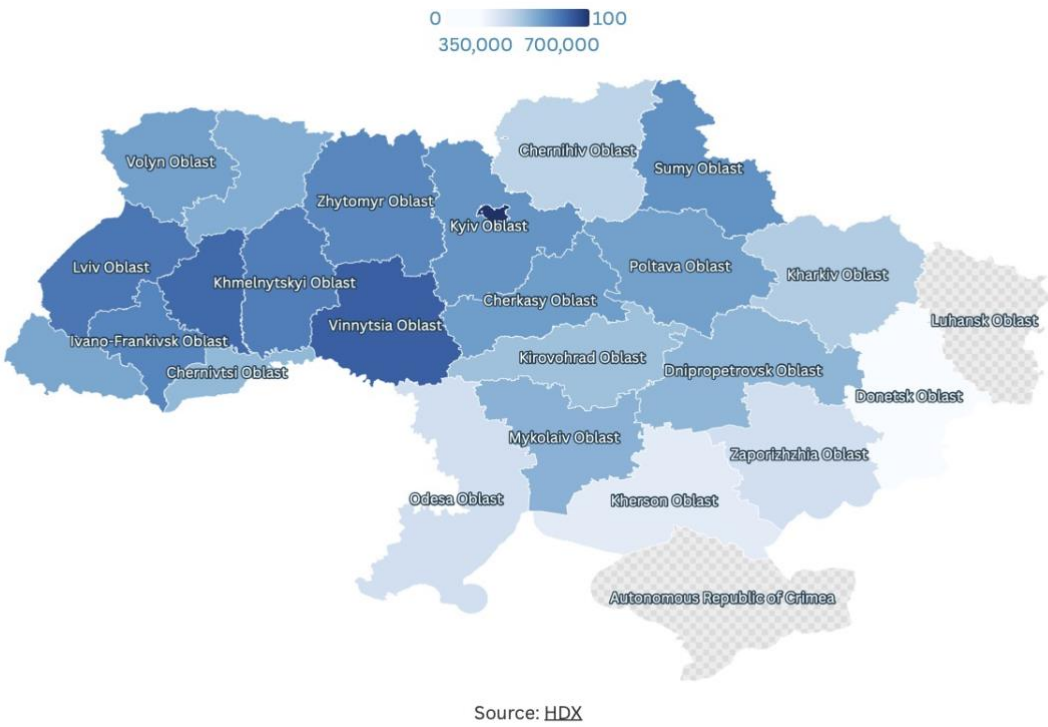


Fig. 2.16. Searches for the word "risk" by representatives of the business and industrial sector of the economy of Ukraine in 2022-2024 by region

Source: compiled by the author based on data [168, 177]

The figures above allow us to see the interest in searching for information about risk during the specified periods. It is worth mentioning the algorithms of Google Trends and noting that they do not give absolute values, but relative ones, when the maximum number of requests is taken as 100%, and all other figures are derived from this. As we can see from Fig. 2.15, the greatest intensity of searching for information about risk was in Vinnytsia region, Kyiv city and slightly lower values in Ivano-Frankivsk region. It is worth noting that the frequency of requests was higher in this period in the West of Ukraine, when the center and the East are characterized by lower search intensity and interest from the business side.

The situation during martial law in Ukraine is slightly different: thus, the highest intensity of search for information on risk was among entrepreneurs in Kyiv. The indicators of other regions are much lower, although Vinnytsia and Ternopil regions studied issues related to this category more intensively. The difference in interest across Ukraine is not very pronounced (excluding Kyiv and the regions already described). The data obtained indicate that business paid more attention to risk during the beginning and continuation of the war than during the pandemic. Also, the low search values in most regions that actively participated in hostilities from the first days or were occupied (with the exception of Sumy and Kyiv regions) are notable.

Also, an important characteristic of interest and content analysis of searches of business representatives is the analysis of related words with the main search word. Thus, the results of searches for related words among representatives of business and the industrial sector of the economy of Ukraine in 2020-2021 (a) and in 2022-2024 (b) are presented in Fig. 2.17.

(а) (б)

Fig. 2.17. Search for words related to the word “risk” by representatives of the business and industrial sector of the economy of Ukraine in 2020-2024

Source: compiled by the author based on [168, 177]

As we can see, there are certain similarities and differences in search terms during these periods. For example, during the pandemic, Ukrainian representatives of business and the industrial sector of the economy were interested in risk management, audit risk, credit risk, etc., as well as issues of reducing the risk of infection with the virus. During the war, in addition to the common related words “risk management”, “audit risk”, “credit risk”, “corruption risk”, others were added that are worth paying attention to: “justified” and “unjustified risk”, “geopolitical risk”, “insurance risk”, “social risk”, etc. This gives us reason to see that business representatives during this period assessed the possible consequences of the war for their business on a larger scale. It can be noted that during the first studied period, the search intensity was slightly lower in terms of searching for related words. Entrepreneurs studied this issue less deeply.

Next, we will present the dynamics of search queries on the topic under study. We will also add to the risk other keywords “economic risks”, as well as “business risks” and “military risks” (they were added in the second analyzed period, since no data was obtained for them in the first). The addition of additional search terms is due to the fact that it is important to compare the dynamics of queries for those types of

risk that are important for the activities of enterprises. The obtained data is illustrated in Fig. 2.18 – 2.19.

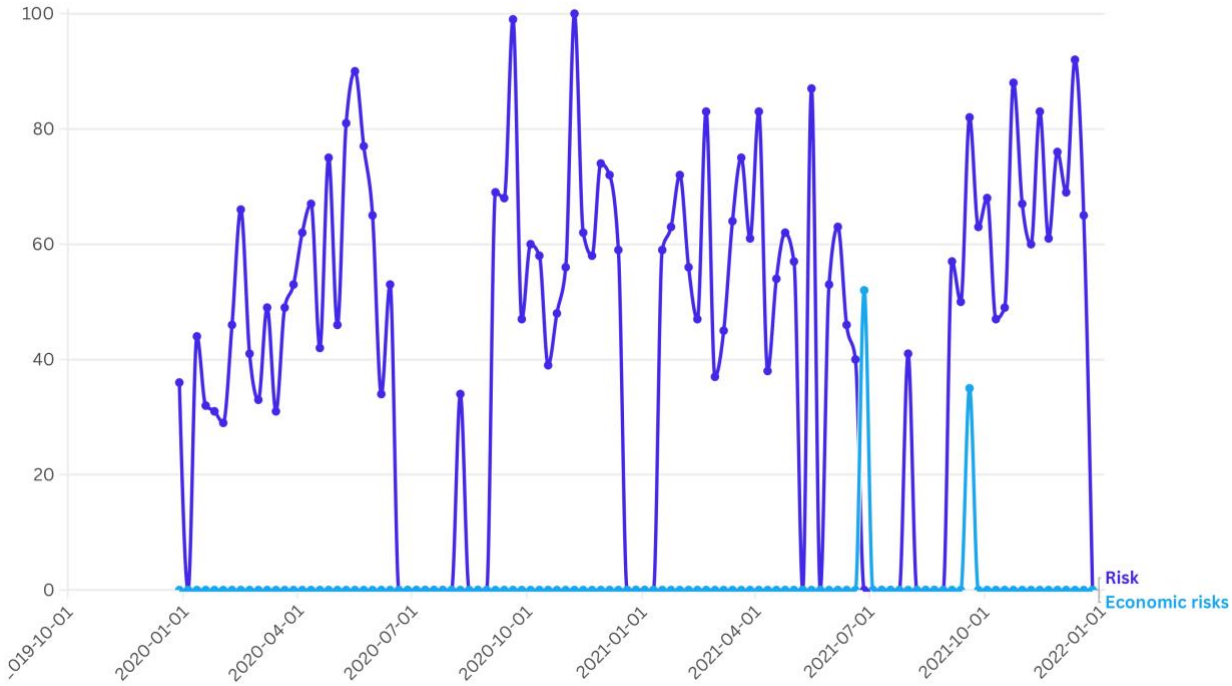


Fig. 2.18. Dynamics of search queries related to risk in 2020-2021

Source: compiled by the author based on [168, 177]

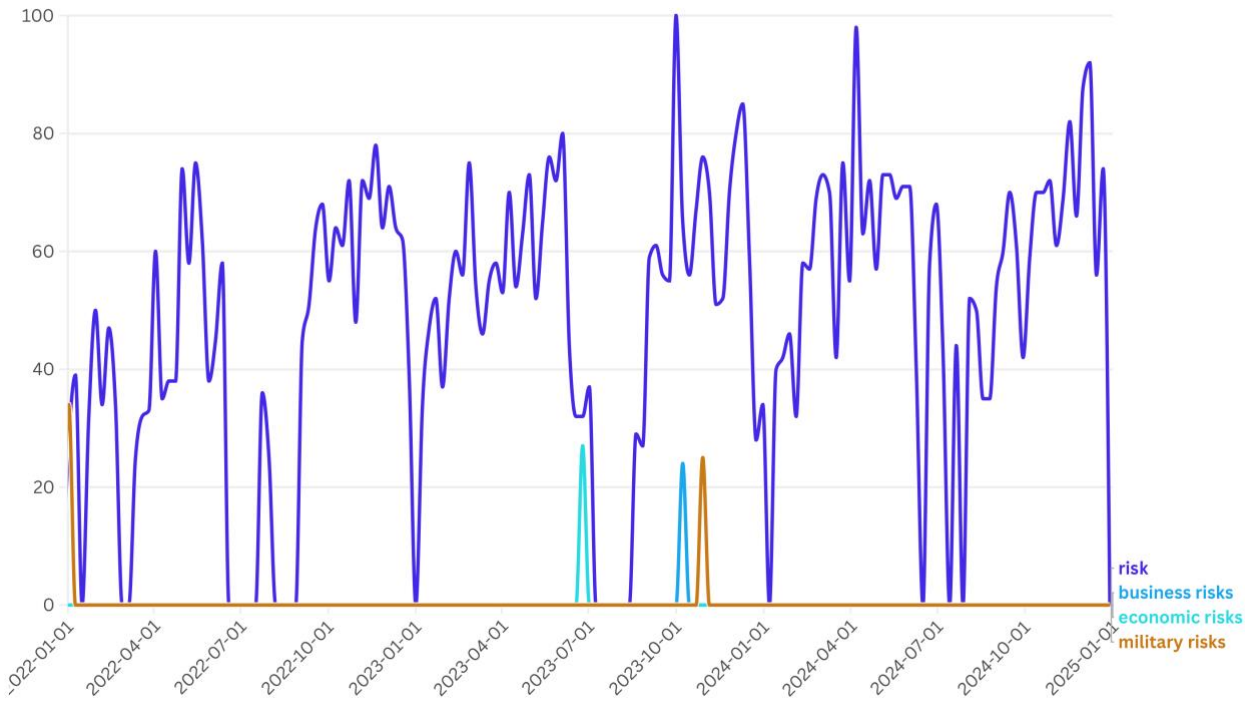


Fig. 2.19. Dynamics of search queries related to risk in 2022-2024

Source: compiled by the author based on data [168, 177]

As we can see, during 2020-2021, among the trends, data was obtained on the risk itself and economic risk. The dynamics are heterogeneous and differ in both declines and falls. It is worth noting that during the pandemic, the maximum number of information searches was not in the first period of the announcement of quarantine measures in Ukraine, but already during the second lockdown – in the fall of 2020. Which is identical to the search results for EU countries. Economic risks have been of interest to business representatives since July 2021, and the trends in queries on these risks do not coincide with the search for “risk”. We can say that economic risks were not the subject of active search by entrepreneurs during this period. This corresponds to the content analysis of this period.

Analysis of Figure 2.19 also allows to see additional information obtained regarding other risks. This figure also reflects uneven trends in searches. Thus, information regarding military risks was of greater interest to entrepreneurs even before the start of a full-scale invasion and at the end of 2023. It is worth noting that the situational nature of interest in various types of risk, rather than its stability.

Searches for information about risk itself are characterized by relative stability, although with periodic declines. The maximum values of information search fell on October 2023 and spring 2024. Which is also quite interesting for analysis, since during this period the war has been going on for quite some time. And it can be assumed that businessmen are starting to focus more on forming a risk management system, studying more information about risk.

If we compare with the results of related words of Ukrainian entrepreneurs during the pandemic, we will see a significant decrease in content not in favor of domestic entrepreneurs. Although in the second analyzed period the situation somewhat leveled off with European partners. But Ukrainian businessmen were currently looking for more information about the types of risks, and not exactly the means of assessing them and mitigating the consequences of their occurrence.

The results obtained are evidence of how much business representatives are interested in studying issues related to risk, how much they understand the importance of risk management and the process of its prediction and mitigation. We see that

European entrepreneurs approach this issue more deeply and consistently, since trends are relatively stable, and the requested information involves not only studying the risks themselves and their types, but also methods of assessing and managing them.

This is important for studying the EU experience with the aim of its implementation in Ukraine, at Ukrainian enterprises. Enterprises should understand the relevance of knowledge about risk management and, when building an appropriate system, approach this issue comprehensively in order to cover all aspects related to risk. Entrepreneurs of Ukraine should know that risk research is not only a study of its essence, but also involves searching for the types of risks that an enterprise may encounter, what consequences this may have for it, as well as how to measure risk and manage it. An example of this can be the risk management practices of the enterprises we examined in section 2.2. Namely ArcelorMittal, Metinvest, Interpipe, which demonstrate advanced risk management practices for Ukraine. Since the risk management systems they have built take into account the various risks that the enterprise faces and have a developed risk management methodology, which specifies specific actions of the enterprise to reduce the likelihood of certain types of risk occurring.

In order to increase the effectiveness of risk management in an enterprise, it is important to use various tools. One of the effective means is the expert opinion of specialists and the opportunity to receive professional advice. Ukrainian businessmen should now use the services of the All-Ukrainian Association of Management Consultants CMC – Ukraine [146], which actively helps Ukrainian business in crisis situations. An example is the projects in which Ukrainian entrepreneurs from this association of consultants can participate. Thus, CMC-Ukraine has successfully implemented projects on consulting entrepreneurs, namely “CMC4Ukraine. Restoration and development of manufacturing enterprises” and Project “Business Development Services for Small and Medium-Sized Enterprises of Ukraine in Crisis Due to the Ongoing War”, which provided business owners with professional consultations on various aspects of enterprise management, exchange of experience between entrepreneurs themselves, which contributed to achieving a synergistic effect

in obtaining knowledge and skills for businessmen in risk management, including [217]. Such an example is important for Ukrainian enterprises, as it reflects the opportunities that entrepreneurs of different levels and scales have to improve their activities. This becomes especially relevant in the context of stimulating the development of small and medium-sized businesses (hereinafter referred to as SMEs) by the Government of Ukraine, world organizations, other countries of the world and various organizations with similar specifics of activity. By contacting CMC-Ukraine, an enterprise receives a tool for its own development in the form of knowledge and skills in managing various aspects of its activities. Risk management may not always be manifested in such a formulation, but be embodied in the activities of the enterprise precisely in risk-based management. That is, to assess risks in accordance with various aspects of the company's activities and areas. An example would be the planning of operational activities precisely on the basis of assessing operational risk within this framework, and not by isolating it as a separate task for the person responsible for risk management. Since not all enterprises can have an appropriate structure in their company. Especially when the enterprise is an SME. Or manage the risk of turnover of qualified personnel by building an effective policy of supporting such personnel in the enterprise, which is developed not directly by risk management specialists, but by those responsible for human resources management. This is what justifies the fact that risk management should be implemented in every area of the enterprise's activity and should not have a separate risk management structure, but rather be integrated into the company's management system.

Thus, having examined the practical aspect of the research topic, we can draw the following conclusions:

The above-described actualizes the topic of the study and indicates the need for risk management on a proactive basis, on the full integration of risk into the enterprise system. For this, it becomes important to study experience, obtain relevant and high-quality information about risk and the process of its management. It becomes important here to understand the need for risk management, to take it into account in one's activities, to form a risk-oriented mindset.

To achieve the above task, we analyzed entrepreneurs' queries about risk, analyzed queries by regions of Ukraine, and analyzed the content of searches for risk-related words. The data obtained show that there are certain differences in the activity of searching for information about risks by region for the two analyzed periods. During a full-scale war, the difference is not as significant as during the COVID-19 pandemic, but the cities of Kyiv, Vinnytsia, and Ternopil regions stand out the most in 2022-2024. The analysis of dynamics is also heterogeneous and its results are somewhat different from the data for EU countries – Poland, Germany, and France. In these countries, the search for information about risk by business representatives is more stable, which indicates the awareness of entrepreneurs and constant monitoring of this issue. The content of the analysis of risk-related words also reflects the same result and indicates a greater number of additional searches about risk by entrepreneurs from these countries. Although the result of Ukraine in 2022-2024 is also already approaching the EU countries analyzed in our study.

Conclusions to Chapter 2

Taking into account the above, we can draw the following conclusions regarding the development of the risk environment of Ukrainian enterprises:

1. The macro environment in which Ukrainian enterprises operate is unstable and characterized by high volatility, instability and crisis situations. This is confirmed by international ratings, according to which Ukraine receives low results. These ratings characterize creditworthiness, logistics efficiency, economic freedom both at the country level and at the enterprise level.

The statistical analysis of the main macroeconomic indicators that directly relate to manufacturing enterprises, which was supplemented by elements of descriptive statistics and the determination of the coefficient of variation, confirmed the instability of the macroenvironment of Ukrainian enterprises, sufficiently high risk indicators for the main macroeconomic indicators. Growth rates also indicate uneven dynamics. The main shock years were 2020 and 2022. This negatively affects the risk environment of manufacturing enterprises and creates an additional burden for the risk management system in terms of analyzing and taking into account the impact of external factors.

2. The result of significant volatility of the macro environment was fluctuations in the income and profit indicators of Ukrainian enterprises, which also changed in accordance with the general dynamics of the considered indicators. Studies of financial and other indicators of selected manufacturing enterprises indicate a change in the dynamics of income, profit, assets and others depending on the period. Shock years also become 2020 and 2022. To substantiate the risk study of selected enterprises, we calculated the coefficients of the liquidity, financial condition and profitability groups. The results obtained indicate the presence of certain problems at enterprises, but for some they are not critical, despite the decrease in financial indicators, and other enterprises demonstrate more negative indicators. The year of the greatest decrease in coefficients is also 2022.

The selected models of Altman, Springate, Tereshchenko, Taffler and Tishaw and the calculation of the Beaver coefficient allowed us to assess the degree of risk of solvency, bankruptcy, and the ability to meet our obligations. The results show that the selected enterprises have certain problems and some are characterized by fairly high risk indicators, while others demonstrate satisfactory results with periodic deviations.

A study of the risk management practices of these enterprises showed that ArcelorMittal, Metinvest, and Interpipe have a stable risk management structure, while KVBZ and AZOT do not have such a well-developed risk management system, which is fully consistent with the previously obtained results of the risk assessment of these enterprises.

3. Analysis of interest in the risk category among business and industrial sector representatives in Ukraine and Germany, France, and Poland reflects certain differences, where EU countries demonstrate more stable interest than Ukraine. Comparison of content analysis of search words and phrases is also characterized by the orientation of European searches towards methods of risk assessment and management. And in Ukraine, they are more focused on searching for the “risk” category and its types. And in the period 2020-2021, search interest in additional words was significantly lower than in the period 2022-2024. Regional analysis of search queries in Ukraine showed uneven search during the COVID-19 period and relative uniformity during the period of full-scale war, but with a sufficiently high indicator in the city of Kyiv, Vinnytsia and Ternopil regions.

CHAPTER 3
DIRECTIONS FOR FORMING RISK MANAGEMENT FOR MANUFACTURING ENTERPRISES

3.1. Development of a conceptual model of a risk management system for manufacturing enterprises taking into account the assessment of macroeconomic risk

Considering the previously discussed in Chapter 1 and the obtained research results in Chapter 2 of this dissertation, it is necessary to develop a conceptual model of the risk management system for manufacturing enterprises, which is justified by the expediency of risk management in order to increase the efficiency of the enterprise. The data we obtained show that at enterprises that have implemented a risk management system at the enterprise and made it proactive, the results of activity are quite distinctive, although they are also under the negative influence of the risks and threats that arise before the enterprises of Ukraine. Manufacturing enterprises can be influenced by various factors, and it is important to take them into account, calculate the probability of risk occurrence, the degree of impact on activities, etc. That is why manufacturing enterprises of various scales should build a risk management system that will analyze these factors and respond in a timely manner and apply appropriate methods and measures. Moreover, it is important to assess the risk, both external, which we can hardly influence, and internal, which is a consequence of the occurrence of external, as well as our ability to analyze and counteract it in advance.

We have determined that Ukrainian enterprises operate in conditions of significant instability, which is exacerbated in certain years. Currently, among the external risks that directly and to a significant extent affect the activities of manufacturing enterprises, there are such risks as logistical, energy, environmental (maybe internal), inflationary, political, and, first of all, military. It can be said that military precedes other risks and their probability and scale are a consequence of its occurrence.

Among the internal risks, one can distinguish production, information and digital, personnel risks, as well as liquidity, insolvency and financial risks. However, the activities of enterprises must take into account and assess all the risks that they face. In addition, the risk management model must be integrated into the activities of enterprises regardless of their field of activity and size. The size of enterprises may affect the organizational mechanism for implementing risk management, but the risk management system must be inherent in all enterprises.

When forming a risk management system for manufacturing enterprises, it is worth relying on Enterprise Risk Management (hereinafter referred to as ERM) as an integrated and holistic risk management system at the enterprise, which includes the assessment of both financial and operational, strategic and other risks, which cannot always be assessed quantitatively, but qualitatively [44]. What is important about ERM is that it is an element of an integrated management system at the enterprise, and not a separate one, which is separated from other management structures [1]. The enterprise is managed on the basis of a risk-oriented approach, when decision-making is carried out taking into account the assessment of the probability and scale of risk occurrence, regardless of the structure that makes the relevant management decision. This creates the foundation for the integration of such a risk management system into an enterprise of any size.

An important component in the risk management for manufacturing enterprises is risk assessment, which has a certain specificity, since not all risk can be assessed quantitatively, based on statistical information. In risk management, the expert method is widely used to assess various aspects and types of risk, but it is subjective in nature. Of course, when managing risks at enterprises and making management decisions, it is worth including expert risk assessment, but the basis for risk assessment must have a numerical justification, which can later be taken into account and expert judgments should be added, taking into account other types of risk that cannot be numerically confirmed, except for expert assessment.

As a basis for building a risk assessment model for further formation of risk management policy, we propose to calculate the macroeconomic risk (hereinafter

referred to as the MAR) of the enterprise as a threat of an external nature and an internal risk of solvency. They characterize the financial risk of the enterprise, which, although not the only risk of the enterprise, is important for the existence of the enterprise itself, because the financial component becomes the basis for regulating various aspects of the activities of enterprises, as it creates a protective financial mechanism for risk management and the enterprise in general. For this purpose, we propose to develop a tool in the form of a matrix that will allow combining the indicator of macroeconomic risk and internal risk of solvency. The results of the enterprise itself and the results at the state level allow us to assess the real current state, which is a reflection of our threats and opportunities. Depending on the results of this matrix and on its basis, the appropriate operational and strategic policy of the enterprise regarding risk will be formed. The results of this matrix are included in the conceptual model of risk management at manufacturing enterprises.

To achieve the stated purpose and develop an appropriate model of the risk management system, it is necessary to initially determine the external risk of the enterprise and the directions for its consideration when forming the risk management system.

We propose to determine external risk by constructing an indicator of macroeconomic risk as one that can be directly assessed and mathematically substantiated, which makes it possible to approach this objectively, without making subjective judgments. In paragraph 2.1 of this dissertation work, we conducted an assessment of the macroenvironment of Ukrainian manufacturing enterprises, on the basis of which we propose to calculate an integral indicator of macroeconomic risk.

To calculate this indicator, we propose to construct a correlation matrix to determine the relationship between the indicators and then construct a regression to determine the factors of influence among the ones we have selected on the net profit (loss) indicator.

We have chosen the net profit indicator as the one that all enterprises aim for. Since obtaining net profit is the main goal of any manufacturing enterprise, which

allows it to continue to carry out its main activities, meet its obligations and receive not only income, but also profit.

In section 2.2, we analyzed the profitability and return indicators of Ukrainian enterprises, but to further build a correlation matrix and regression, we will need to calculate the growth rate for this indicator, in order to see the connection with the variability of the main indicators under study and so that all indicators are normalized. However, the calculation of the growth rate of the net profit (loss) indicator may not reflect completely correct results due to the "-" sign in the case of a year when a loss was noted in several consecutive years. In this case, we cannot use this indicator as it is, but the State Statistics Service of Ukraine also lists this indicator separately as net profit and net loss. This gives us the opportunity to use one of them and use correct calculations of growth rates. Taking into account the focus of enterprises on the net profit indicator (hereinafter referred to as the NP) and its maximization, we will focus on it and include it in the growth rate indicators for further calculations.

As we have already noted, statistical data and growth rates do not fall under the law of normal distribution (see section 2.1), so we cannot calculate the Pearson correlation, but must calculate the Spearman correlation. This correlation is a rank correlation and makes it possible to establish a relationship between variables [164, 178]. When constructing ranks and in our further study of macroeconomic risk, we rely on growth rate indicators, as they make it possible to normalize our values, which differ in different ranges of numbers due to differences in scale in the indicators included in the model.

The growth rates of indicators are ranked by year and subsequently a correlation is established between these ranks. We used MS Excel to rank the indicators. The results are presented in Table 3.1.

To calculate Spearman correlation coefficients, the formula is used [164]:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2-1)}, \tag{3.1}$$

where ρ – is Spearman's rank correlation,

d_i – difference between the ranks of the corresponding variables,

n – number of observations.

Table 3.1.

Ranks of growth rates of macroeconomic environment assessment indicators

	GDP	PPI	ORPP	IPI	CPI	UAH/ USD	UAH/ EUR	CI	CII	NP
2014	3	3	4	3	6	10	10	3	3	4
2015	9	9	10	2	11	11	11	6	4	10
2016	7	6	8	9	8	8	9	9	8	3
2017	8	8	9	6	9	4	4	7	6	7
2018	6	4	6	8	5	3	6	8	10	5
2019	4	2	2	5	3	1	1	4	7	8
2020	2	1	3	4	1	5	5	2	2	2
2021	11	10	11	7	4	2	2	10	9	11
2022	1	11	1	1	10	9	3	1	1	1
2023	10	7	5	11	7	7	8	11	11	9
2024	5	5	7	10	2	6	7	5	5	6

Source: calculated by the author using MS Excel

After calculating the ranks, we can proceed to calculating the correlation coefficients, which we present in the form of a correlation matrix in Table 3.2.

Table 3.2.

Spearman correlation matrix

	GDP	PPI	ORPP	IPI	CPI	UAH/ USD	UAH/ EUR	CI	CII	NP
GDP	1									
PPI	0,455	1								
ORPP	0,827	0,436	1							
IPI	0,509	-0,118	0,318	1						
CPI	0,245	0,700	0,227	-0,327	1					
UAH/ USD	-0,145	0,273	-0,027	-0,355	0,609	1				
UAH/ EUR	0,164	-0,055	0,264	0,082	0,355	0,782	1			
CI	0,909	0,291	0,673	0,745	0,127	-0,236	0,155	1		
CII	0,727	0,036	0,400	0,791	-0,091	-0,482	-0,045	0,909	1	
NP	0,827	0,291	0,618	0,273	0,045	-0,282	-0,036	0,618	0,555	1

Source: calculated by the author using MS Excel

The strength of the relationship according to correlation coefficients varies among scientists, which depends on various reasons. We define a relationship from 0,1 – 0,29 as weak, 0,3 – 0,49 as medium, from 0,5 to 0,69 as strong, from 0,7 and above as very strong [164, 179]. Values above 0,5 are marked in red. Also, values above 0 mean a positive relationship, and below 0, with a "-" sign, a negative one, when an increase in one indicator causes a decrease in the other.

Thus, the results obtained make it possible to see the presence of strong and very strong relationships between different pairs of indicators. GDP has a rather strong relationship with the following indicators: Volume of sales, Industrial production index, Capital investments, Capital investments of industrial enterprises and Net profit. This result is quite logical and justified, since GDP is an integral macroeconomic indicator that includes the results of both production and financial activities of enterprises. GDP has a strong relationship with the Industrial production index, and with others – very strong.

It is noteworthy that the Producer Price Index has a very strong correlation (0,7) with the Consumer Price Index, which also seems logical due to the influence of one indicator on the other. Thus, the result of setting the price of producers of products also affects the Consumer Price Index in the future.

There is also a strong connection between the Volume of Industrial Products Sold and Capital Investments and Net Profit. There is a very strong connection between the indicators of Capital Investments and the Industrial Production Index, which is justified by investment in fixed assets, the creation of production potential of enterprises, and this Index results from this. That is why the connection with Capital Investments of industrial enterprises is even stronger.

It is also worth noting a fairly strong relationship between the hryvnia to USD and hryvnia to EUR, which can also be justified by the fact that these currencies are currently the main ones for Ukraine in international settlements. Accordingly, a change

in the exchange rate of one currency has the same reasons as for another. If a currency devaluation occurs, it occurs relative to the second in the same way.

Net profit is also strongly related to capital investment indicators, which is explained by their dependence, since one is a source for the other. Net profit creates opportunities for further investment. And investment, in turn, creates the basis for the development of production and the further formation or growth of net profit.

That is, the results obtained are quite logical and natural. They explain that fluctuations in one can cause significant fluctuations in the other, increasing the instability and volatility of the macroeconomic environment. They are important for enterprises to conduct a general assessment and diagnosis of the macroenvironment in order to make assumptions about possible directions of further changes.

When constructing a regression to determine the factors that affect net profit, we must consider the concept of “multicollinearity”, which means the dependence between independent variables in the regression model. This can cause problems in interpreting the results of the factor analysis and distort them. The independent variables in the regression model should not be correlated [142, 221]. Studies provide various methods for identifying multicollinearity, including the use of correlation coefficients and the variance inflation factor (VIF).

However, Jeffrey Wooldbridge's work notes that there are some nuances in interpreting statistics when determining multicollinearity, as well as the independent variables that we will use. The scientist notes that if we want to investigate the effect of a certain variable on our Y, then we can ignore the VIF of other coefficients [198].

However, we propose to rely on the following algorithm for selecting potential independent variables in our model: in Table 3.2, all indicators that have a correlation of more than 0,7 should not be included in our regression model. As a result of eliminating factors that have such a relationship, we are left with 3 indicators - GDP, Consumer Price Index and the exchange rate of the hryvnia to the US dollar. Although instead of the consumer price index we can choose the price index of industrial producers, we decide to use the consumer price index in the model, which affects not

only the activities of industrial producers, but also producers of any product in general. Also, between the hryvnia exchange rates to two foreign currencies, we can choose one of them, we choose the US dollar in our study, since this currency is the base for foreign economic operations in Ukraine. In our opinion, these 3 indicators most reflect the degree of influence on the financial result of the enterprise, and they are also independent of each other, which is confirmed by Table 3.2. All other indicators in one way or another either directly affect others (for example, the volume of industrial products sold and GDP), or this follows as a result of the analysis of the correlation matrix. Therefore, the selected 3 indicators seem to us to be the most influential factors for our regression model.

Let us check the selected indicators of GDP, CPI and UAH/USD for multicollinearity using the VIF method according to the formula: [198]:

$$\text{VIF} = \frac{1}{1 - R_j^2}, \tag{3.2}$$

where R^2 – is the coefficient of determination for the estimated regression function.

To calculate this coefficient and regression for these selected indicators, we used MS Excel.

The results of the verification are shown in Table 3.3.

Table 3.3

Results of multicollinearity testing using the VIF method

	R^2	1- R^2	VIF
GDP	0,10767133	0,89232867	1,12066331
CPI	0,75073105	0,24926895	4,0117311
UAH/USD	0,73910945	0,26089055	3,83302497

Source: calculated by the author using MS Excel

The obtained VIF values less than 5 indicate a low degree of multicollinearity between the selected independent variables for our model. Which further justifies the feasibility of adding these indicators to our factor model.

By conducting regression analysis, we will be able to determine the degree of influence of selected factors on the net profit of Ukrainian enterprises. And also, to note how much the indicator depends on the selected factors. In general, we note that regression analysis is a widely used tool in conducting research and which can be applied in management and when making managerial decisions, as it allows us to see the degree of influence of factors and make a forecast of future performance results [79]. This creates the opportunity to predict the development of events, which is based on appropriate calculations and is objective in nature.

Thus, we present in Table 3.4 the initial data for constructing a regression model for assessing the factors influencing the emergency.

Table 3.4.

Input data for regression calculation

	GDP	CPI	UAH/USD	NP
2014	8,3	12,1	48,7	13,1
2015	25,3	48,7	83,8	74,1
2016	20,0	13,9	17,0	12,4
2017	25,0	14,4	4,1	29,9
2018	19,4	10,9	2,3	13,4
2019	11,7	7,9	-5,0	32,1
2020	6,2	2,7	4,3	-22,4
2021	29,1	9,4	1,2	86,4
2022	-3,9	20,2	18,5	-42,8
2023	26,5	12,9	13,1	43,1
2024	15,6	6,5	9,8	22,4

Source: calculated by the author

Using MS Excel, we will calculate the regression for net profit (Table 3.5).

The results obtained indicate the reliability of the model and the high degree of influence of the selected factors, namely 78,8% of the result of the emergency is explained by these three factors (coefficient of determination $R^2 = 0,788$). This is a high indicator and confirms the correctly selected independent variables [131].

Table 3.5.

Regression calculation result

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0,88784826
R Square	0,78827454
Adjusted R Square	0,69753505
Standard Error	20,4656819
Observations	11

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	10915,783	3638,594	8,687	0,0093
Residual	7	2931,909	418,844		
Total	10	13847,692			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-32,693	13,511	-2,420	0,046	-64,643	-0,744	-64,643	-0,744
GDP	3,138	0,671	4,677	0,002	1,552	4,725	1,552	4,725
CPI	-0,098	1,060	-0,093	0,929	-2,604	2,407	-2,604	2,407
UAH/USD	0,315	0,486	0,649	0,537	-0,833	1,464	-0,833	1,464

Source: calculated by the author using MS Excel

Given F = 8,69, which is higher than Ftable = 4,35 for the significance level of 0,05, the model is statistically significant. As indicated by the Significance F = 0,0093, which is significantly lower than the standard significance level of = 0,05 and less than 0,01 (which is even more indicative).

That is, our model showed its significance and significant impact on the indicator of the emergency, the appropriateness of the selected factors. Moreover, it is worth noting that not all variables individually have such indicators of significance, which is justified by the small time period of the study, as well as the importance of taking into account these factors together, as a model, since they have a synergistic effect in our

case, and do not affect in isolation. Summarizing the above, our regression equation has the following form:

$$NP = -32{,}69 + 3{,}14*GDP - 0{,}098*CPI + 0{,}315*UAH/USD, \quad (3.3)$$

It should be noted that a random error term is usually included in regression equations [198, 253]; however, it is not used in estimation equations.

So, having received the results of the regression model, we can proceed to the calculation of the macroeconomic risk indicator, which has an external impact on the activities of enterprises and must be taken into account by the enterprise when forming a risk management system and making management decisions.

This indicator is supposed to be calculated based on the factors that we included in the regression model. Their inclusion in the indicator is justified by the high statistical significance of our model. We propose to calculate the integral indicator MAR using the following formula:

$$MAR_t = \sum(w_i * s_i * z_{it}), \quad (3.4)$$

where w_i – is the weight of the i-th indicator;

z_{it} – standardized value (z-score) of the i-th indicator in a specific period t;

s_i – coefficient of the direction of the indicator's influence on the level of macroeconomic risk (-1, +1);

s_i = -1 – stabilizing factor;

s_i = +1 – risk factor.

In our case, the stabilizing factor is GDP, and the CPI and UAH/USD exchange rate are risk factors.

Specifically for our indicators we get the following formula:

$$MAR_t = w_{GDP}*(-z_{GDP,t}) + w_{CPI}*(z_{CPI,t}) + w_{UAH/USD}*(z_{UAH/USD,t}), \quad (3.5)$$

Moving to calculation of a z-score to standardize our data and include it in our integral measure. This is done to normalize our data, where the values are converted to a common scale, where 0 is the average value. This measure means how much the obtained value differs from the average [180, 254]. Standardization is used to ensure comparability of indicators.

Let us give the z-score formula [196]:

$$z = \frac{(x-\mu)}{\sigma}, \quad (3.6)$$

where z – z-score,

x – value that is being evaluated and should be standardized,

μ - sample mean,

σ - standard deviation (STDEV).

To calculate standardized z-scores, we will use MS Excel and present the results in Table 3.7.

To select the period – the base of our study, we will take a 10-year range (2015-2024). The average and standard deviation are calculated for this period. We have chosen this range of years in order to ensure comparability, homogeneity of the base and relevance of the risk environment. In the future, it is proposed to update the base every 5 years.

In Table 3.6. we present the mean and standard deviation for our model over a given 10-year range.

Table 3.6.

Mean and standard deviation indicators when calculating z-score

	GDP	CPI	UAH/USD
μ	17,5	14,8	14,9
σ	10,4	12,9	25,3

Source: calculated by the author using MS Excel

The results of the calculations are given in Table 3.7. We will take into account the coefficient of the direction of the indicator's influence.

So, we have obtained the data for calculating the z-score, on the basis of which we can proceed to calculating the macroeconomic risk indicator.

Table 3.7.

Obtained Z-scores of macroeconomic indicators

Years	Z-GDP	Z-GDP*S	Z-CPI	Z-UAH/USD
2014	-0,886	0,886	-0,206	1,336
2015	0,756	-0,756	2,638	2,722
2016	0,239	-0,239	-0,066	0,082
2017	0,724	-0,724	-0,027	-0,427
2018	0,188	-0,188	-0,299	-0,499
2019	-0,557	0,557	-0,532	-0,786
2020	-1,093	1,093	-0,936	-0,419
2021	1,122	-1,122	-0,416	-0,541
2022	-2,063	2,063	0,424	0,143
2023	0,871	-0,871	-0,144	-0,072
2024	-0,186	0,186	-0,641	-0,202

Source: calculated by the author using MS Excel

To calculate our MAR indicator, it is also necessary to calculate the weights, according to the formula:

$$w_i = \frac{|\beta_i|}{\sum_{j=1}^{n}|\beta_j|}, \quad (3.7)$$

where w_i – normalized weight of the i–th indicator,

β_i – standardized regression coefficient.

According to scientists, it is the values of the regression coefficients that we can use to estimate the weights of the variables [214].

In our case $w_{i\ GDP} = 0{,}884$, $w_{i\ CPI} = 0{,}028$, $w_{i\ UAH/USD} = 0{,}089$.

The results of the calculation of the MAR indicator are presented in Table 3.8. We will also immediately convert the result of the obtained indicator to a scale of 0-100 using the logistic transformation method. This will limit the range of values to 100 and reduce the impact of extreme emissions.

Transforming the formula of the logistic function (sigmoid) to our indicator, we obtain [25]:

$$\varphi(Z) = \frac{1}{1+e^{-Z}} \quad \rightarrow R = 100 * \varphi(Z) = \frac{100}{1+e^{-Z}}, \quad (3.8)$$

So, we have obtained an indicator of macroeconomic risk, which is presented in Table 3.8. To determine its level, we propose to specify the following threshold values:

up to 33 - moderately acceptable;

34-67 - elevated;

68 – 100 - high.

According to these values, we will enter the risk levels in Table 3.8.

Table 3.8.

Macroeconomic Risk Indicator, 2014-2024

Years	MAR	MAR $_{0\text{-}100}$	Level
2014	0,895	71	high
2015	-0,353	41	elevated
2016	-0,206	45	elevated
2017	-0,678	34	elevated
2018	-0,218	45	elevated
2019	0,408	60	elevated
2020	0,903	71	high
2021	-1,051	26	moderately acceptable
2022	1,847	86	high
2023	-0,780	31	moderately acceptable
2024	0,129	53	elevated

Source: calculated by the author using MS Excel

Moderately acceptable risk level – the lowest level of the indicator, the lower it is, the better. We define this level as such that the risk exists, but the environment is relatively stable, fluctuations are present, but they are not large, in general, the risk can be managed on a general basis, carrying out current monitoring and control of indicators, as well as analyzing the external and internal environment. Also, with the analysis of the dynamics of this risk and its gradual increase to the limit level or the obtained indicator, which is approaching 33, we understand that volatility is increasing, the risk becomes more likely, macroeconomic factors have a greater impact on the activities of the enterprise, and although the risk is not critical, it deserves more attention than at lower numbers. But this does not require reactive attention, but may be current risk management. Proactivity here is manifested in the ongoing construction of forecasts for the development of the macro environment, in preparation for possible

further changes in macro indicators, their anticipated impact on the enterprise, control of this impact and relevant management decisions.

Elevated risk level (34-67) – at this stage, a significant impact of risk on the enterprise is already felt, on its financial stability, macroeconomic instability is increasing. The risk becomes difficult to control. Significant resources are used for risk management, including financial ones. Crisis measures may already take place, when there is no longer a proactive position, but a reactive one, adapting the enterprise's policy to the developing situation.

High level of risk (68-100) – the macro environment is unstable, the probability of negative impact on enterprises is high, the state of the macro environment may be of a crisis nature. At this stage, large-scale crisis instruments are already actively used, a review of risk management policy may take place. Here, the probability of risk occurrence is added to the high level of uncertainty, which complicates forecasting and effective implementation of decisions made.

Thus, we have identified the main levels of macroeconomic risk and the main management actions. However, it is worth noting that at any level of the MAR, various risk management tools are used, even at the moderately acceptable level. The scale and nature of these tools may vary, but they should be present at any level. Proactivity may be more evident at the moderately acceptable level, when certain changes can be predicted, there is time to review and analyze the current risk management policy, and various methods and tools can be used. But at the elevated and high levels, reactive action and the use of crisis measures and tools will take place more. When conducting this assessment, it is also necessary to pay attention not only to the level at which the value falls, but also to its dynamics and location itself. The closer to the thresholds of the level, the more attention should be paid to the level to which it is approaching. If there is a positive trend and the risk is approaching a moderate-acceptable level, then the company can no longer focus on anti-crisis tools, but focus on proactive management methods and improving its financial situation. That is why it is important to take into account previous experience when analyzing the current situation, the obtained MAR indicator for the previous year (previous years), in order to assess the

prospects for further changes, taking into account the data and information that are analyzed by responsible persons and experts.

For greater clarity of the results and a more in-depth analysis, we present Fig. 3.1.

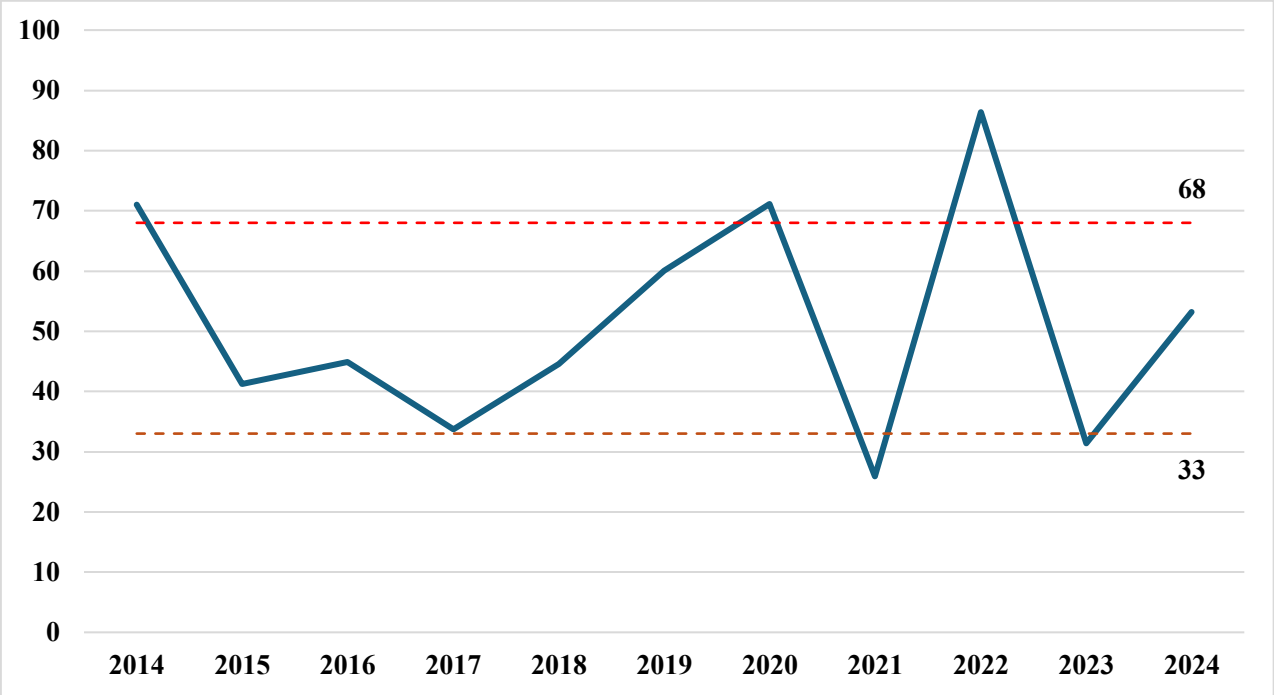


Fig. 3.1. Dynamics of macroeconomic risk in Ukraine, 2014-2024

Source: compiled by the author

We see that the MAR has uneven dynamics, which quite logically and reasonably correlates with the general trend in the country. But the highest level for the calculated period was obtained only in 2022, even the 2020 indicator did not have such high indicators, although it entered the high-risk level. It is also noteworthy that after 2020 and 2022 there is a significant decrease in the MAR risk indicator. There may be several explanations for this: firstly, we calculate our index on growth rates in order to remove strong emissions and normalize our model, and growth rates after shocks may be high compared to the previous year, when it is compared with very low indicators; and, secondly, the rapid adaptation of Ukrainian enterprises to the current situation. This difference between 2020 and 2022 can be explained by the fact that despite the shock state, in 2022 it was more systemic and had a deeper nature for the entire economy and the state. Periods of quarantine restrictions ended quickly and enterprises returned to work, while the movement of the population was, on the contrary, limited

by quarantine measures. When in 2022 the consequences were greater, which was additionally strengthened in a negative sense by the outflow of labor.

An important role in reducing the indicator after the shock years is also played by the adaptation of the economy, when enterprises and the state can quickly adjust to the changes that are coming, when enterprises are ready for energy failures, changes in supply chains. This affects the stabilization of macroeconomic indicators and these extreme indicators become smaller. Therefore, the dynamics of this indicator is uneven and reflects significant fluctuations in macroeconomic risk for Ukraine as a whole, and enterprises. As of 2024, according to our assessment, the level of this risk is increased, which requires careful attention and a quick response from the management apparatus.

Thus, we proposed the construction of a risk management model at manufacturing enterprises, which will include an analysis of the external and internal environment. To assess the external environment, the calculation of the Macroeconomic Risk (MAR) indicator was proposed, which is based on the selection of factors and the construction of a correlation-regression analysis. By selecting indicators in the factor model, between which there is no strong correlation, between which there is no multicollinearity of indicators, a regression analysis was conducted, the results of which indicate the significance of the model and a significant impact on the size of net profit of GDP indicators, consumer price index and hryvnia exchange rate to the dollar. Due to the standardization of the growth rates of the selected indicators using z-score, determination of their weight coefficients, an integral indicator of macroeconomic risk was calculated, which was converted to a scale of 0-100 by logistic transformation. The results obtained indicate a significant level of this risk and rather high fluctuations. However, after reaching peak values, its decrease is observed, which indicates the adaptability of the system and adaptation to the current situation. It is also noteworthy that during the analyzed period the MAR indicator passed to the moderately acceptable level twice - precisely after strong growth and high risk indicators. For further research and determination of the place of this indicator, we will proceed to its integration into the general risk management system of manufacturing enterprises.

3.2. Tools for assessing internal risk and selecting risk management methods for manufacturing enterprises

For a complete risk assessment of manufacturing enterprises, it is necessary to do not only an assessment of the external environment and calculate the macroeconomic risk, but also the internal one. The assessment of internal risk makes it possible to see also potential threats to the enterprise from within in terms of the risk that is measured. Although, internal risk also largely depends on external factors, including macroeconomic risk. The calculation of these two indicators will make it possible to see where the enterprise is. We propose to visualize this in the form of a matrix, which will allow to visualize the results obtained and suggest appropriate risk management methods.

That is why, after assessing the external – macroeconomic risk, we propose to assess the internal risk. Taking into account the mathematical possibility, we can determine the risk of insolvency, that is, the risk at which the enterprise will not be able to meet its obligations. For this, we propose to take as a basis the results of calculations of discriminant models for 5 enterprises, which we calculated in section 2.2 of this work. We propose to translate the obtained results into a scale from 0 to 100, where 0 is the lowest indicator according to the model - the lowest solvency, and 100 is a very high positive result - the highest solvency. Translation to this scale is necessary in order to unify the results we have obtained and for the purpose of further visualization of the location of the enterprise. However, the method of converting from 0 to 100 differs from the one we used in section 3.1, since for these methods we used the values that are normative and based on them we built formulas and calculated the values converted to this scale using MS Excel. Also, for “0” in all models we took the numbers not those after which the highest level of risk begins, but slightly lower ones, since risk is the probability of occurrence and, taking into account the long-term unstable conditions of Ukraine and also the ability of domestic enterprises to quickly adapt to such conditions, it seems logical and necessary to assess the highest level of risk as slightly lower than the minimum normative value.

It is of great importance to present in Table 3.9 the calculations of the results of discriminant models on a scale of 0-100.

Table 3.9.

Converting the results of discriminant models to a scale of 0-100

Years	Enterprises				
Altman z-score model					
	ArcelorMittal	Metinvest	Interpipe	KVBZ	AZOT
2019	28	41	55	100	0
2020	55	51	100	100	0
2021	100	100	83	27	0
2022	0	27	100	69	0
2023	0	50	100	12	0
Springate Model					
	ArcelorMittal	Metinvest	Interpipe	KVBZ	AZOT
2019	0	0	100	100	0
2020	0	6	100	100	0
2021	100	100	100	0	0
2022	0	0	100	100	0
2023	0	0	100	0	0
Tereshchenko's Model					
	ArcelorMittal	Metinvest	Interpipe	KVBZ	AZOT
2019	1	9	100	100	100
2020	10	27	100	45	0
2021	100	100	87	0	3
2022	0	0	100	8	0
2023	0	0	100	0	100
Taffler and Tishaw model					
	ArcelorMittal	Metinvest	Interpipe	KVBZ	AZOT
2019	34	100	100	100	100
2020	100	100	100	100	100
2021	100	100	100	100	100
2022	0	0	100	100	100
2023	0	100	100	100	100
Beaver coefficient					
	ArcelorMittal	Metinvest	Interpipe	KVBZ	AZOT
2019	9	9	100	100	7
2020	55	16	100	42	3
2021	100	100	20	2	5
2022	0	0	84	8	0
2023	0	6	100	4	7

Source: calculated by the author using MS Excel

Thus, the results of the discriminant models were converted into unified risk scale using threshold-zonal normalization with linear interpolation within the financial condition zones.

So, we see that the results of the transfer are fully consistent with the results obtained in section 2.2. ArcelorMittal's indicators vary greatly depending on the year according to different models, demonstrating the greatest stability and solvency, the lowest level of risk in 2021. Metinvest's results are also variable, but more stable. According to the Taffler-Tischaw model, the company has the highest result, excluding 2022. The most positive solvency indicators in Interpipe during the analyzed years and according to the 5 models, excluding some years, are notable. KVBZ and AZOT are also uneven across the analyzed years and differ both among themselves and with other enterprises. The results of AZOT are notable, where according to the Altman, Springate and Beaver methods the indicators are the lowest, but according to Tereshchenko and Taffler-Tischaw in 2023, on the contrary, they are very positive and exceed, for example, ArcelorMittal. This may be a result of the fact that the companies belong to different industries, although both are manufacturing, and also that the mining and metallurgical industry of Ukraine suffered more from military restrictions, and also that ArcelorMittal is more export-oriented than AZOT. And under conditions of significant logistical restrictions this leads to a deterioration in financial indicators.

Based on the results obtained, we propose to derive the general risk of financial insolvency or Financial Distress Risk (hereinafter – FDR), which indicates the presence of financial problems in an enterprise and the threat of inability to meet its obligations, even the possibility of bankruptcy. To calculate it, we will use the results obtained above, which show us the financial condition indicator (hereinafter – FCI), since the higher it is, the better for an enterprise. To do this, we will use the following formula [214]:

$$\mathrm{FCI_t} = \sum_{i=1}^{n} w_i * S^{i,t} , \tag{3.9}$$

where $S^{i,t}$ – financial condition indicator for the i-th model in year t on a scale of 0-100,

w_i – weight of the i-th model;

i – model;

n – number of models by which the indicator is calculated.

Given that it is difficult to determine which of the models we have selected has the greatest weight, we propose to give the same weight to each model. Therefore, considering 5 models for calculating and analyzing the financial condition, the weight of each of them is 0,2. The final calculation is made according to the following formula:

$$FCI_t = \frac{S_{Altamn,t} + S_{Springate,t} + S_{Tereshchenko,t} + S_{Taffler,t} + S_{Beaver,t}}{5}, \quad (3.10)$$

We will perform the calculations using MS Excel. The results are presented in the Table 3.10.

Table 3.10

Results of calculating the integral indicator of financial condition

Years	ArcelorMittal	Metinvest	Interpipe	KVBZ	AZOT
2019	14	32	91	100	41
2020	44	40	100	77	21
2021	100	100	78	26	22
2022	0	5	97	57	20
2023	0	31	100	23	41

Source: calculated by the author using MS Excel

But to comply with the methodology for calculating the macroeconomic indicator, it is necessary to convert it to a scale, 0 is the lowest risk indicator, and 100 is the highest risk indicator. To do this, we propose to do a mathematical inversion for calculating the FDR and subtract the FCI from 100. The formula will look like this:

$$FDR = 100 - FCI \quad (3.11)$$

But before that, we will also apply the bounding method, which involves avoiding absolutely extreme estimates, since in the end we can potentially get incorrectly interpreted results when the risk is equal to 0 (absent at all) or 100 (the highest level of occurrence). But when it comes to risks, there is always a chance that it will not occur or, conversely, even with the lowest probability of occurrence, it will occur and bring undesirable results to the enterprise. In order to take this error into

account, we will use the lower limit as 5 and the upper as 95 [180, 252]. This will mean that even with the highest risk score, the company still has a chance to avoid it by taking certain actions. This increases the interpretive reliability of our integral FDR indicator. In practice, using this method means that values up to and including 5 (0-5) will result in a value of 5, as well as relative to 95, when values in the range 95-100 will result in a value of 95.

Having performed this operation and using the appropriate formula, we can present the results of calculating our integral indicator of financial insolvency risk in Table 3.11.

Table 3.11

Enterprises' Financial Distress Risk, 2019-2023

Years	ArcelorMittal	Metinvest	Interpipe	KVBZ	AZOT
2019	86	68	9	5	59
2020	56	60	5	23	80
2021	5	5	22	74	78
2022	95	95	5	43	80
2023	95	69	5	77	59

Source: calculated by the author using MS Excel

The results obtained indicate significant changes in this indicator in ArcelorMittal, Metinvest, KVBZ. Interpipe also experienced an increase in this integral indicator in 2021, but in other years its values were the smallest. KVBZ had the lowest value in 2019 with further growth. Moreover, in the crisis years of 2020 and 2022, its results were not the greatest, in contrast to 2021 and 2023. This may indicate a slightly distant impact of the crisis years on the company's activities. AZOT does not have the lowest values during the analyzed period, but does not reach the level of 90 - 95. Although during 2020-2022 the results are characterized by a high risk of insolvency.

To determine the risk level, we will use the same scale that we proposed in the previous section of work 3.1, where up to 33 is a moderately acceptable level of risk; 34-67 is an elevated risk; 68 – 100 is a high risk. According to this, ArcelorMittal has had a very high risk of insolvency for the last two years, Metinvest, after a high level in 2022, significantly improved its financial condition and reduced it to 69, but still the result is high. Interpipe is characterized by a moderately acceptable level of risk

throughout the analyzed period. KVBZ has different levels of risk: from moderately acceptable in 2019 to high in 2021 and 2023. AZOT is characterized by a high risk of insolvency during 2020-2022 and elevated in 2019 and 2023.

It is necessary to add that in relation to this risk, as well as in relation to the MAR, even with a result that falls into the moderately acceptable level, the enterprise must build its risk management policy and form it on a proactive basis. When the enterprise has an FDR of up to 33 inclusive, this means that the enterprise has the opportunity to predict in advance and plan possible scenarios for responding to the risk in the event of its occurrence. When the enterprise moves to the next level - elevated risk, its actions can sometimes be both proactive and reactive, because here it is possible to identify quite high problems with the solvency of the enterprise. And at a high level – one proactive position may no longer be enough and it is necessary to act quickly and taking into account the reality that the enterprise has encountered. But the enterprise, in any case, must form a risk management system on a proactive basis, with the aim of preventive risk management.

Now, having the results of two integral indicators, we can take them into account when determining where the enterprise is currently located and propose a matrix consisting of 9 quadrants that determine the appropriate level of risk for the enterprise, taking into account macroeconomic risk and insolvency risk. On this basis, the enterprise should build its further risk management policy.

It is assumed that at the beginning of the year the enterprise receives macroeconomic indicators (we have proposed and taken into account in the MAR model those indicators that are already known at the beginning of the calendar year) and has information about its own indicators (even if they are not yet covered in the official report on the website). The enterprise assesses those integral indicators that we have proposed and identifies its place (its quadrant) in this matrix. This makes it possible to immediately, at the beginning of the year, see its main threats, external and internal problems and make an appropriate management decision regarding the risk management strategy that will be applied at the enterprise, and on this basis to develop appropriate tactical and operational actions for its implementation.

In our case, we have complete data on the MAR up to 2024 inclusive, but for the integrated financial risk indicator of insolvency, data at the time of calculating the coefficients and models were available only up to 2023 inclusive. Therefore, we propose to develop matrix data for the enterprises we have selected for 2022 and 2023. This will provide an opportunity to visualize the results of enterprises in these two years and see the dynamics and determine the actions that should be applied at production enterprises for the purpose of risk management.

We present the results in Fig. 3.2 and Fig. 3.3.

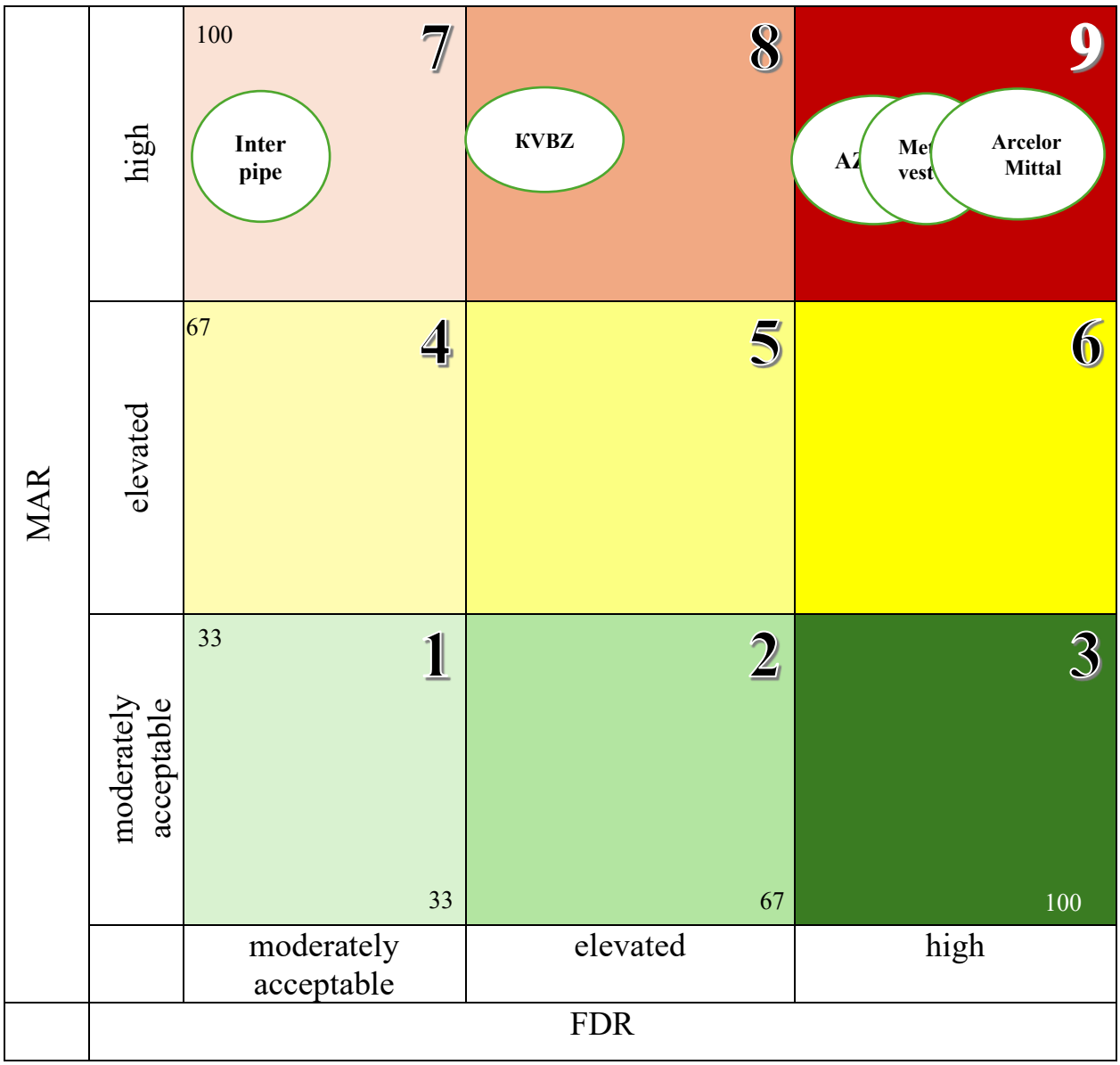


Fig. 3.2. Macroeconomic and financial distress risks matrix of selected manufacturing enterprises in 2022

Source: compiled by the author

As can be seen from the matrix shown in Fig. 3.2, Interpipe has the best position, although it is located in quadrant 7, which is characterized by high macroeconomic risk. That is, the risk of insolvency of the enterprise itself is low, but due to high macroeconomic risk, the place of this company in this quadrant. That is, the greatest threats and unplanned situations may arise precisely because of external risk, and not because of the financial problems of the enterprise.

KVBZ is in quadrant 8, which is characterized by a high level of MAR and an elevated FDR. And 3 companies – AZOT, Metinvest and ArcelorMittal – are in quadrant 9 with a high level of risk according to both integral indicators.

Let us compare the situation with 2023, which is illustrated in Fig. 3.3.

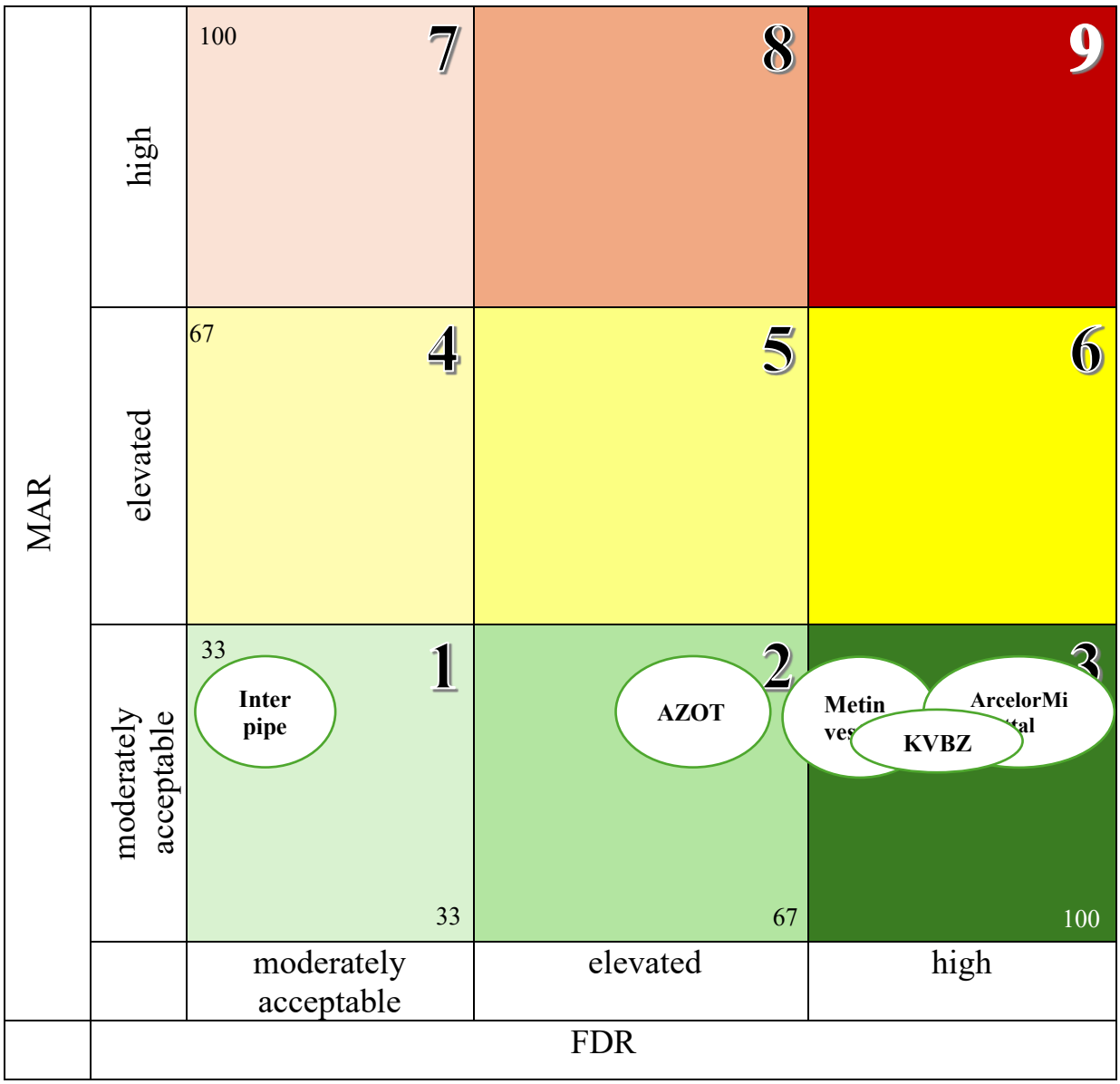


Fig. 3.3. Macroeconomic and financial distress risks matrix of selected manufacturing enterprises in 2023

Source: compiled by the author

According to the figure, the external risk has decreased significantly and the companies have moved into the green zone, but the results according to FDR vary. Interpipe is again in the best position and its risk according to both indicators is the lowest, AZOT has moved according to the FDR result from the high-risk zone to the elevated-risk zone, and in the quadrant characterized by a high level of FDR are again Metinvest (although it has reached almost the minimum value for this quadrant), ArcelorMittal, and KVBZ, which has also worsened its financial condition.

This matrix is constructed in such a way that the X-axis shows the FDR result, and the Y-axis shows the MAR. According to the external MAR risk and its levels, we offer a color scheme that reflects the level of risk. So, the lowest – moderately acceptable is marked in green, which means the possibility of not applying reactive measures and crisis measures, but analyzing the situation, making forecasts and planning response methods in a planned mode. The next level – an elevated MAR level – we propose to highlight in yellow, as such, when it is already necessary to increase the level of attention and sometimes it will be necessary to resort to reactive actions. We highlight the highest MAR level in red, which means the need to conduct a thorough analysis of changes that may occur and, possibly, already apply anti-crisis measures. Also, we note that the brightness of the color depends on the level of risk according to the FDR: the least bright color corresponds to a moderately acceptable level of financial insolvency risk, medium brightness – to an elevated level, and the most saturated bright color – to a high level of risk. Such a color scheme will take into account different psychotypes of people according to the type of information perception and will allow you to react more quickly to the situation that has developed, depending on the quadrant where the company is located.

Each quadrant is characterized by the threats that the enterprise may face, and the corresponding strategies and methods of responding to risks can be applied to it. The characteristics of the quadrants according to these two are given in Table 3.12.

Table 3.12

Characteristics of the macroeconomic and financial distress risks matrix

Quadrant	Risk Level (MAR - FDR)	The main characteristic	Nature of response
1	2	3	4
1	moderately acceptable – moderately acceptable	This quadrant is characterized by a low level of risk for both integral indicators. However, it is important to observe the dynamics over the years and predict trends. The results of indicators that are approaching the limit of this level – 33 – indicate a possible transition next year to quadrants with an elevated or high level. It is also important to remember that even low values for these indicators do not mean the impossibility of risk, they simply indicate the relative stability of the environment and a low level of insolvency of the enterprise, that is, a relatively stable financial condition. But this is not a guarantee of the absence of the probability of risk, therefore it requires ongoing control, analysis and management of it.	Proactive. Analysis of the current state, forecasting the future, monitoring the activities and external environment of the enterprise, assessing the potential impact of external changes on enterprises, etc. Decisions on risk management methods are made depending on potential threats.
2	moderately acceptable – elevated	The macroeconomic environment is relatively stable, although there is always a possibility of this risk occurring and affecting the company's activities. And financial insolvency is already at an elevated level and there is a risk of potential bankruptcy (although not imminent), inability to meet its obligations. This may be a consequence not so much of an external risk as of the influence of other factors and the ineffective work of the company in identifying and managing risks.	Reactive-proactive. At this stage, the enterprise is already beginning to apply anti-crisis elements in management. Risk management resources are significant. The policy is adopted taking into account financial insolvency, the ratio of the enterprise's assets, equity. The emphasis is on identifying the causes of such FDR and eliminating them. Opportunities are sought to correct the financial situation, find

Continuation of Table 3.12

1	2	3	4
			sources of financing, increase demand and sales of products. Proactivity here remains in terms of predicting its further development and attempting to control future deterioration, as well as in relation to the MAR.
3	moderately acceptable – high	Macroeconomic risk is low, but requires control and monitoring. The risk of financial insolvency has entered a critical zone, which indicates serious problems with the company's solvency and financial condition in general, there is a high risk of bankruptcy of the company. However, there is always a possibility to get out of this situation thanks to effective management decisions.	Reactive-proactive. The enterprise requires the application of crisis measures to ensure its further functioning and sustainable activities. However, the MAR is more or less balanced and not the main factor of such a state. An analysis of the impact of other external risks is required, as well as the adoption of appropriate decisions by the enterprise to remove the enterprise from such a state. Decisions can be made on the diversification of production, changes in the enterprise's strategy, orientation on demand and the needs of society. For enterprises that depend on exports and have problems with logistics, the search for other opportunities for product sales is maintained. Proactivity here is maintained relative to the MAR.

Continuation of Table 3.12

1	2	3	4
4	elevated – moderately acceptable	The MAR is no longer so small and its impact is felt on the work of enterprises in general. The macro environment is volatile, unstable, which requires large resources to be able to regulate the consequences. However, the risk of financial insolvency does not demonstrate the same results, which indicates either a skillful risk management policy at the enterprise, or a slightly delayed reaction of this enterprise due to a certain specifics of production.	Proactive-reactive. Despite the growth of the MAR, the main emphasis here is on proactive actions in relation to the enterprise, when we still have the opportunity to mitigate further changes that will come. Management, taking into account the result of the MAR, makes decisions on leveling or reducing the negative consequences of changes taking place in society. It may be necessary to make a decision on insurance of certain risks, currency transactions, and a revised pricing policy of the enterprise. Reactivity here is manifested in the regulation of the consequences that the MAR already has for enterprises, production.
5	elevated – elevated	This quadrant characterizes an increased level of MAR and FDR, which indicates a fairly significant level of instability in the environment, its impact on the activities of enterprises and the need to use significant resources for risk management. The location of the enterprise in this quadrant is already problematic for the company and indicates potential threats to the enterprise's activities, significant problems with its solvency.	Reactive-proactive. Management applies crisis measures and tries to bring the enterprise into other, less danger quadrants. The impact of MAR on the enterprise's activities is analyzed and appropriate conclusions are drawn. Great efforts are spent on risk control. Proactivity remains in the desire to see further forecast results and, accordingly, decisions are already being

Continuation of Table 3.12

1	2	3	4
			made, and methods are also applied to prevent falling into quadrants with a high level. Management here also takes place regarding the possible consequences of MAR: reassessment of the enterprise's pricing policy, taking into account exchange rate fluctuations, etc., as well as the application of FDR management measures: searching for sources of financing for activities, using insurance mechanisms, focusing on increasing product sales.
6	elevated – high	The MAR is elevated, demonstrating the instability of the environment that affects the activities of enterprises. A high level of FDR indicates problems with solvency and a high probability of bankruptcy. Starting from this quadrant and the following ones are already problematic for enterprises and require greater efforts to manage risks and their consequences.	Reactive-proactive. The enterprise applies active measures, which are already crisis, since FDR indicates real problems with solvency. To prevent negative consequences and maintain further activity of enterprises, management analyzes the reasons for this state, both external and internal, and also builds a policy for managing financial risk, which is already high, and managing MAR. Proactivity here still remains in terms of preventing the transition of MAR to the next level.
7	high – moderately acceptable	MAR indicates high instability of the environment, which has a significant negative impact on the results of the enterprise. However, the risk of	Reactive-proactive. The company tries to manage the effects of the unstable macroeconomic

Continuation of Table 3.12

1	2	3	4
		financial insolvency is low, but this does not mean that it is impossible. The reasons for such a discrepancy in the results between MAR and FDR may lie in the specifics of the production process of a particular enterprise, when the impact is somewhat remote, as well as the greater influence of other factors on this enterprise. And other factors have a more positive impact. And this is also a characteristic of a skillful and effective risk management system at the enterprise. For example, Interpipe in 2022.	environment by reallocating resources from other activities and reducing the need for resources due to its own moderate-acceptable level. This will probably allow some restraint on price increases due to inflation and exchange rate fluctuations.
8	high – elevated	High MAR is characterized by volatility and significant fluctuations in important macroeconomic indicators, which has its impact on financial flows and economic processes within the country. It also results in an increased level of FDR, when enterprises are already facing a real problem of solvency.	Reactive. The company is making a lot of efforts to manage the results of a high MAR, as well as reduce the risk of financial insolvency. At this stage, actions become reactive, as a reaction to what has already happened, and the measures taken are already of an anti-crisis nature.
9	high – high	The instability of the macro environment is combined with the insolvency of the enterprise. This quadrant indicates real problems in the development of the enterprise and causes the need to apply anti-crisis measures and large resources of the enterprise to manage the solvency and the consequences of the IDA impact. This is the most undesirable quadrant for all enterprises.	Reactive. Risk management is largely based on the principles of crisis management, when the enterprise is faced with a real threat of bankruptcy, as well as a deterioration in the external environment. Decisions for enterprises in this quadrant must be carefully thought out and justified due to the high probability of losing the enterprise in general.

Continuation of Table 3.12

1	2	3	4
			These may also be decisions regarding changes in the financial, marketing and general strategy of the enterprise, diversification of production, involvement of the enterprise's insurance funds, etc. The main thing is to find sources of financing for the enterprise while maintaining an appropriate ratio of own and borrowed.

Source: compiled by the author

Thus, we have proposed a characteristic of the macroeconomic and financial distress risks matrix, which makes it possible to see the location of the enterprise in it and determine the main directions of its development and the threats that arise for it. It is worth noting that risk management methods depend on many factors. First of all, this is the size of the enterprise itself. An example is ArcelorMittal, which in 2022 and 2023 demonstrates negative results according to the FDR indicator. In 2022, together with Metinvest and AZOT, they fell into the 9th quadrant. However, we understand that the capabilities of these companies are quite large in terms of resolving the issue and preventing bankruptcy. We would like to emphasize once again that the high result of the second integral indicator, that the risk may occur, indicates the current state, but there is always a probability that the enterprise will be able to find a way out, its risk management methods will be effective and the enterprise will be able to move to another, lower, quadrant.

As we have already studied in the first chapter, the risks faced by an enterprise are much more than those assessed by us above. However, we believe that financial risk is one of the main ones, which is existential for the further existence of the enterprise. Also, the financial component is the main prerequisite for the functioning of the enterprise, creating a basis for protection against the occurrence of other risks.

Financial risk in terms of assessing insolvency and stability can be assessed not by an expert, but based on objective data, as well as macroeconomic risk, which is more reliable and does not have a subjective opinion. That is why we propose to assess the enterprise based on this matrix for the purpose of further risk management. But this is not the only thing that should form the basis of the enterprise's risk management. It is also important to identify and assess other risks that manufacturing enterprises of different levels may face. Taking these risks into account and assessing them is essential for a balanced, holistic risk management system in manufacturing enterprises.

Any enterprise faces external and internal risks. In addition to the above, on the basis of which we propose to build a matrix of macroeconomic and financial distress risks, we recommend that each enterprise, regardless of its scale and field of activity, analyze other types of risks that the enterprise faces. To do this, it is necessary to establish at the level of the enterprise management those potential risks that should be taken into account in the enterprise's risk management system and responsible persons who should assess the potential threat and the consequences of their occurrence for the enterprise. At the level of a microenterprise, this responsible person can be either the manager himself, or together with an accountant or other persons involved in this. At the level of a small enterprise, these can be those responsible for areas in the enterprise (for example, production, financial part, marketing, etc.). Starting from a medium-sized enterprise and above, these can be specialized departments that manage risk. But we must note that even the presence of a separate management level responsible for risk does not mean that they should function completely separately. Risk management requires cooperation between all levels of the enterprise and constant communication between different departments.

Therefore, the responsible person must expertly determine on a scale of 0-100 the level of risk inherent in a particular risk in the coming year and form a risk management system accordingly. It is necessary to determine external and internal risks at the enterprise that may affect the activities of the enterprise. Among the external risks, we will highlight military, energy, logistical, environmental risks as the main ones. But each enterprise must form this list for itself. Legal, tax, political,

inflationary and others can be added to them. Internal risks, in addition to what we have highlighted, we will define personnel, production, information and digital, environmental, and also, depending on the specifics of the activity, liquidity, insolvency or financial risk. Environmental risk can be both internal and external in relation to any enterprises, which is especially relevant for production.

We describe the main risks by the level of impact on enterprises and the nature of actions to manage them in Tables 3.13 and 3.14.

Table 3.13

Characteristics of the impact of major external risks on manufacturing enterprises and areas of action for managing them

Level	Boundary limits	The main characteristic	Nature and main response measures
1	2	3	4
Military risk			
Moderately acceptable	up to 33	Military actions do not have a significant direct impact on the activities of enterprises, their production process. The consequences of the impact are easily predicted and subject to preventive management.	The enterprise plans the main indicators in a planned manner, assesses the probability of changes and deviations from the planned. Develops development scenarios and proposes measures to reduce the negative impact, which depend on the specifics of the enterprise's activities and the consequences of the impact.
Elevated	34-67	Military operations are already having a tangible impact on the direct activities of the enterprise and its financial stability. At this stage, it is difficult to control the risk and assess its consequences. Depending on the specifics of the enterprise (production of products for the defense-industrial complex, defense industry), there may be an increase in sales and financial indicators.	The enterprise is no longer proactive, but reacts to the changes that occur. Risk is difficult to control and manage. The main response methods should be focused on ensuring physical security and maintaining production indicators, planning the movement of people and production to safer areas.
High	68-100	Significantly affects the activities of the enterprise, reducing the possibility of production and functioning of the enterprise. Uncertainty of activity occurs, the impossibility of forecasting and evaluating development scenarios.	The enterprise is focused on ensuring the physical safety of personnel and their families, preserving production facilities by providing shelter or transportation to safer places.

Continuation of Table 3.13

1	2	3	4
Energy risk			
Moderately acceptable	up to 33	The impact on the company's operations is not significant, it is amenable to planning and forecasting key indicators. Outage schedules are stable and operational.	The enterprise operates under normal conditions or can control the supply of electricity. Plans are being developed to purchase possible alternative sources in the event of a potential increase in risk.
Elevated	34-67	The impact of risk is increasing and is already much more noticeable. Power outage schedules are unstable, and it is becoming more difficult to predict production processes.	The enterprise uses financial resources to ensure alternative energy supply, plans production activities more strictly and, at the same time, promptly makes appropriate decisions. A possible option is to diversify production in terms of focusing on less energy-consuming production.
High	68-100	Significant impact on production process and results. Planning and forecasting capabilities are low or almost non-existent.	Almost complete transition to alternative power supply, revision of the company's production strategy towards the production of less energy-intensive products.
Logistics risk			
Moderately acceptable	up to 33	The impact on the company's operations is insignificant. Logistics routes remain either unchanged or changes are controlled. Indicators are forecasted.	The enterprise manages according to the plan, builds a logistics policy, forecasts development scenarios. Management methods include observation and monitoring of changes and decision-making based on their results.
Elevated	34-67	The impact of this risk is growing, it is becoming difficult to control, and it is more difficult to predict changes.	Development of alternatives for logistics routes, warehouses and stock formation.
High	68-100	Significant impact of risk on the company's activities, disruption of logistics routes, forecasting is difficult or impossible.	Using alternative ways of supplying goods and storing products.

Continuation of Table 3.13

1	2	3	4
Environmental risk			
Moderately acceptable	up to 33	The impact of the risk is not noticeable, the enterprise operates under normal conditions, meets all standards and works in accordance with environmental law.	The company monitors the situation and forecasts possible changes in accordance with disasters, climate change, changes in legislation and international standards. In the event of an increase in the probability of occurrence, companies prepare for appropriate legal and regulatory changes, as well as for preventing the negative consequences of the occurrence of natural disasters.
Elevated	34-67	The impact is already noticeable, there are certain threats in terms of natural disasters, climate change, which may affect the possibility of producing products, and changes in standards (for example, the EU) may be significant and pose certain threats to export-oriented enterprises.	In the event of disasters, the company acts taking into account the specifics of these disasters and the possibilities of their prevention, giving priority to ensuring the physical safety of personnel. In the event of changes in national and international standards and legislation, the company makes appropriate changes in accordance with them.
High	68-100	The impact of the risk is significant, the enterprise suffers significantly from it, which poses a threat to both the health and life of personnel and the ability to produce products and sell them on both domestic and foreign markets.	The company provides all opportunities to ensure the health and life of personnel, as well as to change the production process to meet standards and requirements at both the national and international levels, which requires significant capital investments.

Source: compiled by the author

Thus, we have considered the main types of external risk, which we propose to determine at the level of production enterprises additionally by expert means and the main directions of action for their management. It should be emphasized that

environmental risk has both an external and an internal dimension. If we are talking about external, then this may be the probability of natural disasters, climate change, as well as changes in standards and environmental legislation at both the national and international levels. The internal dimension of environmental risk is manifested in environmental pollution as a result of the enterprise's production, its failure to comply with environmental standards, inefficient waste management, etc., which is associated with the enterprise's own activities and its impact on the environment.

Let us now consider internal risks and the main measures to manage them (Table 3.14).

Table 3.14

Characteristics of the impact of major internal risks on manufacturing enterprises and areas of action for managing them

Level	Boundary limits	The main characteristic	Nature and main response measures
1	2	3	4
Personnel risk			
Moderately acceptable	up to 33	The impact of the risk is imperceptible or insignificant. Changes and turnover of personnel are natural and do not affect the results of the enterprise. Personnel flows are predictable and controllable.	The enterprise systematically manages personnel, forecasts its changes, analyzes and monitors the labor market. All changes are controlled.
Elevated	34-67	Staff turnover is increasing, their professional qualities are decreasing. This affects the quality of the products produced and the functioning of the enterprise in general.	The company is actively studying the reason for the increase in staff turnover and reacting accordingly. For example, reviewing salaries in the direction of increase, career advancement, etc. To improve the qualifications of personnel and support their continuous development, various educational courses are held, where employees who meet the professional requirements of the company are also invited.

Continuation of Table 3.14

1	2	3	4
High	68-100	The impact of the risk is significant. There is increasing staff turnover, a shortage of labor, and a decline in the professional qualifications of staff.	Support for personnel is significantly increased in order to maintain its quantitative and qualitative composition. Various motivation programs are being formed and the best personnel are being retained at the enterprise. Issues of increased labor outflow are being studied and appropriate measures are being taken. If the military risk increases, which poses a threat to human life and increases labor migration, then in this case work formats and the aspect of remote work can be reviewed where possible. Also, considerable attention is paid to either improving the qualifications or training of personnel.
Production risk			
Moderately acceptable	up to 33	Risk does not have a strong impact, production activities are as planned, volume fluctuations and product shortages are within regulatory limits and depend on the industry. Increase in failure rates and equipment damage is controlled.	The enterprise systematically manages production processes, monitors changes and deviations, forecasts production volumes, equipment repairs and its planned replacement. If the risk increases, the possibility of updating equipment and switching to other production technologies is calculated.
Elevated	34-67	Risk significantly affects the activities of the enterprise, there are failures in production and equipment operation, the production of new products is slowed down. It is becoming increasingly difficult to control the process.	The enterprise actively responds to the changes that occur, replaces or repairs equipment, predicts possible further changes in production and forms ways to prevent them.
High	68-100	Risk increases significantly and has a strong impact on production activities, slowing down	The enterprise focuses its main efforts on responding to the changes that are taking place. It

Continuation of Table 3.14

1	2	3	4
		production and reducing the ability to meet its obligations.	replaces equipment. The main financial resources are spent on covering failures, purchasing new equipment, and technological re-equipment of the enterprise.
Information and digital risk			
Moderately acceptable	up to 33	The risk impact is low, information flows are controlled, there is no leakage of personal data, digital tools are configured and managed.	The company controls digital processes and information flows, monitors digital systems and attempts to attack them, involves specialists in ensuring digital and information security in working order. Analyzes new fraud and hacking schemes, takes them into account when adjusting activities.
Elevated	34-67	Greater likelihood of occurrence and impact of risk, there may be precedents of leakage of personal information of employees and customers, hacking of the company's system.	Responding as events occur, finding new ways to protect, and installing elements of stronger information and digital security systems.
High	68-100	This level can be defined as a state of information or digital danger, a high probability of loss of control over these processes and systems. The enterprise needs a complete review of the security system.	A complete review of the information protection system and digital processes in the company, taking into account all technological developments and innovations. Installation of a new information and digital security system.
Environmental risk			
Moderately acceptable	up to 33	The company controls the production process, emissions and adheres to environmental standards.	Emissions, leaks and pollution indicators are monitored and compared with regulatory standards. Innovations in the industry are studied to reduce the environmental impact of production.
Elevated	34-67	The company's emissions are increasing, the negative impact on the environment is greater. The probability of non-	The company analyzes the likely increase in environmental pollution, its causes and influences them in order to

Continuation of Table 3.14

1	2	3	4
		compliance with regulations and standards.	eliminate them. New technological requirements and opportunities for reducing the negative consequences of the company's activities are being studied.
High	68-100	Very high level of risk, where deviation from standards can be strong, non-compliance with international, European, national standards is also significant.	The enterprise is reformatting its own policy of managing environmental risks and emissions. It is switching to new production technologies that involve more environmentally responsible production.

Source: compiled by the author

Thus, we have considered the main internal risks of manufacturing enterprises, which should also be analyzed by the company's responsible employees and the nature of actions in case of their occurrence. The list of assessed and predicted internal risks may depend and vary depending on the specifics of the enterprise's work and its size.

Consideration of these risks is important for building a full-fledged risk management system for enterprises, but it was the financial part that was given more time in our study, because any risks at the stage of elevated and high require additional tools and resources to manage them. Most often, such resources are financial. Which justifies the direction and proposals of this study.

In general, for the development of the risk management system for manufacturing enterprises, we proposed the calculation of the integral Financial Distress Risk, which was calculated by the weighted average method of 5 models, which were calculated in the 2nd chapter, and which showed the uneven development of the solvency of Ukrainian enterprises. After obtaining this indicator, the possibility of taking into account the macroeconomic risk indicator and constructing a macroeconomic and financial distress risks matrix was considered, which makes it possible to see the state of development of the enterprise according to these indicators. Based on the 9 quadrants of the matrix, we proposed a descriptive characteristic of the action of risks and areas of management of these risks.

After that, we proposed, in addition to the above, to determine the external and internal risks of the enterprise and the areas of influence of these risks by expert means, with the proposal of certain actions according to the level of risk.

It is assumed that an approach that combines the assessment of macroeconomic risk with financial risk, as well as other external and internal risks, will allow building a multifaceted risk management system for manufacturing enterprises.

3.3. Organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises

Under modern conditions, an important component of risk management is digital tools, which are actively developing and provide many opportunities for increasing the efficiency of risk management. Thanks to them, they become more effective, the speed and validity of decision-making increases, and there is an opportunity to transfer part of the functional responsibilities to digital tools. This significantly increases the efficiency of this process, since the basis of successful risk management is the speed of reaction, anticipation and forecasting of possible changes, and a thorough analysis of the problem that already exists and could potentially arise. It is digital tools that provide this opportunity and create the basis for increasing the efficiency of risk management. This is especially relevant for manufacturing enterprises, where the process of manufacturing finished products itself can also be automated and robotic.

Scientists describe digital transformation as “the process of using digital technologies” to improve the performance of enterprises and increase the efficiency of management decisions [83], which also affects the possibilities of digitalization of risk management as part of the overall enterprise management system. The lack of alternatives to digitalization of management processes is also significantly actualized in the conditions of the crisis caused by military actions, which determines the implementation of progressive methods and intelligent technologies as a critically necessary prerequisite for restoring functional stability, significantly minimizing risks and adapting manufacturing enterprises to extreme challenges of the external environment in the post-war period [143, 144].

Let us define the technologies that can be applied in risk management. Thus, the team of authors – Perevozova I.V., Shaiban V.M., Dedelyuk O.V. – mention the following digital technologies that contribute to increasing the efficiency of management and the effectiveness of companies' activities – cloud services, Internet of Things (IoT), artificial intelligence (AI), blockchain [83]. As we can see, there are various digitalization tools that can be used in enterprise risk management. Accordingly, this determines the areas of their application, as they may have different implementation practices.

Thus, Dielini M.M., Vakulenko V.L., Dramaretska K.P. indicate areas where digital tools can be used, and they also note the difference between the application of these technologies at manufacturing enterprises and agricultural ones. Scientists note that digital technologies can be applied in various production and business processes, not necessarily in the implementation of risk management. Even the introduction of new technologies into the production process prevents the likelihood of the risk of producing low-quality products or, in general, improves the situation with the management of the production process, costs, terms and quality of work performed [30].

An important issue of today, namely, the implementation of digitalization of production process management for the restoration and development of agricultural enterprises in the deoccupied territories, is raised by Balanovskaya T.I., Dielini M.M., Vakulenko V.L. The results of their research indicate that under conditions of resource scarcity, digitalization of the agricultural sector acts as a driving force for its restoration and allows transforming operational data into effective management decisions. This will minimize production risks and increase the technological sustainability of enterprises in the post-war period [4].

Stepanenko R.D. specifically identifies digital tools that can be used in risk management in various areas. Let us illustrate this in Fig. 3.4.

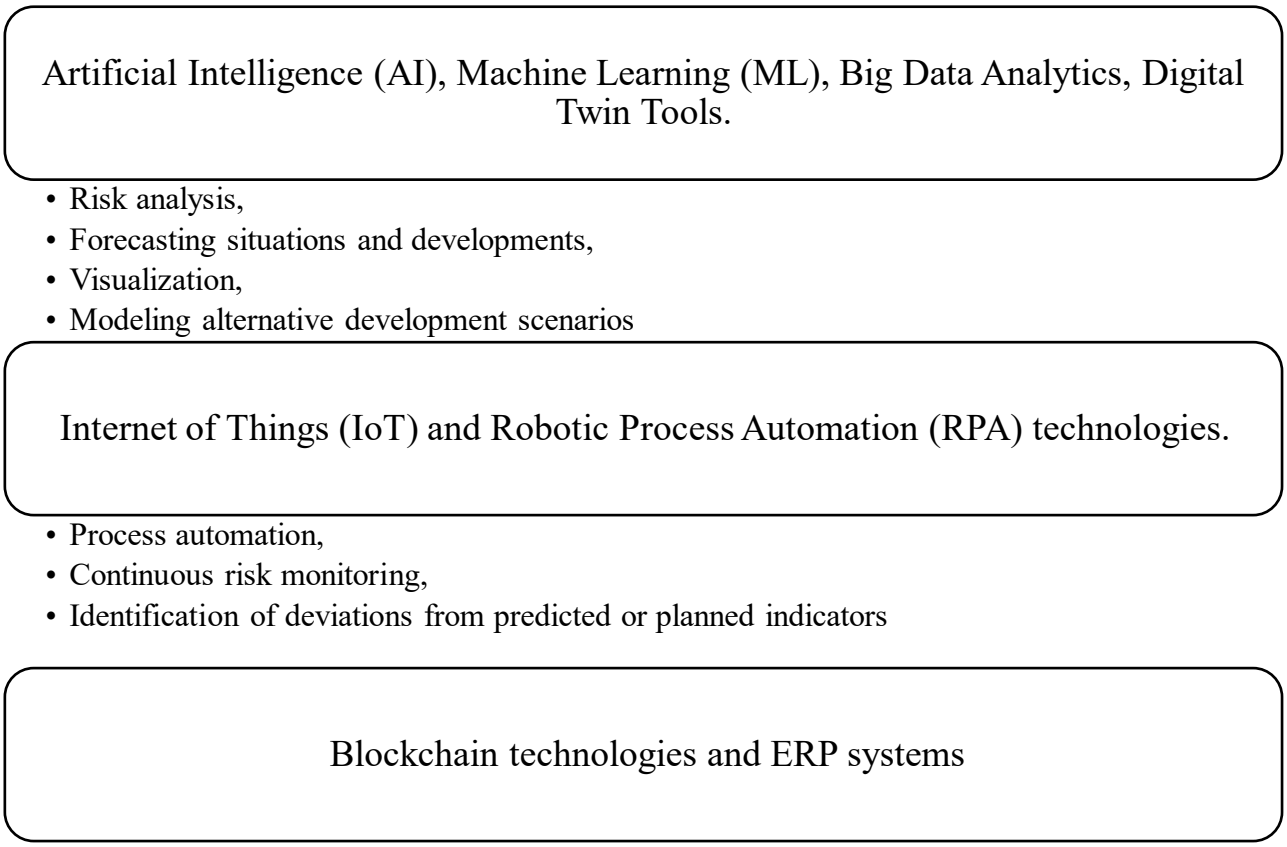


Fig. 3.4. Directions of application of digital technologies in enterprise risk management

Source: compiled by the author for [14, 229]

Thus, we see that the possibilities of using digital technologies are quite large and provide a wide range of directions for increasing the efficiency of risk management. This is especially important and possible for manufacturing enterprises that are focused on the production of finished products. After all, such processes can be robotic and automated, which significantly increases the efficiency of production risk management.

However, we should note that there are also various software that can be used in risk management. These include Visure Requirements ALM, IBM Engineering Requirements Management DOORS, Sparx Systems Enterprise, Spira Team, ReQtest, Helix RM, etc [30].

The use of a software product may depend on the scale of the enterprise, which is justified by the fact that micro-enterprises will not introduce software products that are designed for larger enterprises, as it is not always appropriate. But for the most part, ERPs are already designed for enterprises, starting from a small level.

The areas of use of AI in risk management are also broad. Thus, scientists provide information that in business it is used in various ways: from customer service, cybersecurity, inventory management to accounting, in supply chain operations, market segmentation, etc [201]. AI is also very often used as a tool for working with BigData for data analysis and forecasting, which is one of the components of risk management [116].

Terekhov D. and Zhelavska N. identify the following areas of application of AI: automation of decision-making processes; optimization of personnel management; forecasting and strategic planning; optimization of operational activities; control and monitoring of activities [124]. That is, they are aimed at conducting analysis, data processing, forecasting, modeling, comparing between planned and actual and making decisions based on this. And the combination of AI with RPA – robotics, which consists in delegating certain tasks to robots – significantly increases the efficiency of using such digital tools. Together, they can significantly improve the quality of the production process, control the operational process and prevent the risk of poor-quality production, insufficient production (since AI can analyze previous data and predict based on them), failures in work [24]. The production process of certain industries is easier to automate, which improves the efficiency of enterprises, their inventory management and costs.

Thus, we see that the range of functions that can be transferred to AI is quite wide. However, we should not forget about the main problems and threats that the use of AI poses – the presence of hallucinations when the information provided by it needs to be verified; the costs of training personnel, the distribution of responsibility for decisions, etc. [124]. But we must accept that AI is becoming a full member of our daily activities and the work of enterprises, bringing significant positive results to

them. The fact that the processes of digitalization of production are the norm of today's activities is no exception [216].

Many different programs implement AI in them, which further contributes to achieving a positive effect from their application. In our opinion, AI plays an important role and should be used by enterprises to analyze statistical data of the enterprise's work, analyze statistical data of macroeconomic development, which also affects the activities of the enterprise, build forecasts based on this and model various scenarios. But the issue of ethics and integrity remains important when implementing and using AI elements in the activities of the enterprise.

When forming a risk management system for manufacturing enterprises, digital technologies can be used for: automation and robotization of processes, which will increase the accuracy and quality of work performed; calculations of planned and actual calculations for analyzing deviations and building forecasts; monitoring the general activities and processes of the enterprise in order to identify current threats and deviations.

Table 3.15 lists some software products that can be used in the formation of risk management for manufacturing enterprises, which we propose to determine by the size of enterprises (data as of January 2026).

Table 3.15

Software products for risk management for manufacturing enterprises

Enterprise size	Digital tool	Direction of use	Type of risk being managed
1	2	3	4
Micro-enterprises	MS Excel	Calculation of key financial indicators, descriptive statistics, calculation of coefficient of variation, data forecasting, data visualization.	Financial, solvency.
	Google Sheets		
	PowerBI	Visualization, forecasting, and influencing factors.	Financial, solvency.
	Tableau, LookerStudio etc.	Data visualization.	Financial, solvency.

Continuation of Table 3.15

1	2	3	4
	Google Notebook	AI visualization, infographics.	Financial.
	Python	Calculation of key financial indicators, descriptive statistics, calculation of coefficient of variation, data forecasting, data visualization.	Financial, solvency.
Small businesses	MS Excel	See above	Financial, solvency.
	Google Sheets	See above	Financial, solvency.
	PowerBI	See above	Financial, solvency.
	Tableau, LookerStudio та ін.	See above	Financial, solvency.
	Google Notebook	See above	Financial, solvency.
	Python	See above	Financial, solvency.
	BAS ERP	Analysis of enterprise activities, production management and planning, cost management, budgeting, financial management, procurement, warehouse and inventory management, etc.	Production, logistics, financial.
	SAP Business One	Financial Management, Sales and Customer Management, Inventory Management, Business Intelligence, Analytics and Reporting, etc.	Financial, solvency, logistical.
	Dynamics 365 Business Central	AI-based ERP - Copilot. Integration with Microsoft 365, Microsoft Teams, Microsoft Outlook, etc. Process automation and procedure optimization. Finance, budget, expense management.	Financial, solvency, budgetary, logistical.

Continuation of Table 3.15

1	2	3	4
		Supply chain management, etc.	
	Oracle NetSuite	Accounting, sales, supply chain and warehouse management, human resources management, advanced analytics. Cloud product. AI-powered.	Financial, solvency, logistics, personnel.
Medium-sized enterprises	BAS ERP	See above	Production, logistics, financial.
	SAP Business One	See above	Financial, solvency, logistical.
	Dynamics 365	Includes various products that can be combined or used separately: Dynamics 365 Supply Chain Management, Dynamics 365 Finance, Dynamics 365 Commerce, Dynamics 365 Project Operations, Dynamics 365 Human Resources, Dynamics 365 Business Central	Financial, solvency, budgetary, logistical, personnel.
	Oracle Fusion Cloud Enterprise Resource Planning	Financial management, project management, procurement management, risk management and compliance, ERP analytics, enterprise performance management.	Financial, solvency, logistical.
	Oracle Fusion Cloud Human Capital Management	Personnel management, workforce, payroll module, human capital management analytics.	Personnel.
	Oracle Fusion Cloud Supply Chain & Manufacturing	Supply chain planning, inventory management, manufacturing,	Financial, production, logistics.

Continuation of Table 3.15

1	2	3	4
		logistics, product lifecycle management, etc.	
	Visure Requirements ALM	Risk management based on Failure Mode and Effects Analysis (FMEA).	Production.
Large enterprises	Dynamics 365	See above	Financial, solvency, budgetary, logistical, personnel.
	SAP Cloud ERP (Public та Private Edition)	Financial management, procurement management, supply chain management, sales management, service management, production management (design, planning, production process, quality management).	Financial, solvency, production, logistics, personnel.
	Oracle Fusion Cloud Enterprise Resource Planning, Oracle Fusion Cloud Human Capital Management, Oracle Fusion Cloud Supply Chain & Manufacturing	See above	Financial, production, logistics, personnel.
	Visure Requirements ALM	See above	Production.
	IBM Engineering Requirements Management DOORS	The main focus is on requirements management through collaboration, compliance management, cost management, quality management, etc. AI is widely used to improve work. These tools can, in general, be applied to medium-sized enterprises, but the very	Production.

Continuation of Table 3.15

1	2	3	4
		specifics of the scale of projects that the program is focused on are more inherent in large.	

Source: compiled by the author based on [14, 45, 153, 171, 183, 209, 211, 212, 213, 226, 227, 242, 251]

So, we see some software products that can be used in risk management. They provide a wide range of functions that allow to manage both the entire enterprise and those parts of it that are directly related to risk management. However, since we believe that risk management should be a holistic system integrated into all areas and processes of the enterprise, it is worth taking into account the maximum capabilities of these software products. We add that most of them already use AI, which is a combination of several modern tools to increase the efficiency of activities. Thanks to the use of digital tools, it is possible to manage not only production, financial risks, but also personnel, environmental, etc., if you analyze and visualize changes in the company's personnel, indicators related to environmental issues.

We should also note that the use of digital tools in our activities also carries negative aspects: on the one hand, it is the increase in costs for their implementation, training of personnel in the necessary skills, and, on the other hand, it is the risks that arise from the development of these digital technologies. Namely: cyber threats, which manifest themselves in the risk of information leakage, hacker attacks, malicious software, and AI can have hallucinations, information must always be checked to reduce these risks. Automation and robotics can carry the risk of equipment going out of working order, the high cost of training qualified personnel, the difficulty of finding a specialist of the appropriate profile in the event of a breakdown. One of the risks inherent in the digitalization process is the obsolescence of digital technologies, tools and programs, the emergence of new alternatives.

To manage these side effects of the digitalization of the management process, appropriate protective measures should be used in terms of installing high-quality

software and protecting the company's information, cooperating with experts in the field of information protection and protecting the company from cyber threats. To work with AI, use only reliable information, train specialists with the appropriate skills to work with AI, and critically check the information received from AI. The use of new technologies always involves risks, but the expected effect is positive and should significantly increase the efficiency of enterprises. Managing these risks should also become an integral part of the enterprise's risk management system, ensuring the implementation of the main stages of risk management. To manage risks associated with the automation of production or management processes, it is necessary to have sufficient financial support and training of personnel, as well as the choice of such digital technologies that are sufficiently used and known in the territory of the enterprise, which ensures the availability of specialists of the appropriate profile in the event of equipment failure.

One of the risks associated with digitalization is the development of technologies, which can lead to the obsolescence of those used. To manage it, we offer constant monitoring of possible changes and training of personnel in new functions and capabilities. This requires additional financial resources, but allows to quickly adapt to new changes and requirements.

It becomes necessary to integrate the entire risk management system into the overall activities of enterprises, to allocate responsibilities and to ensure organizational coherence. Organizational responsibility for risk management may vary in enterprises depending on their size. We present this in Table 3.16.

Thus, we have proposed an appropriate organizational mechanism for risk management for manufacturing enterprises, which differs depending on the size of the enterprise and offers a distribution of responsibilities and functionality in relation to risk management, determines the areas of cooperation with different parts of the enterprise. The difference in functional responsibilities and structural units depends on the scale of the enterprise, the number of its personnel and production specifics.

Table 3.16

Organizational mechanism for risk management for manufacturing enterprises

Enterprise size	Responsible person/unit /structure	Risk management functions	Collaboration with other employees/ department
1	2	3	4
Micro-enterprise	Owner/ Director/ Manager	Analysis of the external environment, comparison of planned and actual indicators, monitoring of major changes in the company, consumer behavior, changes in production norms and standards, etc. It is possible to build a matrix of macroeconomic and financial distress risks by the company head or manager if such functionality is approved.	Taking into account the number of personnel, cooperation occurs by obtaining information from the relevant employee for analysis of activities directly to those who manage risk.
Small business	Head/ responsible for the directions	Managers in the relevant areas analyze planned and actual indicators, as well as the external environment within their areas of responsibility. The person responsible for the financial part or the head of the company builds a matrix of macroeconomic and financial distress risks, analyzes its dynamics for the year. The head of the company makes appropriate decisions regarding risk management methods.	Cooperation with departments in terms of collecting data on the results of their activities and planned indicators, deviations, as well as expert assessment of risks inherent in their area of responsibility. Coordination with those responsible for the areas of risk response tools and methods of their management. Cooperation with the information department (specialist) to manage information and digital risk. Coordination of expenses with the finance department.
Medium-sized enterprise	A separate personnel unit may be introduced.	It is advisable to introduce a separate unit or department that will be responsible for risk management at the enterprise. In the case of creating a separate department, it is possible to combine functional responsibilities with others, for	Cooperation with finance, production, HR, information and digital support departments and others (names may vary at each enterprise) on

Continuation of Table 3.16

1	2	3	4
		example, compliance, crisis management. The responsible person or department will compile a matrix of macroeconomic and financial distress risks, as well as summarize expert assessments of those responsible for the areas for the risks inherent in them across the enterprise. Develop various alternative risk management scenarios and offer them to the manager for selection.	identifying their inherent risks and their expert assessment. Constant monitoring of reports provided by them on planned and actual performance indicators, built forecasts. Cooperation with the information department (information security department or related to this activity) on information and digital risk management. Cost coordination with the financial department.
Large enterprise	A separate department responsible for risk management (may have different names, but one of its main functions is risk management).	A department whose main activity is risk management. This department may have different names or have specialists responsible for risk management within it. This department coordinates the work of other departments in transmitting data on its inherent risks, builds a matrix of macroeconomic and financial distress risks, identifies the main threats and offers the management of the department and departments with the relevant direction risk management methods that have a short-term and medium-term horizon. Decisions, strategies and methods regarding the general risk management policy of enterprises or in the event of a risk that threatens the existence of the enterprise are agreed with the management of the entire enterprise.	Cooperates with departments in the direction to obtain information from them on planned and actual indicators, assessed risks, forecasting. possible development scenarios. Cooperation with the information department (information security department or related to this activity) on information and digital risk management. Coordination of expenses with the finance department.

Source: compiled by the author

In order to ensure the functioning of a stable risk management system, it is proposed to track planned and actual indicators, measure deviations, build a matrix of macroeconomic and financial distress risks, expert assessment by those responsible for other types of risk, build forecasts and development scenarios, etc. For this, it is not necessary to create a separate unit if the enterprise is small, but the implementation of this activity and the appropriate analysis from the point of view of assessing deviations as a risk are necessary. For this, an important tool that can increase the efficiency of this activity can be the digitalization process, which allows not only to manage specific risks (production, logistics), but also to build appropriate systems for analysis, automation of calculations, information storage, data processing, visualization of the results obtained, analytical dashboards, etc. In this regard, digital tools act as an important assistant for increasing the efficiency of risk management for manufacturing enterprises.

One of the important mechanisms of risk management for manufacturing enterprises is economic, which is mostly the basis for the formation of a risk management system and its implementation in reality. It manifests itself as budgeting of the risk management system itself – the allocation of financial resources to ensure the risk management process, as well as the implementation of methods. On the one hand, financing of the risk management activity itself is required: organization of the appropriate management level, purchase of software, training of personnel in appropriate skills related to risk management. On the other hand, the application of various management methods also requires financial resources, namely: in the case of a decision to insure the risk, appropriate payments are required, in the case of diversification of production, financial resources and support play an important role, if the enterprise decides to relocate the company, then in this case, the need for a financial budget increases even more, etc. In addition, one of the methods of risk management is to reduce costs, that is, also the use of economic resources in terms of its reduction. Thus, the importance of the economic mechanism for the risk management process of enterprises is substantiated.

The economic mechanism of risk management for manufacturing enterprises can be presented as follows (Fig. 3.5):

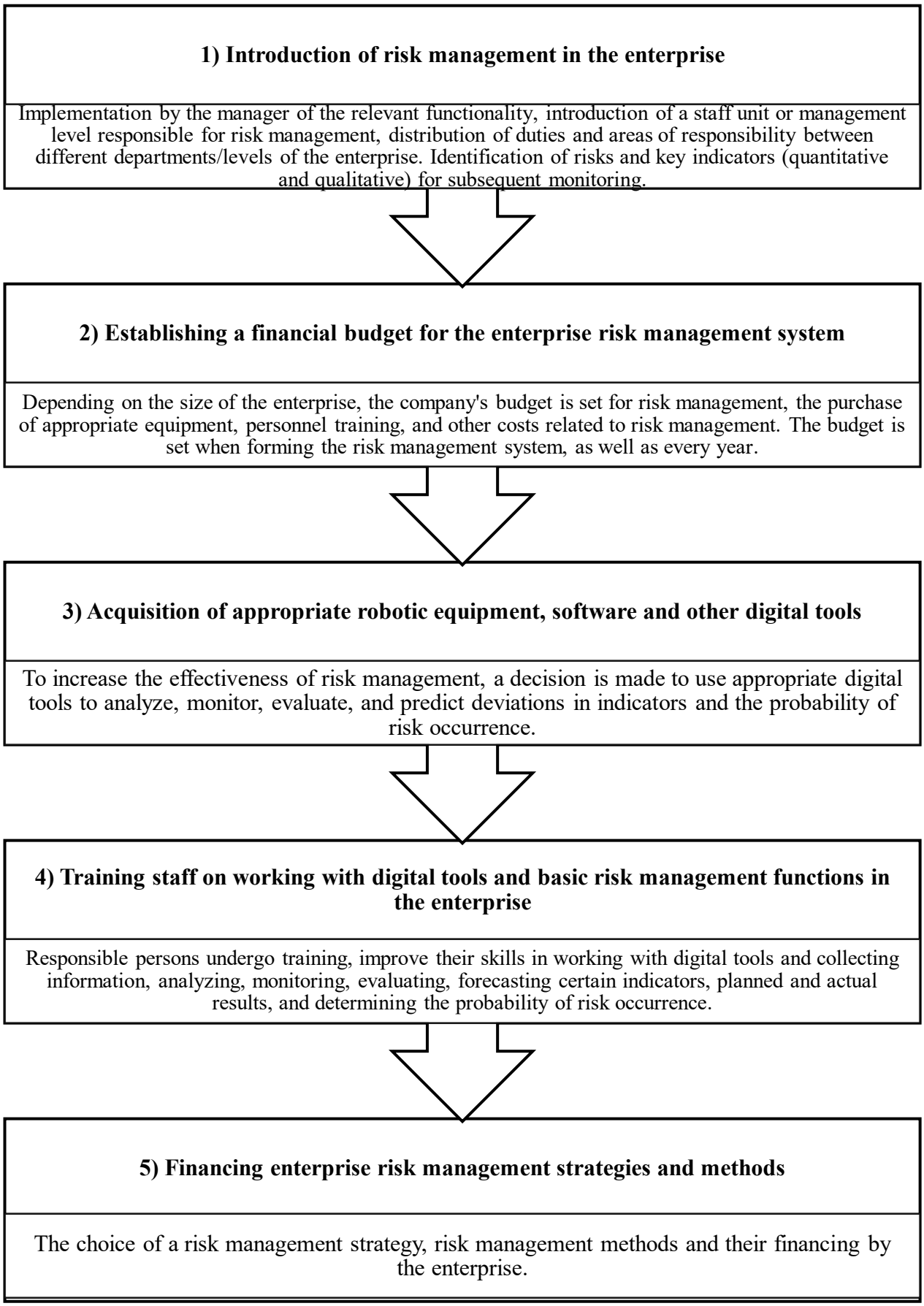


Fig. 3.5. Stages of implementation of the economic mechanism of the risk management system for manufacturing enterprises

Source: compiled by the author

In Fig. 3.5 we have illustrated our vision of the economic mechanism for implementing risk management at the enterprise. Moreover, the stages after the 1st may be parallel or repeated over time. Thus, with the development of technologies or the emergence of new functions in the software, personnel need to improve their qualifications again, or the technological equipment itself may need repair or change. What can be attributed to this budget. The proposed stages are decisive for enterprises when forming a risk management system and can be adapted to the needs of each individual enterprise depending on its size. It is important to initially establish the risks that are analyzed at this enterprise and the indicators by which they are evaluated. Risks may change in the course of the activity, but the main list is approved at the first stage with the possibility of further change. Developing a system of indicators by which these risks are measured is also a necessary component of forming a risk management system, because the employees responsible for it will subsequently monitor, record changes and assess the likelihood of risk occurrence.

As a generalization of the above, we see that the formation of a risk management system for manufacturing enterprises is a multifaceted process that combines various elements and mechanisms regardless of the size of the enterprise. It is important to form it in such a way that this system shows its viability both after its launch and during the implementation process. It combines both organizational-economic and digital mechanisms, which should be links in one process and lead to the effective operation of the entire enterprise. Risk management should not be the responsibility of only one staff unit or a separate link, it should be part of the functional responsibilities of various departments and employees. By this we mean that organizational and digital risk management occurs depending on the type of risk. So, if we are talking about personnel risk, then the analysis of the probability of its occurrence, consequences and causes of occurrence, proposals for its management should be carried out not by the person responsible for risk management at the enterprise, but by the personnel management department with the transfer of relevant information and coordination of actions with the person responsible for risk management. But one of the most harmonious cooperation in risk management is the cooperation of the person responsible for risk

management with the financial department, with which the budget of the risk management system and deductions for the implementation of the risk management strategy and methods are agreed.

We propose a Model of an integrated complex of organizational-economic and digital mechanisms for forming a risk management (RM) system for manufacturing enterprises, which is presented in Fig. 3.6.

In Fig. 3.6 we have illustrated a model of an integrated complex of organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises. According to it, the person or unit responsible for risk management (in a micro-enterprise this may also be the owner of the company) carries out the general process of risk management at the enterprise, forms the enterprise's risk management policy, evaluates, analyzes, monitors certain performance indicators, develops an annual macroeconomic and financial distress risks matrix, and also actively cooperates with other departments that also perform certain risk management functions specific to their area of responsibility. After agreeing on the main points and mutual transfer of data on the relevant risks, the person or unit responsible for risk management cooperates with the financial department both on risk management and on evaluating the results of the financial part, as well as from the point of view of risk assessment and risk-based management. After coordination with the financial department, the person responsible for risk management, together with the financial department, coordinates with the head of the enterprise the financial budget of risk management, the directions of choosing strategies and methods of risk management. This is the foundation for the formation of a risk management system for manufacturing enterprises. The interpretation and implementation itself may vary depending on the size of the enterprise, its industry and the products manufactured, but the basis should be such that it will allow achieving full integration of risk management into the overall management system, creating conditions for preventive risk management in order to protect the enterprise from the threat of further crisis management when the risk reaches the level of crisis.

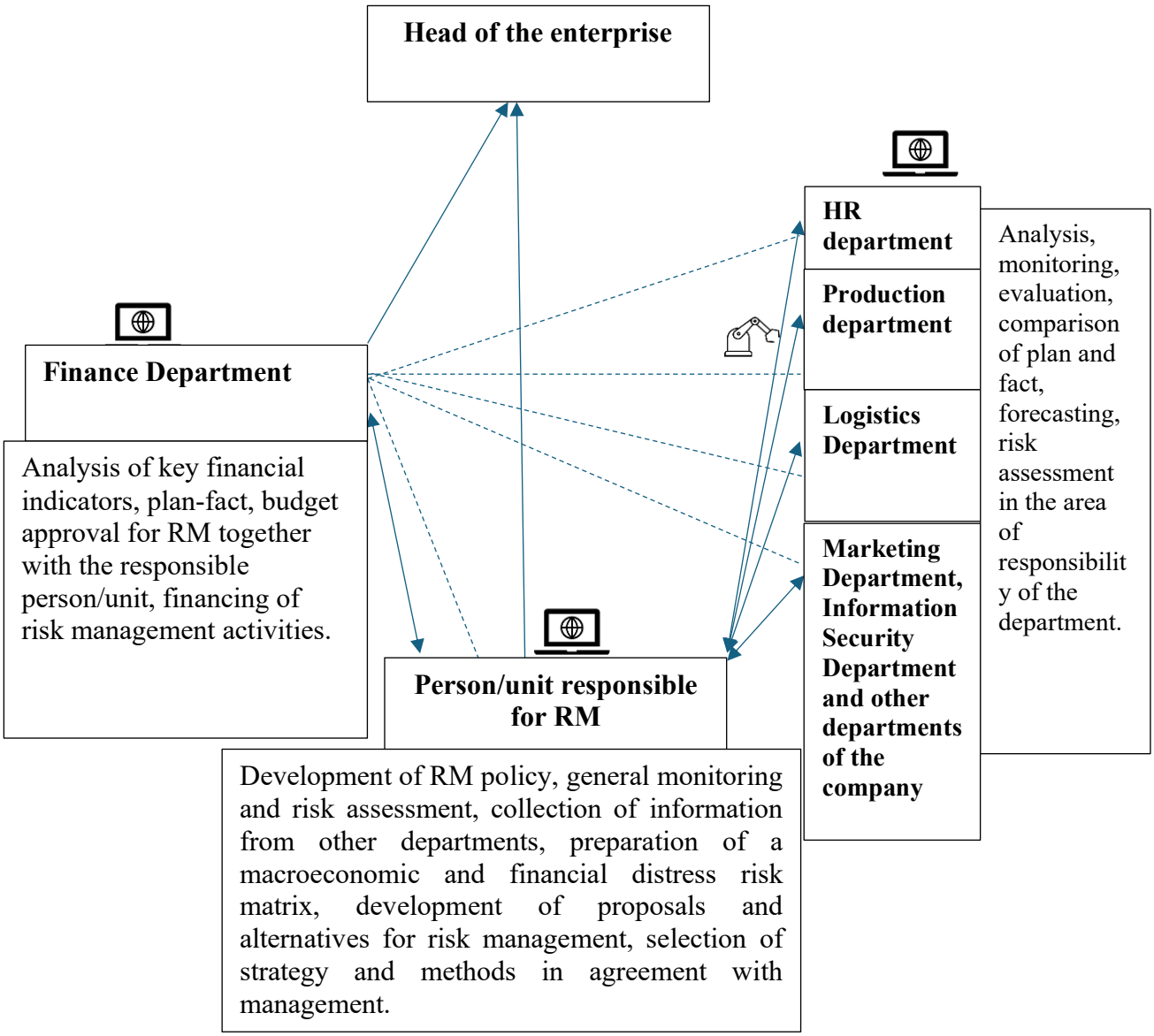


Fig. 3.6. Model of an integrated complex of organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises

Source: compiled by the author

So, we have proven the relevance and opportunities provided by digital tools in risk management at manufacturing enterprises, and indicated the directions of their use. It has been determined that the processes of robotization of work processes significantly increase the effectiveness of risk management at manufacturing enterprises, as the quality of work performance improves, the efficiency of production management and, accordingly, related areas increases. If we take risk management directly, digital tools allow us to significantly improve the quality and speed up the processes of data analysis, forecasting, and scenario modeling. But the opportunities for managing other areas are also increasing, which also significantly increases the effectiveness of risk management at the enterprise. It is important that technologies and software products are created that allow us to make the risk management process integrated into the entire enterprise management process and holistic, which has a significant positive effect on the activities of enterprises. We have proposed software products and directions for their application in risk management at manufacturing enterprises by size. It is noted that digitalization also carries certain risks and threats, the management of which should become part of this integrated risk management system and requires thorough training, both technical and personnel. In general, the possibilities of using digital tools in risk management are significant, creating a basis for increasing the efficiency and quality of management decision-making, relying on the results of such tools as AI, RPA, various software, etc.

An organizational mechanism for implementing a risk management system in manufacturing enterprises of various levels and scales is proposed. The main functional responsibilities of those responsible for risk management are indicated, as well as the boundaries of their responsibility and decision-making. An important role in the organizational mechanism of risk management is assigned to the head of the enterprise, whose corresponding functionality depends on the size of the enterprise.

It is also recommended to combine the organizational with the economic mechanism, which becomes a prerequisite for the possibility of implementing the risk management system, since the financial component is the basis for both the formation of the risk management system and its further implementation. A necessary component

of the organizational-economic mechanism is the definition of a system of risks that will be assessed at the enterprise and a system of indicators, both quantitative and qualitative, by which the relevant employees will subsequently monitor and analyze the probability of risk occurrence and its level.

A model of an integrated complex of organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises has been developed, which embodies all the processes described above and is universal for enterprises. Its universal nature allows it to adapt to the needs of enterprises of different levels and in accordance with the characteristics of production, which will allow the most effective construction of a risk management system at manufacturing enterprises in Ukraine.

Conclusions to chapter 3

1. We proposed the construction of a conceptual model of the risk management system for manufacturing enterprises, which will be based on the assessment of external and internal factors. For this, we calculated an integral indicator of macroeconomic risk, which includes the GDP indicator, the consumer price index and the hryvnia exchange rate to the US dollar. The selection of these indicators was also based on the conducted correlation-regression analysis, which selected indicators between which there is no very strong connection and multicollinearity, and the regression model is characterized by the significance and validity of the selected indicators as factors of influence on net profit. Further standardization of indicators using the z-score method allowed us to bring them to a comparable scale and calculate macroeconomic risk, which is characterized by uneven dynamics and significant fluctuations, which correlates with statistical data. However, for the most part, the MAR is at an elevated level. But, taking into account the macro environment of Ukraine, we have characterized each level of this risk and noted that a strong risk management system should be built at any level. At the first level, it is more balanced and reactive, characterized by a proactive position, and at the higher and higher levels it is more crisis in nature.

2. The calculation of the integral financial distress risk (FDR) was proposed, which is a weighted average indicator of 5 discriminant models calculated for 5 enterprises. FDR characterizes the financial condition of the enterprise in terms of its solvency, ability to meet its obligations, and the probability of bankruptcy. The results obtained indicate changes in this indicator over the analyzed period in ArcelorMittal, Metinvest, and KVBZ. Interpipe has a more stable position, with a slight deterioration in 2021. AZOT's positions also range from an elevated level to a high.

Based on this indicator, together with the macroeconomic indicator MAR, we have developed a matrix of macroeconomic and financial distress risks. This matrix is constructed in such a way that the X-axis is the result of FDR, and the Y-axis is MAR. The matrix consists of 9 quadrants. According to the external risk of MAR and its levels, we offer a color scheme that reflects the level of risk. Each quadrant was characterized and a certain risk management strategy and courses of action were proposed in it.

It is also proposed to conduct an expert assessment every year for other external and internal risks, along with a description of the impact at each level of these risks and directions of action for their resolution. Building such a risk management system will make this process an effective and holistic mechanism.

3. The opportunities provided by digital tools and technologies in the implementation of enterprise risk management are identified. Thus, digitalization has significant positive consequences for the process and results of risk management, namely, the efficiency of the management process increases due to the reduction of data processing time, which is very important in risk analysis and assessment; the ability to build analytical dashboards that allow to visualize clearly the results of enterprise activities and key indicators; monitor the production process in real time; automation and robotization of the production process, which reduces the number of defective products, optimizes costs, allows more accurately to predict the need for technical upgrades of equipment, etc. One of the main positive opportunities is the integration of risk management into the overall enterprise management system by digitalizing this process.

The distribution of software products by enterprise size and the main functions they perform and which can be transferred to the risk management for manufacturing enterprises is proposed, which allows enterprises to choose various digital tools according to the most acceptable categories and parameters for them. The main risks that digitalization carries in terms of cyber threats, the risk of information leakage, technology obsolescence, etc. are indicated. The inclusion of this risk in the management system and the main directions for their reduction are proposed.

Taking into account and using the capabilities of digital technologies becomes part of the digital mechanism of the risk management system for manufacturing enterprises, which is supplemented by the organizational-economic mechanism of this system. The organizational component is represented by a proposal for the functional distribution of management functions in the risk management system between the relevant personnel or units of the enterprise. These proposals take into account the size of the enterprise and can be flexible depending on other conditions and the industry of the enterprise. It has been determined that an important component of both the formation and further activity of the risk management system is the economic component, which forms the economic mechanism and consists in coordinating the risk management budget, distributing financial resources both for the analysis, assessment and monitoring activities themselves and for the implementation of the main risk management measures, identifying the main risks that the enterprise monitors and which can be supplemented, expanded or changed, and developing a system of quantitative and qualitative indicators by which the enterprise's activities and the probability of risks occurring are analyzed and assessed.

The developed model of an integrated complex of organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises is adaptive to the needs of enterprises of various sizes and industries and allows integrating the risk management process into the overall enterprise management system, which will increase the efficiency and effectiveness of the activities of manufacturing enterprises.

CONCLUSIONS

The thesis developed conceptual principles and scientific and methodological provisions for the formation of a risk management system for manufacturing enterprises. The results of the research indicate the achievement of the set goal and provide grounds for formulating the following conclusions and proposals.

1. The results of the study of the genesis of scientific views on the nature of risks allowed us to state a significant transformation of approaches to the interpretation of the concepts of “risk”, “uncertainty”, “risk management” and “manufacturing enterprise” depending on the specific industry and time period. It was found that in the conditions of modern challenges, risk management of manufacturing enterprises should be considered as a comprehensive management system that is not limited to tools for minimizing negative consequences. It was established that the key characteristic of a modern system is its ability to identify and use potential opportunities that arise in a risk environment in order to form sustainable competitive advantages of the enterprise.

Within the framework of the clarification of the conceptual and categorical apparatus, the relationship between the concepts of “risk” and “crisis” was revealed, where the latter was defined as the result of the implementation of a critical set of risks under the conditions of ineffectiveness of the risk management system. It was established that risk is an anticipatory state of uncertainty, while the crisis is a phase of violation of the functional stability of the enterprise. Such a distinction allows us to interpret risk management as a “strategic monitoring system”, which is designed to break the cause-and-effect relationship between risk and crisis through timely identification of negative triggers and ensuring the viability of the business entity.

2. Within the framework of the analysis of the phasing of the risk management process, the sequence of functioning of the risk management system of manufacturing enterprises is systematized. In particular, six interrelated stages are distinguished, from preparatory to monitoring, the purpose of integrating which is to ensure the validity of management decisions.

As a result of the study of debatable issues regarding the classification of risk assessment methods, it has been proven that the key difference between qualitative and

quantitative analysis lies in the object of research: qualitative methods focus on identifying factors, sources and potential consequences of risk events, while quantitative methods focus on mathematically measuring the probability of their realization.

It is proven that the choice of methods of influencing risks (differentiated into internal and external) is a derivative of the chosen model and strategy of enterprise management, and the variability of methodological tools is due to the industry specifics and scale of activity, where the criterion for optimality of choice is the expected economic effect. The result of the study was the formation of a hierarchical model for building a risk management system, which acts as a preventive tool for early detection of threats. This allows for the transition from situational response to proactive prevention of crisis states, which is important for ensuring the sustainable functioning of manufacturing enterprises.

3. The results of the analysis of regulatory legal acts regulating the legal framework of risk management in Ukraine, international standards and their implementation into domestic legislation revealed the need to improve approaches to the formation of the regulatory framework by introducing proactive management mechanisms. In particular, at the legislative level, it is recommended that enterprises develop Business Continuity Management Strategies based on BCMS requirements and obtain an ISO 22301 certificate accordingly, which will improve the risk management system and, as a result, increase the competitiveness of Ukrainian enterprises in the global market, and propose the introduction of investment tax credits for business entities that have confirmed the compliance of their management systems with ISO 22301:2019, ISO 31000:2018 standards, which will provide them with significant preferences over other enterprises (compensation for the costs of digitalization of risk management and reputation growth).

The need to continue work on harmonizing Ukrainian legislation with international standards is also substantiated, in terms of developing industry strategies based on business continuity management systems (BCMS), modernizing the regulatory framework in the field of cybersecurity of industrial facilities by implementing requirements for the mandatory integration of digital risks, and

implementing international standards in the State Technical Regulations of Ukraine. The introduction of such steps will allow transforming approaches to crisis management, moving from fragmented risk response to the formation of a comprehensive risk management system.

4. The study found that the risk macroenvironment of the functioning of manufacturing enterprises is characterized by increased variability, volatility and instability. Thus, the results of the country risk assessment (Table 2.2) indicate low positions of Ukraine in world rankings (according to the Logistics Performance Index (LPI) and the Index of Economic Freedom (IEF) – indicators of increased risk, according to country risk assessments by AM BEST, Coface and Allianz Trade – the highest levels of risk). Given that the state of the risk macroenvironment is a determining factor in identifying threats, it becomes necessary to integrate indicators of the risk external environment into the general risk management system of manufacturing enterprises.

Statistical analysis of the main indicators of the macro environment that are relevant to manufacturing enterprises, with additional calculations of the coefficient of variation (V), standard deviation (STDEV) and moving average (SMA) for the period 2014-2024, revealed the presence of imbalances caused by macro shocks due to the COVID-19 pandemic and full-scale invasion in 2020 and 2022, respectively.

Calculations of these indicators, in particular the coefficient of variation (V), which is a relative measure of risk and an indicator of volatility, made it possible to prove the necessity to implement a mechanism for integrating the results of the analysis of quantitative indicators into the process of forming risk management for manufacturing enterprises.

5. The results of the analysis of the financial condition of a representative group of enterprises (PJSC “ArcelorMittal Kryvyi Rih”, LLC “Metinvest Holding”, PC “Interpipe”, PJSC “Kryukiv Carriage Building Plant”, PrJSC “AZOT”) showed that in the conditions of the COVID-19 pandemic and martial law, there is a significant deficit of solvency and a decrease in the efficiency of capital allocation, which demonstrates the direct dependence of enterprises on macroeconomic instability and external influences on their activities.

When conducting a quantitative assessment of financial risks using 5 models (Altman, Springate, Tereshchenko, Tafler and Tishaw, and the Beaver coefficient), a close relationship was found between the quality of risk management and the financial results of enterprises. It was proven that enterprises with a built-in hierarchical risk management structure, such as ArcelorMittal, Metinvest and Interpipe, have higher resistance to crises, and enterprises with a fragmented approach to risk management, such as AZOT and KVBZ, have deviations from the values, i.e. they have higher indicators of the probability of bankruptcy.

The analysis conducted confirms all previous calculations and indicates the need to form holistic risk management systems for manufacturing enterprises.

6. As a result of the study of the dynamics of search queries regarding interest in the category “risk”, the uneven formation of risk-oriented thinking among Ukrainian entrepreneurs compared to EU countries was revealed. Analysis of EU countries (Poland, Germany and France) showed that the European experience of search activity is based on the constant interest in the tools of risk assessment and management, which indicates interest in this issue, understanding of the importance of studying not only theoretical approaches, but also risk management methods and greater awareness. At the same time, in Ukraine, search queries are characterized by situationalism, increasing during crises, regional specificity (Kyiv, Vinnytsia and Ternopil regions hold the lead) and orientation in searches in the majority on terminological aspects.

The analysis conducted is the basis for the implementation of EU best management practices at Ukrainian domestic enterprises in order to build an effective risk management system.

7. It is proposed to include in the risk management model at manufacturing enterprises an assessment of macroeconomic risk based on the calculation of an integral indicator, which includes GDP indicators, the Consumer Price Index and the hryvnia to US dollar exchange rate, standardized using z-score. The choice of these indicators is justified by the conducted correlation and regression analysis. The conducted analysis of the impact of these indicators on net profit confirmed the feasibility of including and substantiating their changes in the net profit indicator of enterprises. The obtained for this indicator results allow us to determine 3 levels of

macroeconomic risk – moderately acceptable, elevated and high, at each of which it is recommended to implement a certain risk management strategy. Obtaining an indicator at the lowest level does not mean the absence of necessary actions, but a proactive position in analyzing the situation and predicting possible changes, developing action plans. The next two levels also provide for an appropriate response to the changes that occur at the enterprise as a result of the occurrence of such a risk.

8. To assess internal financial risk, we have proposed the calculation of the integral financial distress risk (FDR), which is based on taking into account 5 discriminant models calculated in Chapter 2 for 5 manufacturing enterprises. This indicator characterizes the risk of insolvency of the enterprise, the inability to meet its obligations. The results obtained reflect the unevenness of its changes in the 5 analyzed enterprises over 5 years. Interpipe has the best positions. Other enterprises have experienced significant fluctuations during this period.

Taking into account this indicator and together with the MAR indicator, we offer a matrix of macroeconomic and financial distress risks, which consists of 9 quadrants and reflects the place of the enterprise in terms of external and internal risk. This makes it possible to assess external threats and their impact on the enterprise, as well as the internal possibility of providing financial resources. The matrix consists of 9 quadrants, which are characterized by a certain ratio of external macroeconomic and internal risk of financial insolvency. For each quadrant, we have proposed its characteristics and the strategy and directions of action of enterprises that find themselves in it.

It is also recommended that other external and internal risks be assessed by experts, in accordance with which tables have been developed indicating the nature of the impact on the enterprise and the areas of action to manage these risks.

9. The main opportunities and directions of digitalization for risk management of manufacturing enterprises are considered, on the basis of which the use of software products is proposed, which will significantly increase the effectiveness of risk management. The developed recommendations differ in the size of enterprises, which makes it possible to adapt the proposed recommendations to the needs and requirements of manufacturing enterprises in Ukraine, depending on their scale and specifics of their activities. The risks that arise as a result of digitalization are identified

and directions for their management are proposed. It is important to integrate these risks into the general risk management system of enterprises in order to analyze the probability of their occurrence and manage them.

The organizational mechanism of risk management is substantiated, which outlines the functional distribution between employees or departments of the enterprise regarding risk management and takes into account the different sizes of enterprises in Ukraine. The organizational mechanism is supplemented by an economic one, its stages are recommended and the importance of budgeting and financing the risk management process, the development of a system of indicators that will analyze the work of the enterprise and allow assessing the probability of risks occurring, is determined.

A model of an integrated complex of organizational-economic and digital mechanisms for forming a risk management system for manufacturing enterprises has been developed, which summarizes the stages, directions and distribution of responsibility in the process of implementing risk management and is adaptive to the relevant needs of enterprises of different sizes, scales and industries. The proposed model of an integrated complex of organizational-economic and digital mechanisms allows forming an integrated, effective and comprehensive risk management system for manufacturing enterprises. This model eliminates the negative impact of macroeconomic volatility, allows to strengthen financial stability and serves as the basis not only for the formation of a risk management system, but also for increasing the overall efficiency of manufacturing enterprises.

The use of these conclusions and proposals is a methodological basis for further research on the formation of a risk management system for manufacturing enterprises.

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APPENDICES

Appendix A

Logistics Performance Index

2007															
	Overall LPI		**Customs**		**Infrastructure**		**Ease of Shipment**		**Logistics Services**		**Ease of Tracking**		**Domestic Logistics Costs**		**Timeliness**	
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**
Singapore	4,19	1	3,90	3	4,27	2	4,04	2	4,21	2	4,25	1	2,70	113	4,53	1
Netherlands	4,18	2	3,99	1	4,29	1	4,05	1	4,25	1	4,14	4	2,65	121	4,38	5
Germany	4,10	3	3,88	4	4,19	3	3,91	4	4,21	3	4,12	5	2,34	136	4,33	8
Ukraine	**2,55**	**73**	**2,22**	**97**	**2,35**	**74**	**2,53**	**83**	**2,41**	**90**	**2,53**	**80**	**3,25**	**21**	**3,31**	**55**
Rwanda	1,77	148	1,80	143	1,53	148	1,67	148	1,67	148	1,60	148	3,07	52	2,38	135
Timor-Leste	1,71	149	1,63	147	1,67	146	1,50	149	1,60	149	1,67	147	3,33	16	2,25	141
Afghanistan	1,21	150	1,30	150	1,10	150	1,22	150	1,25	150	1,00	150	3,13	40	1,38	150

2010																
	Overall LPI		**Customs**		**Infrastructure**		**International Shipments**		**Quality Logistics Services**		**Tracking and Tracing**		**Timeliness**			
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**		
Germany	4,11	1	4,00	3	4,34	1	3,66	9	4,14	4	4,18	4	4,48	3		
Singapore	4,09	2	4,02	2	4,22	4	3,86	1	4,12	6	4,15	6	4,23	14		
Sweden	4,08	3	3,88	5	4,03	10	3,83	2	4,22	2	4,22	3	4,32	11		
Ukraine	**2,57**	**102**	**2,02**	**135**	**2,44**	**79**	**2,79**	**84**	**2,59**	**77**	**2,49**	**112**	**3,06**	**114**		
Sierra Leone	1,97	153	2,17	110	1,61	152	2,33	134	1,53	154	1,73	152	2,33	152		
Eritrea	1,70	154	1,50	154	1,35	155	1,63	154	1,88	150	1,55	154	2,21	153		
Somalia	1,34	155	1,33	155	1,50	154	1,33	155	1,33	155	1,17	155	1,38	155		

Continuation of Appendix A

2012															
	Overall LPI		**Customs**		**Infrastructure**		**International Shipment**		**Logistics Competence and Quality**		**Tracking and Tracing**		**Timeliness**		
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	
Singapore	4,13	1	4,10	1	4,15	2	3,99	2	4,07	6	4,07	6	4,39	1	
Hong Kong SAR, China	4,12	2	3,97	3	4,12	7	4,18	1	4,08	5	4,09	5	4,28	4	
Finland	4,05	3	3,98	2	4,12	6	3,85	4	4,14	1	4,14	1	4,10	15	
Ukraine	**2,85**	**66**	**2,41**	**88**	**2,69**	**70**	**2,72**	**83**	**2,85**	**61**	**3,15**	**50**	**3,31**	**68**	
Haiti	2,03	153	1,78	150	1,78	151	1,94	148	1,74	154	2,15	139	2,74	129	
Djibouti	1,80	154	1,72	154	1,51	154	1,77	154	1,84	153	1,73	153	2,19	154	
Burundi	1,61	155	1,67	155	1,68	153	1,57	155	1,43	155	1,67	154	1,67	155	
2014															
	Overall LPI		**Customs**		**Infrastructure**		**International shipments**		**Logistics quality and competence**		**Tracking and tracing**		**Timeliness**		
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	
Germany	4,12	1	4,10	2	4,32	1	3,74	4	4,12	3	4,17	1	4,36	4	
Netherlands	4,05	2	3,96	4	4,23	3	3,64	11	4,13	2	4,07	6	4,34	6	
Belgium	4,04	3	3,80	11	4,10	8	3,80	2	4,11	4	4,11	4	4,39	2	
Ukraine	**2,98**	**61**	**2,69**	**69**	**2,65**	**71**	**2,95**	**67**	**2,84**	**72**	**3,20**	**45**	**3,51**	**52**	
Afghanistan	2,07	158	2,16	137	1,82	158	1,99	156	2,12	152	1,85	159	2,48	149	
Congo, Dem. Rep.	1,88	159	1,78	158	1,83	156	1,70	160	1,84	158	2,10	151	2,04	159	
Somalia	1,77	160	2,00	147	1,50	160	1,75	159	1,75	160	1,75	160	1,88	160	

Continuation of Appendix A

2016

	Overall LPI		Customs		Infrastructure		International shipments		Logistics quality and competence		Tracking and tracing		Timeliness			
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**		
Germany	4,23	1	4,12	2	4,44	1	3,86	8	4,28	1	4,27	3	4,45	2		
Luxembourg	4,22	2	3,90	9	4,24	4	4,24	1	4,01	10	4,12	8	4,80	1		
Sweden	4,20	3	3,92	8	4,27	3	4,00	4	4,25	2	4,38	1	4,45	3		
Ukraine	**2,74**	**80**	**2,30**	**116**	**2,49**	**84**	**2,59**	**95**	**2,55**	**95**	**2,96**	**61**	**3,51**	**54**		
Somalia	1,75	158	1,29	159	1,57	156	1,86	157	1,85	156	1,51	160	2,35	152		
Haiti	1,72	159	1,70	158	1,47	159	1,81	159	1,68	159	1,56	158	2,02	160		
Syrian Arab Republic	1,60	160	1,11	160	1,24	160	1,36	160	1,39	160	2,10	138	2,40	147		

2018

	Overall LPI		Customs		Infrastructure		International shipments		Logistics quality and competence		Tracking and tracing		Timeliness			
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**		
Germany	4,20	1	4,09	1	4,37	1	3,86	4	4,31	1	4,24	2	4,39	3		
Sweden	4,05	2	4,05	2	4,24	3	3,92	2	3,98	10	3,88	17	4,28	7		
Belgium	4,04	3	3,66	14	3,98	14	3,99	1	4,13	2	4,05	9	4,41	1		
Ukraine	**2,83**	**66**	**2,49**	**89**	**2,22**	**119**	**2,83**	**68**	**2,84**	**61**	**3,11**	**52**	**3,42**	**56**		
Burundi	2,06	158	1,69	159	1,95	146	2,21	139	2,33	117	2,01	156	2,17	158		
Angola	2,05	159	1,57	160	1,86	153	2,20	143	2,00	155	2,00	157	2,59	140		
Afghanistan	1,95	160	1,73	158	1,81	158	2,10	152	1,92	158	1,70	159	2,38	153		

Continuation of Appendix A

2023															
	LPI		**Customs**		**Infrastructure**		**International Shipments**		**Logistics Competence and Quality**		**Timeliness**		**Tracking and Tracing**		
Country	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	**score**	**rank**	
Singapore	4,3	1	4,2	1	4,6	1	4,0	2	4,4	1	4,3	1	4,4	1	
Finland	4,2	2	4,0	4	4,2	5	4,1	1	4,2	3	4,3	1	4,2	3	
Denmark	4,1	3	4,1	2	4,1	9	3,6	14	4,1	9	4,1	10	4,3	2	
Germany	4,1	3	3,9	7	4,3	3	3,7	8	4,2	3	4,1	10	4,2	3	
Netherlands	4,1	3	3,9	7	4,2	5	3,7	8	4,2	3	4,0	17	4,2	3	
Switzerland	4,1	3	4,1	2	4,4	2	3,6	14	4,3	2	4,2	4	4,2	3	
Ukraine	**2,7**	**79**	**2,4**	**90**	**2,4**	**89**	**2,8**	**75**	**2,6**	**92**	**3,1**	**76**	**2,6**	**94**	
Somalia	2,0	138	1,5	140	1,9	133	2,4	111	1,8	140	2,3	134	1,8	137	
Afghanistan	1,9	139	2,1	120	1,7	139	1,8	139	2,0	136	2,3	134	1,6	140	
Libya	1,9	139	1,9	134	1,7	139	2,0	136	1,9	139	2,2	138	1,8	137	

Source: [206]

Appendix B

Ukraine's Index of Economic Freedom, 1999-2025

Index Year	Overall Score	Property Rights	Govern-ment Integrity	Judicial Effecti-veness	Tax Burden	Govern-ment Spending	Fiscal Health	Business Freedom	Labor Freedom	Monetary Freedom	Trade Freedom	Invest-ment Freedom	Financial Freedom
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1995	39,9	30,0	10,0	N/A	61,8	47,1	N/A	55,0	N/A	0,0	55,0	50,0	50,0
1996	40,6	30,0	30,0	N/A	57,7	47,1	N/A	55,0	N/A	0,0	66,0	50,0	30,0
1997	43,5	50,0	30,0	N/A	61,1	49,1	N/A	55,0	N/A	0,0	66,0	50,0	30,0
1998	40,4	30,0	30,0	N/A	64,4	51,0	N/A	55,0	N/A	0,0	53,0	50,0	30,0
1999	43,7	30,0	30,0	N/A	63,0	43,0	N/A	55,0	N/A	39,3	53,0	50,0	30,0
2000	47,8	30,0	28,0	N/A	62,3	41,9	N/A	55,0	N/A	63,0	70,0	50,0	30,0
2001	48,5	30,0	26,0	N/A	63,8	49,6	N/A	55,0	N/A	62,3	70,0	50,0	30,0
2002	48,2	30,0	15,0	N/A	66,1	58,9	N/A	55,0	N/A	58,2	71,0	50,0	30,0
2003	51,1	30,0	21,0	N/A	67,1	68,1	N/A	55,0	N/A	64,0	74,6	30,0	50,0
2004	53,7	30,0	24,0	N/A	67,5	77,8	N/A	55,0	N/A	74,5	74,4	30,0	50,0
2005	55,8	30,0	23,0	N/A	83,0	78,6	N/A	55,0	55,8	76,2	76,2	30,0	50,0
2006	54,4	30,0	22,0	N/A	90,2	75,8	N/A	43,1	53,2	72,9	77,2	30,0	50,0
2007	51,5	30,0	26,0	N/A	83,6	53,2	N/A	43,6	52,8	68,4	77,2	30,0	50,0
2008	51,0	30,0	28,0	N/A	79,0	43,0	N/A	44,4	53,1	69,9	82,2	30,0	50,0
2009	48,8	30,0	27,0	N/A	77,0	39,0	N/A	40,5	52,4	68,1	84,0	30,0	40,0
2010	46,4	30,0	25,0	N/A	77,9	41,1	N/A	38,7	57,7	61,2	82,6	20,0	30,0
2011	45,8	30,0	22,0	N/A	77,3	32,9	N/A	47,1	50,0	63,2	85,2		30,0
2012	46,1	30,0	24,0	N/A	78,2	29,4	N/A	46,2	51,2	67,7	84,4	20,0	30,0
2013	46,3	30,0	23,0	N/A	78,2	29,4	N/A	47,6	49,9	71,0	84,4	20,0	30,0
2014	49,3	30,0	21,9	N/A	79,1	37,5	N/A	59,8	49,8	78,7	86,2	20,0	30,0
2015	46,9	20,0	25,0	N/A	78,7	28,0	N/A	59,3	48,2	78,6	85,8	15,0	30,0
2016	46,8	25,0	26,0	N/A	78,6	30,6	N/A	56,8	47,9	66,9	85,8	20,0	30,0

Continuation of Appendix B

1	2	3	4	5	6	7	8	9	10	11	12	13	14
2017	48,1	41,4	29,2	22,6	78,6	38,2	67,9	62,1	48,8	47,4	85,9	25,0	30,0
2018	51,9	41,0	29,0	29,5	80,2	45,0	75,9	62,7	52,8	60,1	81,1	35,0	30,0
2019	52,3	43,9	29,6	31,5	81,8	46,9	82,6	66,1	46,7	58,6	75,0	35,0	30,0
2020	54,9	47,5	37,9	42,2	81,1	47,2	83,9	61,3	48,3	63,0	81,2	35,0	30,0
2021	56,2	48,5	37,9	41,1	88,7	48,2	87,7	63,5	48,7	65,8	79,2	35,0	30,0
2022	54,1	39,7	33,8	31,4	89,1	44,5	73,6	61,1	60,7	71,2	78,6	35,0	30,0
2023	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NaN	N/A	N/A	N/A	N/A
2024	N/A	23,0	32,5	30,4	N/A	N/A	N/A	N/A	N/A	N/A	73,2	N/A	N/A
2025	N/A	21,5	35,4	29,9	N/A	N/A	N/A	N/A	N/A	N/A	73,2	N/A	N/A

Source: [238].

Appendix C

Gross investment of enterprises by type of economic activity in 2012-2024, thsd. UAH*

	Code NACE Rev. 2	Years	Gross investment of enterprises	Including							
				Gross investment in tangible non-current assets	of them				Gross investment in intangible non-current assets other than goodwill	of them	
					In land	In acquisition of existing buildings	In construction and improvement of buildings	In machinery and equipment		In concessions, patents, licences, trade marks and similar rights	In purchased software
Total		**2012**	235684789	227389779	1741993	6182028	104108303	106931752	8295010	3631615	2694055
		2013	222671032	212208077	1094417	5200778	101561769	94740863	10462955	5646121	2687530
		2014	183954497	176712637	932610	2858218	86662565	79157302	7241860	2939648	2314431
		2015	218801758	200590448	1313456	5404886	86467426	98857091	18211310	12349975	3766396
		2016	288142597	276466591	1743744	8496494	106133723	148266741	11676006	4134374	4785017
		2017	366116303	349938361	1895381	6512797	121120078	204952111	16177942	5624697	6443127
		2018	480314142	444177199	1645821	10770711	166605237	246713668	36136943	23739488	6869920
		2019	533728974	510940069	2313512	10655539	205658178	249527603	22788905	7248537	7455293
		2020	409065379	384496521	2250206	5291462	152031085	201209061	24568858	3868331	8237750
		2021	545219654	514549613	2680785	6166737	206301987	267478323	30670041	5915565	11207302
		2022	344303239	323872930	989001	2368508	105278370	180498356	20430309	3268395	9750782
		2023	520187646	489546889	1471214	4289607	181728195	271251163	30640757	4556306	12552437
		2024	616990761	573112487	4531857	4954396	204334224	326273603	43878274	8833108	16621910

Continuation of Appendix C

Gross investment of enterprises by type of economic activity in 2012-2024, thsd. UAH

Branch	Code NACE Rev. 2	Years	Gross investment of enterprises	Including							
				Gross investment in tangible non-current assets	of them				Gross investment in intangible non-current assets other than goodwill	of them	
					In land	In acquisition of existing buildings	In construction and improvement of buildings	In machinery and equipment		In concessions, patents, licences, trade marks and similar rights	In purchased software
1	2	3	4	5	6	7	8	9	10	11	12
Agriculture, forestry and fishing	A	2012	19205800	19140303	47486	401219	4887292	11801123	65497	14752	19249
		2013	18919105	18577946	19782	351749	4000114	11762416	341159	10836	15310
		2014	18582362	18506895	88678	340695	4134991	11912084	75467	9415	24459
		2015	29798481	29619503	52355	987236	5763644	19880371	178978	4020	25564
		2016	50319592	50048198	96031	574349	7659092	38224491	271394	2555	36920
		2017	64084079	63475866	153154	402294	9893216	48934470	608213	11023	50951
		2018	66576317	65253458	193090	2165277	12473291	45460348	1322859	5398	58127
		2019	59910061	58486071	317769	1087637	12160411	37835055	1423990	41336	39225
		2020	50634301	49732853	272134	621609	10279367	32941860	901448	5938	44096
		2021	69966300	68259098	180552	1084033	12790957	47802589	1707202	9873	105664
		2022	51355693	50273867	60015	422377	9486603	34446342	1081826	1402	67057
		2023	65150627	63325702	112495	587446	12502988	42093228	1824925	25570	100936
		2024	81764595	79505994	2844456	866547	15105271	53863564	2258601	10292	417590
Industry	B+C+D+E	2012	106802464	105337825	366559	1566984	48073615	51987860	1464639	331913	478555
		2013	105292801	102916175	91050	878886	51011672	47201319	2376626	1462531	468074
		2014	85174872	83758743	305484	711898	42569908	37655228	1416129	418132	331304
		2015	87961431	86059313	181142	901410	43064830	39427558	1902118	780720	637274
		2016	114656763	112608533	283722	1470819	52096328	55676245	2048230	598901	696028
		2017	144184086	140141885	242536	1185393	58264752	76197219	4042201	795654	1955741

	Continuation of Appendix C										
	2	3	4	5	6	7	8	9	10	11	12
		2018	200908467	197622688	420109	3408933	87561089	101051070	3285779	859044	1220688
		2019	255397386	251214986	454510	2244535	120432571	119485269	4182400	1240218	1589917
		2020	181513913	178363669	306613	1361376	85530818	84582098	3150244	676648	1234194
		2021	243855992	236896900	697572	2294988	114672072	109485800	6959092	541541	3824835
		2022	126146989	122930947	356349	875737	51730199	65727227	3216042	379379	2045388
		2023	221130301	216468570	719274	1651250	102222582	105971570	4661731	352134	2258610
		2024	261502937	251422683	771241	1909055	108451876	133046752	10080254	1954468	3000194
Mining and quarrying	B	2012	31912891	31346662	3547	210824	12798034	18040062	566229	66741	42358
		2013	23659456	23205162	7382	22074	12923482	9864216	454294	83340	90899
		2014	19212245	18585355	3093	12254	11891899	6474876	626890	48485	37569
		2015	17907509	17215816	12036	6889	10389838	6548649	691693	351260	48469
		2016	22884625	22137889	14825	142782	11724765	9848675	746736	92785	155567
		2017	35551169	33141917	18374	522902	16597732	15435178	2409252	143773	1321706
		2018	53630041	52540225	150932	88507	27384582	23333121	1089816	117668	414818
		2019	69276384	67792805	53427	50417	33889662	32017439	1483579	360506	309721
		2020	51293903	50444813	38541	306136	29865142	18026262	849090	88293	115247
		2021	61669575	60124567	121185	278443	34283816	24890437	1545008	3067	326394
		2022	25149586	24850047	6604	3794	14930471	9564915	299539	819	143531
		2023	63759190	62876004	14697	29322	46168398	15975971	883186	2287	48836
		2024	63275978	60418601	24700	330747	42186035	17278948	2857377	12883	275159
Manufacturing	C	2012	46663235	46101681	348261	1271885	15300845	27701086	561554	245309	220207
		2013	45349907	43629390	78432	760625	12451410	28747904	1720517	1360813	235406
		2014	42364938	41737977	284340	670419	12855371	26839540	626961	345641	182511
		2015	47202690	46112849	162730	846352	13902168	29818762	1089841	418128	499901
		2016	59461377	58332457	252421	1266134	14583889	40565527	1128920	484565	425623
		2017	74844470	73357711	222435	620720	17772853	52326018	1486759	636383	533360
		2018	102004123	100074809	199800	3237272	26856291	67134439	1929314	703717	611733
		2019	105720792	103953893	372329	2095338	25194003	71404558	1766899	639867	653757
		2020	84554724	82674703	262193	988868	25428224	52904062	1880021	571816	754529
		2021	113300687	109120406	568617	1897932	32727961	66480901	4180281	474975	2479979
		2022	60744765	59204069	345422	741208	15250399	40272353	1540696	223243	813712

	Continuation of Appendix C										
	2	3	4	5	6	7	8	9	10	11	12
		2023	91198477	89182085	701858	1268142	18729852	64960401	2016392	297912	979893
		2024	122333808	117475513	723687	1483201	24800212	85626444	4858295	1838651	831961
Electricity, gas, steam and air conditioning supply	D	2012	26522844	26251015	12348	77659	19050872	5588293	271829	17907	208160
		2013	34304201	34122179	2890	56922	25071585	7303420	182022	13312	132542
		2014	22783857	22640109	17112	17979	17508328	3909518	143748	21355	99291
		2015	21317632	21207599	2601	28540	17919945	2470214	110033	8678	84141
		2016	30095360	29938603	16091	39749	24594741	4407743	156757	18730	106479
		2017	30943131	30817270	362	26697	22590981	7089508	125861	12869	93346
		2018	42006858	41760966	68561	69151	31807221	9033094	245892	34702	185664
		2019	76499909	75613068	16393	88364	59543213	14510478	886841	233704	611744
		2020	42099566	41717447	4661	40724	28267040	12294848	382119	14025	341472
		2021	63369733	62197435	7751	29024	45175889	15478738	1172298	61163	996210
		2022	35796186	34449100	267	72103	19571406	13622771	1347086	155046	1076536
		2023	55266332	53672341	1413	120974	31441603	20819439	1593991	41310	1209880
		2024	68106605	65806282	20841	26030	37956440	26398478	2300323	99436	1862520
Water supply; sewerage, waste management and remediation activities	E	2012	1703494	1638467	2403	6616	923864	658419	65027	1956	7830
		2013	1979237	1959444	2346	39265	565195	1285779	19793	5066	9227
		2014	813832	795302	939	11246	314310	431294	18530	2651	11933
		2015	1533600	1523049	3775	19629	852879	589933	10551	2654	4763
		2016	2215401	2199584	385	22154	1192933	854300	15817	2821	8359
		2017	2845316	2824987	1365	15074	1303186	1346515	20329	2629	7329
		2018	3267445	3246688	816	14003	1512995	1550416	20757	2957	8473
		2019	3900301	3855220	12361	10416	1805693	1552794	45081	6141	14695
		2020	3565720	3526706	1218	25648	1970412	1356926	39014	2514	22946
		2021	5515997	5454492	19	89589	2484406	2635724	61505	2336	22252
		2022	4456452	4427731	4056	58632	1977923	2267188	28721	271	11609
		2023	10906302	10738140	1306	232812	5882729	4215759	168162	10625	20001
		2024	7786546	7722287	2013	69077	3509189	3742882	64259	3498	30554
Construction	F	2012	10255988	10204184	268164	149406	7666370	1998538	51804	8114	10048
		2013	14450761	14418479	160702	169000	11840196	1966145	32282	5441	8089
		2014	12901144	12806696	71690	171580	10774775	1659697	94448	63775	6873

	Continuation of Appendix C										
	2	3	4	5	6	7	8	9	10	11	12
		2015	13462117	13405057	20154	87400	11515314	1636526	57060	4590	16722
		2016	14709962	14671194	105332	200290	10934264	3195580	38768	4975	12393
		2017	16381756	16281969	135344	240753	10545375	5036258	99787	56745	21886
		2018	18286948	18191621	58819	198573	11835334	5639537	95327	4175	39427
		2019	21466060	21356481	29338	183325	13218807	5632703	109579	23148	28715
		2020	13855700	13780800	139202	201434	6674783	6230644	74900	6311	16181
		2021	19976804	19900363	278856	126430	9913243	8781640	76441	2463	58326
		2022	12030721	11791786	26945	176029	7212124	3686486	238935	10611	155080
		2023	14977297	14154186	10044	102711	5826890	7706746	823111	12643	148375
		2024	12048106	11967616	34999	166168	5889708	5511314	80490	10554	29388
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	2012	20157632	19448570	388338	1360115	7857509	8886226	709062	359470	293525
		2013	21211733	19963532	137930	823953	7867514	10016487	1248201	644527	536129
		2014	20172706	18946601	174373	503703	8962786	8294081	1226105	563633	540154
		2015	19704345	18553238	288710	629309	6454654	10071070	1151107	212273	849244
		2016	27722810	26265402	295007	1427242	6803698	15619157	1457408	607059	684070
		2017	32546006	31327360	428327	1015209	6616857	20623993	1218646	311567	635917
		2018	48367806	39085495	252373	817184	9778323	24947049	9282311	8107306	820988
		2019	54669652	52286451	615562	1805295	11488594	23986256	2383201	929347	858556
		2020	40384538	37570396	1011412	1174899	11415805	19430985	2814142	770823	939561
		2021	58396171	54436077	1024255	1168985	16875631	28687617	3960094	224480	957249
		2022	36362911	33693113	252043	351955	10543155	18366443	2669798	438128	1417591
		2023	54819640	51490160	467775	430263	14416321	29404781	3329480	148687	1855829
		2024	69323095	65192249	642624	650292	17334926	39580124	4130846	187217	3117395
Transportation and storage	H	2012	30027739	29688247	47840	112822	13072946	15898683	339492	23517	277460
		2013	18940137	18596218	41649	135390	8808000	9061115	343919	18624	169659
		2014	14921599	14684535	32948	144971	7304113	6884827	237064	13531	95095
		2015	18493229	18298880	116087	623260	7147355	9771702	194349	11838	108916
		2016	25339900	25127560	84016	264578	10097788	13836820	212340	20002	126657
		2017	38862266	38317081	74720	214292	11793117	24750857	545185	23925	400692
		2018	51457303	50788998	37849	217793	15674549	33480656	668305	208370	398626
		2019	44850046	43590966	194530	818593	14082140	25783522	1259080	89387	380061

Continuation of Appendix C

2	3	4	5	6	7	8	9	10	11	12
	2020	34814835	34423376	42159	444057	10822146	21430611	391459	49927	234384
	2021	43462480	42883431	55982	264899	14280436	26633851	579049	10674	467398
	2022	49674886	48929096	19082	171106	9647257	22794734	745790	108125	535297
	2023	53313568	52657281	44280	93943	16167235	32776080	656287	18559	448247
	2024	60102713	59431873	48251	130542	20052692	34052653	670840	14512	441220
J	2012	9839468	6474314	1794	45253	1673824	4448549	3365154	2128703	754099
	2013	9820162	7178713	271	113605	1363243	5439262	2641449	1630003	594973
	2014	8120920	5630200	111	9639	852822	4518062	2490720	1580072	660908
	2015	22900497	10213933	244	68577	772025	9087892	12686564	10708498	1450937
	2016	15707002	10935907	908	650530	1229843	8659909	4771095	2220077	1962593
	2017	18696616	11985774	11032	134347	1912596	9469434	6710842	3693874	2054599
	2018	29684191	12878833	4172	48864	1370198	10808814	16805358	13049109	2258009
	2019	21259832	13101105	311	23404	1751729	10192820	8158727	3630295	2223118
	2020	22343060	13185403	36	46826	1751905	10411048	9157657	837518	2806240
	2021	23754284	14069191	439	17452	1891965	11091874	9685093	4522639	2923731
	2022	16834706	11382037	17	2714	1275274	9455327	5452669	1743152	2319501
	2023	23764314	14836129	–**	4517	1434228	12857527	8928185	2452271	4172127
	2024	33686465	19720255	2	3065	1957920	17083780	13966210	4891256	5898981
I	2012	3245755	3232196	57979	43597	2246843	691835	13559	1656	8981
	2013	2399530	2382628	44855	45859	1602848	542760	16902	4013	10214
	2014	1409244	1397710	7398	9755	979090	329905	11534	912	9489
	2015	1076074	1053512	43232	81460	468560	406697	22562	11110	10439
	2016	1503890	1463574	5667	25491	855298	470256	40316	1594	25498
	2017	2063126	2036876	34001	75952	1076373	699684	26250	5882	8824
	2018	2501747	2464270	20123	10937	1400228	823217	37477	11066	21842
	2019	2413664	2034962	21612	34823	744383	870801	378702	4782	13247
	2020	1960740	1723146	8839	4400	810036	667833	237594	3572	14904
	2021	2701549	2686953	33096	7228	1210521	1091989	14596	1580	12342
	2022	2141817	2124624	50668	11312	654202	1295670	17193	382	15662
	2023	3343487	3299416	6632	8245	1831425	1197963	44071	6241	29969
	2024	3004364	2958474	38126	60702	1095095	1471085	45890	7422	29225

Continuation of Appendix C

1	2	3	4	5	6	7	8	9	10	11	12
Financial and insurance activities	K	2012	7212328	5901506	71882	1031572	1128064	3361396	1310822	81661	684372
		2013	6447250	5132030	35303	650602	921716	3127069	1315220	118947	678395
		2014	6199723	4934995	24270	248344	761024	3522615	1264728	109901	493349
		2015	6372430	5140537	202524	588946	824204	3263246	1231893	133190	501000
		2016	7666278	5779907	247786	574270	663540	3822030	1886371	250991	930158
		2017	8020105	6028147	29393	410630	402246	4726895	1991958	314303	1016294
		2018	10703123	8070981	125244	412441	479916	6579128	2632142	141331	1575801
		2019	10704441	7687480	57834	288106	1015388	5598442	3016961	225801	1676785
		2020	11593786	7279932	76858	464903	1261497	4625505	4313854	159080	2164256
		2021	10103330	5993585	–	99214	1106324	3830510	4109745	130325	1753292
		2022	8824360	4180081	64834	76801	324285	3192691	4644279	181068	2424261
		2023	17313939	11187671	60527	365828	510321	8468069	6126268	402350	2293567
		2024	18787662	11051060	7229	238016	776402	8491700	7736602	290857	2412791
Real estate activities	L	2012	13783667	13720972	289043	608510	10539075	2037123	62695	34360	13553
		2013	14329737	14263545	428762	1357352	10162794	2118134	66192	32097	21365
		2014	10914514	10879585	211398	574597	7927720	2049078	34929	7479	17323
		2015	10437893	10391005	393241	1239520	7008228	1579532	46888	23245	16801
		2016	17872466	17607879	410850	3138179	11161846	2555564	264587	184629	35864
		2017	21795918	21569791	725160	2308623	14443577	3731652	226127	132657	51656
		2018	26074209	25933868	503259	2921387	16689742	5237106	140341	56613	49956
		2019	29732533	29619339	468404	3715323	17559317	5756953	113194	24832	62756
		2020	18158835	17996473	226616	654386	12565758	3404473	162362	12832	117771
		2021	22546524	22070221	367671	768575	15906269	3995952	476303	58670	263868
		2022	12279887	11936309	102733	172306	8214239	3078897	343578	29384	183013
		2023	19521499	19085325	2624	503423	12538563	5380414	436174	22389	183643
		2024	24567564	24245256	71675	437404	17432103	5456361	322308	11721	197856
Professional, scientific and technical activities	M	2012	5840394	5621547	112729	206753	3083523	2116342	218847	92155	88427
		2013	3092693	2848564	36531	129974	1729206	799478	244129	49658	118392
		2014	2326673	2198466	7810	78231	1457168	580763	128207	14361	55681
		2015	3399644	3258001	3966	128471	2017369	1033658	141643	30180	81072
		2016	4945210	4647700	59702	77182	3025164	1317190	297510	93917	133785

Continuation of Appendix C

2	3	4	5	6	7	8	9	10	11	12
	2017	6643260	6327551	13823	70623	3641007	2397659	315709	72572	120131
	2018	8442888	8044964	9014	166851	4630205	2853239	397924	88087	268973
	2019	9506577	9061848	63774	265961	5586022	2401103	444729	40729	340916
	2020	9252801	8062572	107080	8345	5791026	1898010	1190229	661288	361907
	2021	14097989	13220586	2	8053	10004472	2780997	877403	336668	418124
	2022	3964158	3529349	655	8954	1585998	1630595	434809	114225	272686
	2023	11704833	10580324	9090	341303	7417747	2422865	1124509	622050	400908
	2024	14142863	12935954	394	359721	9015276	2995220	1206909	332423	618803
N	2012	5051645	4948414	24053	452692	1553462	2780667	103231	67552	28672
	2013	3771687	3716213	14899	417797	1020295	2068126	55474	14658	30871
	2014	2163092	2060559	5946	47484	541338	1320623	102533	15460	67413
	2015	3531795	3418174	6408	47792	982381	2072730	113621	22550	51493
	2016	5488830	5233690	152586	55060	787528	3907846	255140	40508	120282
	2017	9162594	8956739	35647	367791	1134255	6772430	205855	51853	99981
	2018	10489766	10255750	3230	284631	2376012	7206386	234016	31932	118835
	2019	13021428	12719145	14761	49768	3233864	7870801	302283	52886	185893
	2020	8622059	8331351	10958	91302	2371939	5419794	290708	2849	223406
	2021	12102683	11603600	5133	128409	2368513	8359532	499083	73294	328245
	2022	6266622	5903487	319	32799	1451233	4098077	363135	79850	257732
	2023	8702059	8438135	85	7027	1216461	6567776	263924	172740	59620
	2024	10543635	10172389	10608	57652	1454988	7993388	371246	37744	90278
P	2012	192749	190182	104	6318	100623	72304	2567	1698	839
	2013	121818	120844	937	4826	59535	48081	974	188	584
	2014	121774	118535	121	1967	56787	52831	3239	275	2083
	2015	110576	107934	586	157	49611	50077	2642	1098	1535
	2016	188925	184457	–	5656	88568	68308	4468	1154	3181
	2017	436868	430572	533	10432	223646	165298	6296	864	5388
	2018	497184	491850	29	75773	211237	134564	5334	1042	3769
	2019	362635	346796	97	50432	58967	100591	15839	461	15231
	2020	312568	310155	22470	165660	17184	64568	2413	199	1547
	2021	381426	376925	197	6768	171131	139777	4501	219	4045

Administrative and support service activities

Education

											Continuation of Appendix C
	2	3	4	5	6	7	8	9	10	11	12
		2022	178118	171762	1500	3874	59546	96089	6356	102	5265
		2023	144245	132321	3541	155	21651	89657	11924	247	4951
		2024	502890	424287	21773	9687	180398	177768	78603	38242	20043
Human health and social work activities	Q	2012	995986	990521	2397	30761	446769	415942	5465	566	3931
		2013	985386	979765	4439	8759	467491	402100	5621	891	3726
		2014	510058	501546	2071	12171	169640	276334	8512	664	4863
		2015	637426	619650	1289	2685	149226	417738	17776	793	14183
		2016	1198281	1178883	22	27382	334042	674491	19398	1053	16147
		2017	1715981	1696631	11509	74260	393608	1027643	19350	3261	13973
		2018	3277256	3231600	3916	28266	918565	2032849	45656	6055	26547
		2019	6581194	6532344	47024	67977	2008276	3652201	48850	5832	34095
		2020	13623015	12900143	16563	44148	2241925	9886998	722872	650930	53056
		2021	19988444	19859161	26547	186815	3840553	13944472	129283	1762	75327
		2022	16045625	15917160	50002	60906	2378595	12334785	128465	56206	36168
		2023	22546634	22100265	34837	191467	4573133	15695770	446369	175963	85649
		2024	22635092	22253235	40470	64233	4822435	15735696	381857	7659	139401
Arts, entertainment and recreation	R	2012	2758235	2177136	63327	165211	1520924	392692	581099	485480	31446
		2013	2811689	1040110	76222	106616	691010	145447	1771579	1653209	31433
		2014	385520	238762	−	1899	157816	68404	146758	142019	4093
		2015	804390	341798	842	16453	220585	85690	462592	405616	327
		2016	645892	543189	2072	4282	356656	148599	102703	101880	668
		2017	1106544	949074	−	240	707963	199186	157470	150447	6020
		2018	2809362	1629451	14396	5890	1163693	336273	1179911	1169613	4995
		2019	3383320	2434693	27811	18612	2030106	260103	948627	939465	6062
		2020	1771054	635069	7559	8117	407658	156010	1135985	30414	3372
		2021	3252416	1670738	116	4888	1081518	487630	1581678	1356	4537
		2022	2053638	977415	1	1561	678397	233362	1076223	126368	6606
		2023	3405416	1460806	−	1956	919278	480019	1944610	144027	492336
		2024	3909758	1439448	9	1265	591682	697122	2470310	1038347	190113
Other service activities	S	2012	314939	313862	298	815	257464	42472	1077	18	898
		2013	76543	73315	1085	6410	16135	42924	3228	498	316

Continuation of Appendix C

2	3	4	5	6	7	8	9	10	11	12
	2014	50296	48809	312	1284	12587	32770	1487	19	1344
	2015	111430	109913	2676	2210	29440	72604	1517	254	889
	2016	176796	170518	43	1184	40068	90255	6278	5079	773
	2017	417098	413045	202	1958	71490	219433	4053	70	1074
	2018	237575	233372	198	7911	42855	123432	4203	347	3337
	2019	470145	467402	175	1748	287603	100983	2743	18	716
	2020	224174	201183	1707	–	89238	58624	22991	2	22875
	2021	633262	622784	10367	–	188382	364093	10478	21	10319
	2022	143108	131897	3838	77	37263	61631	11211	13	9475
	2023	349787	330598	10	73	129372	138698	19189	435	17670
	2024	469022	391714	–	47	173452	117076	77308	394	18632

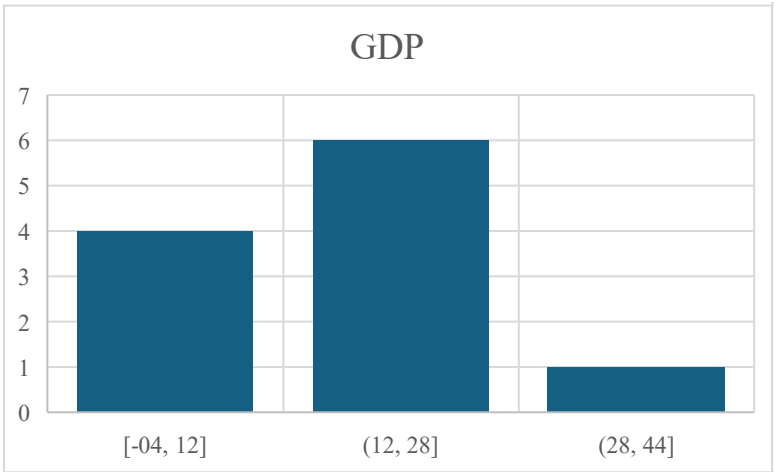
Source: [27]

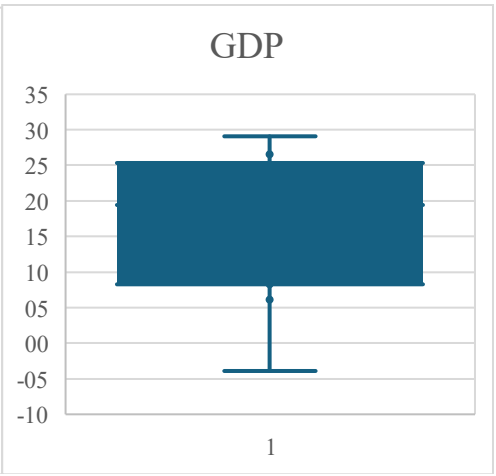
* Data exclude on and budget organizations, for 2014–2021 the temporarily occupied territories of the Autonomous Republic of Crimea, the city of Sevastopol and a part of temporarily occupied territories in the Donetsk and Luhansk regions data for 2022–2024 exclude the territories which are temporarily occupied by the russian federation and part of territories where the military actions are/were conducted.

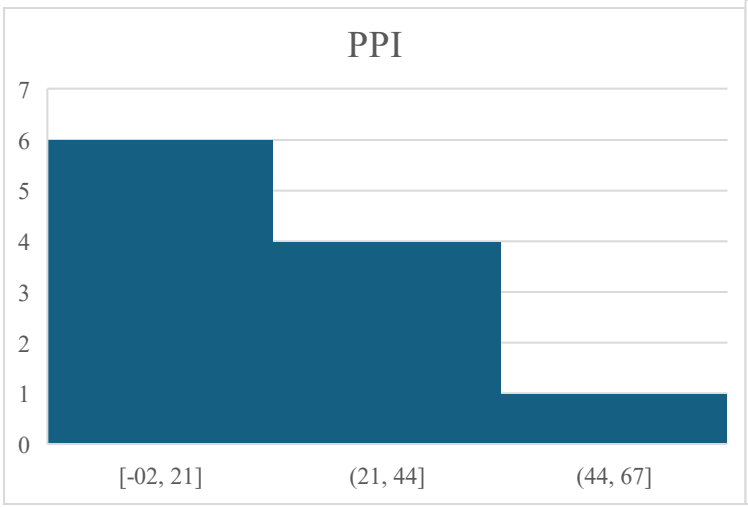
** "-" - not observed

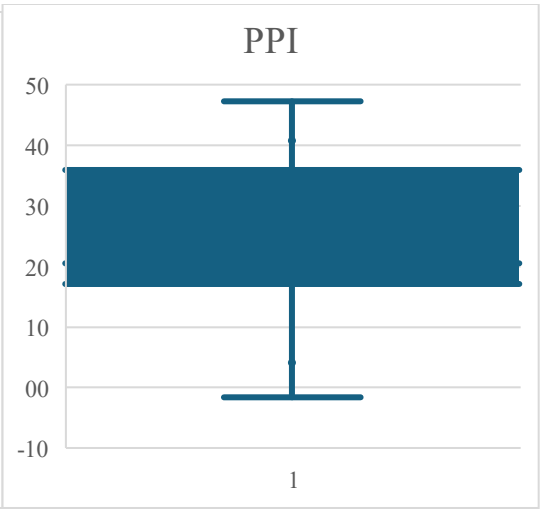
Appendix D

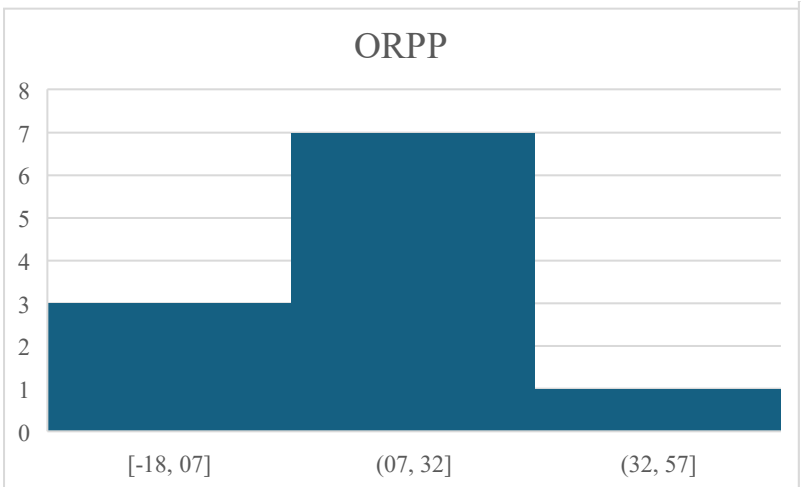
Box plots and histograms of the distribution of macroeconomic indicators

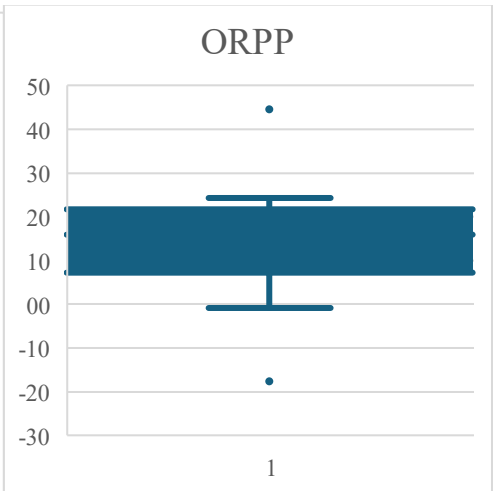


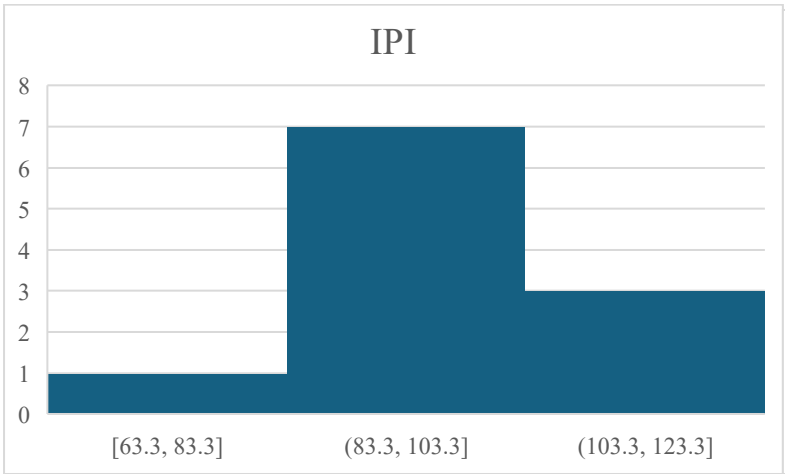


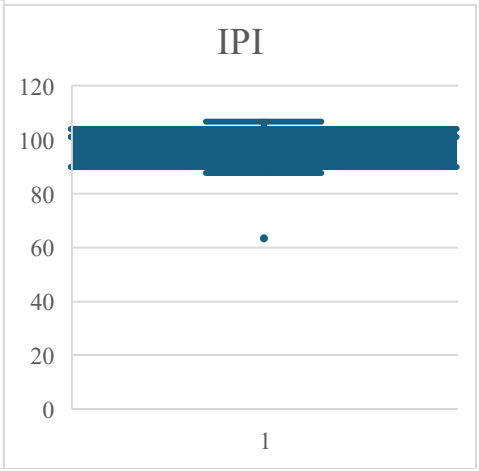


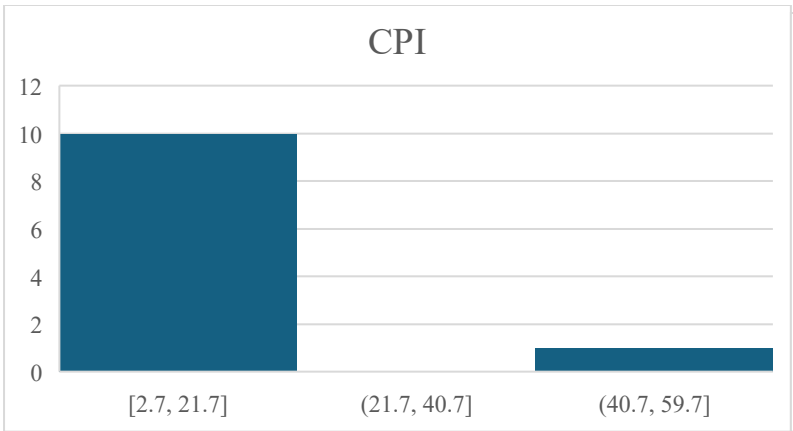


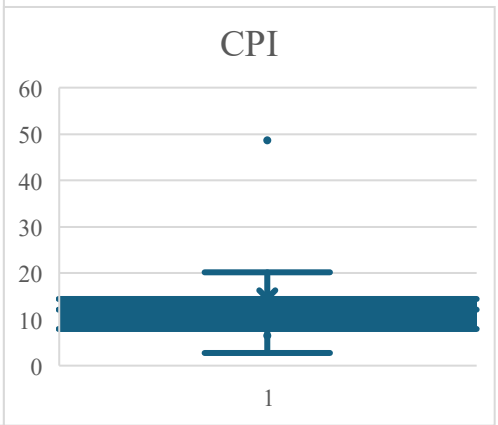


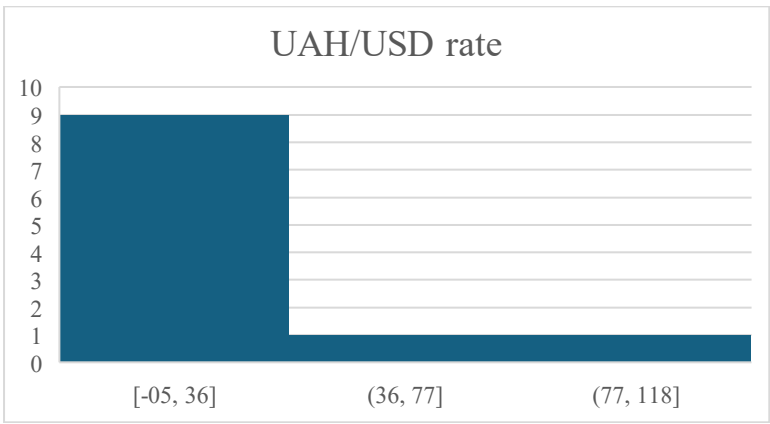


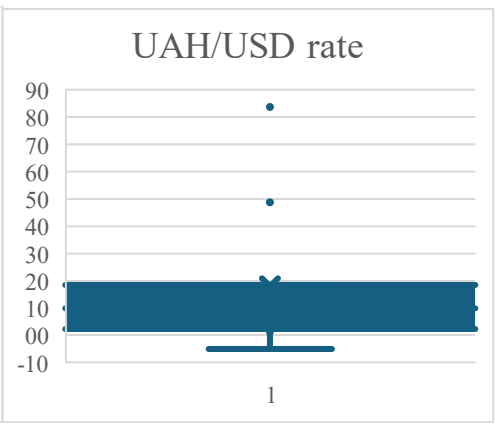


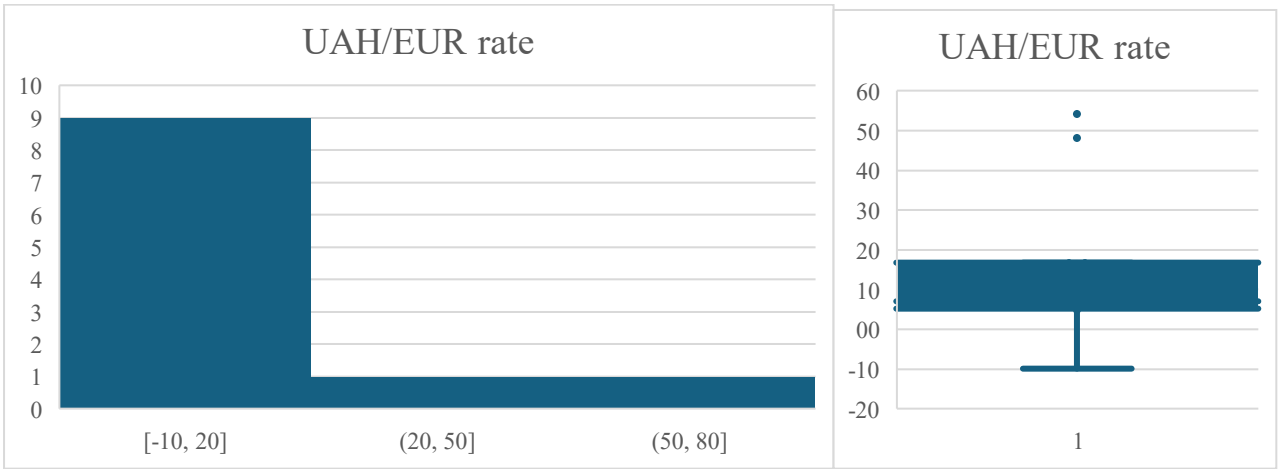


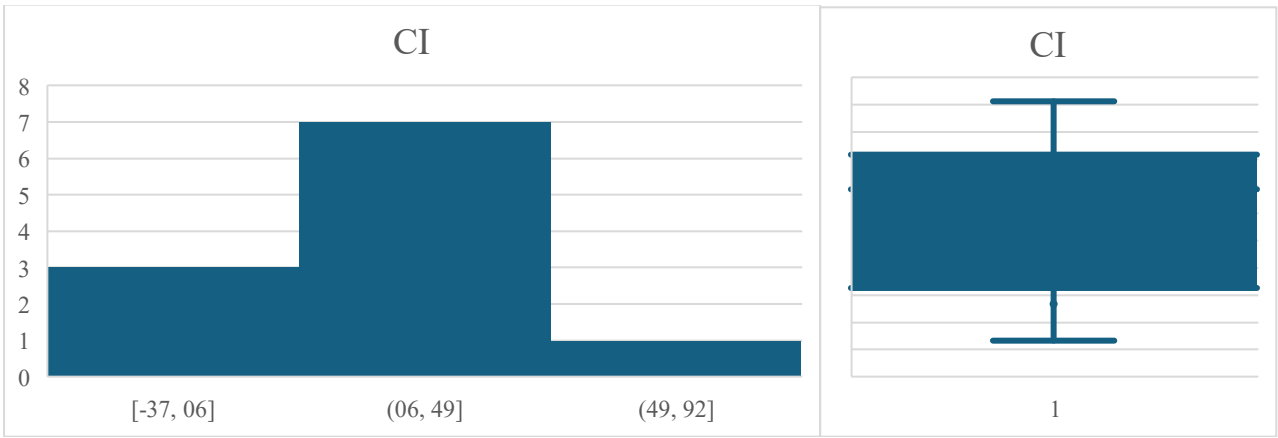


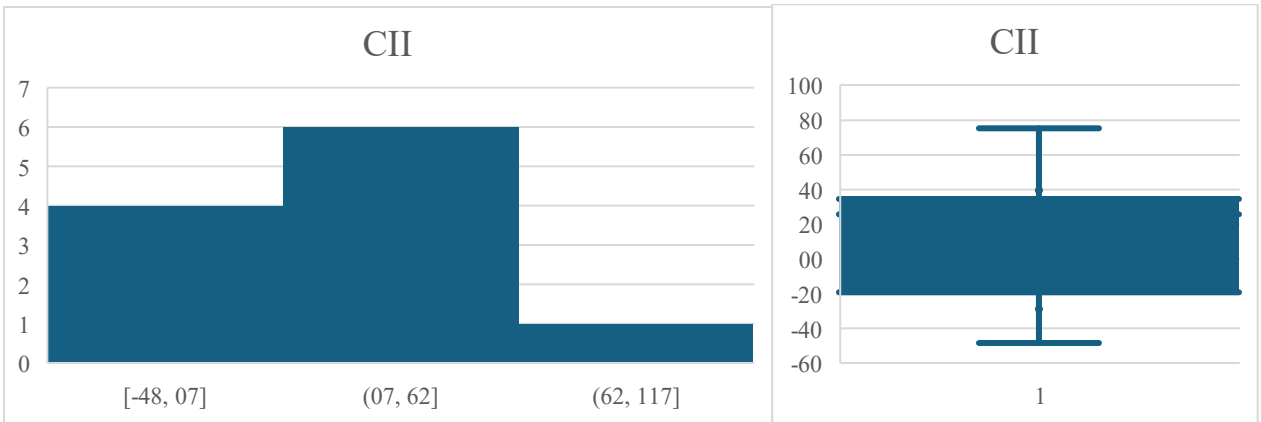












Source: compiled by the author

Appendix E

The increase in calculated coefficients based on the results of the activities of selected manufacturing enterprises

		Arcelor Mittal	Metinvest	Interpipe	KVBZ	AZOT
Current liquidity ratio	2020/2019	0,31	0,13	0,90	5,70	0,04
	2021/2020	0,41	-0,33	0,33	-6,90	-0,09
	2022/2021	-0,48	-0,23	-0,31	0,94	-0,02
	2023/2022	-0,74	0,04	0,33	-1,34	0,03
Quick liquidity ratio	2020/2019	0,26	0,21	0,47	3,95	0,04
	2021/2020	0,16	-0,39	0,30	-4,24	-0,09
	2022/2021	-0,57	-0,16	-0,18	0,76	-0,02
	2023/2022	-0,41	0,11	0,28	-0,65	0,02
Absolute liquidity ratio	2020/2019	0,01	0,15	-0,04	3,85	-0,00031
	2021/2020	0,01	0,01	0,13	-3,69	-0,00001
	2022/2021	-0,01	-0,15	0,01	-0,45	0,00001
	2023/2022	-0,03	0,06	0,43	0,95	0,00002
Financial leverage ratio	2020/2019	-0,16	0,07	-1,04	-0,21	-0,02
	2021/2020	-0,07	-0,07	0,91	0,34	0,46
	2022/2021	0,49	1,06	1,20	-0,14	0,18
	2023/2022	1,09	0,42	-1,80	0,28	-0,06
Financial dependency ratio	2020/2019	-0,07	0,02	-0,21	-0,13	-0,01
	2021/2020	-0,03	-0,02	0,19	0,19	0,25
	2022/2021	0,19	0,17	0,11	-0,07	0,16
	2023/2022	0,20	0,04	-0,22	0,12	-0,06
Financial independence (autonomy) coefficient	2020/2019	0,07	-0,02	0,21	0,13	0,01
	2021/2020	0,03	0,02	-0,19	-0,19	-0,25
	2022/2021	-0,19	-0,17	-0,11	0,07	-0,16
	2023/2022	-0,20	-0,04	0,22	-0,12	0,06
Financial risk ratio	2020/2019	-0,16	0,07	-1,04	-0,21	-0,02
	2021/2020	-0,07	-0,07	0,91	0,34	0,46
	2022/2021	0,49	1,06	1,20	-0,14	0,18
	2023/2022	1,09	0,42	-1,80	0,28	-0,06
Operating margin	2020/2019	7,7%	5,1%	17,2%	-9,9%	-112,6%
	2021/2020	25,1%	19,3%	-11,7%	-11,7%	69,5%
	2022/2021	-143,1%	-44,6%	15,3%	11,0%	-243,6%
	2023/2022	90,1%	23,2%	8,0%	-12,0%	210,0%
Capital investment to revenue ratio	2020/2019	-0,02	-0,02	-0,002	0,01	-0,005
	2021/2020	-0,01	-0,01	0,004	-0,002	
	2022/2021	-0,02	-0,01	-0,03	-0,01	
	2023/2022	0,04	-0,005	0,01	0,00002	
Net profit margin	2020/2019	4,8%	1,9%	-51,3%	-8,2%	-132,2%
	2021/2020	21,9%	21,4%	-14,5%	-11,0%	84,6%
	2022/2021	-135,0%	-52,9%	12,8%	10,1%	-248,4%
	2023/2022	83,6%	23,8%	4,7%	-8,1%	314,2%
Return on assets	2020/2019	3,1%	1,1%	-56,1%	-18,6%	-27,7%
	2021/2020	25,2%	28,5%	-9,1%	-6,7%	14,0%
	2022/2021	-88,0%	-50,1%	12,0%	6,0%	-33,5%
	2023/2022	38,3%	15,5%	5,8%	-3,8%	46,6%

Source: calculated by the author

Appendix F

Results of calculations of manufacturing enterprises using discriminant models

ArcelorMittal					
	2019	2020	2021	2022	2023
Altman Z-score model					
X_1	0,104	0,138	0,225	0,215	-0,063
X_2	0,302	0,341	0,433	-0,063	-0,323
X_3	-0,028	0,023	0,294	-0,955	-0,219
X_4	1,647	2,223	2,632	1,154	0,512
X_5	0,641	0,720	1,035	0,832	0,891
Z = 0,717X1+0,847X2+3,107X3+ 0,42X4+0,998X5	1,574	2,113	3,579	-1,551	0,104
Springate model					
X1	0,104	0,138	0,225	0,215	-0,063
X2	-0,028	0,023	0,294	-0,955	-0,219
X3	-0,101	0,048	1,416	-2,800	-0,478
X4	0,641	0,720	1,035	0,832	0,891
Z = 1,03X1 + 3,07X2 + 0,66X3 + 0,4X4	0,210	0,534	2,483	-4,225	-0,697
Tereshchenko's model					
X1	0,138	0,310	1,111	-1,755	-0,264
X2	2,647	3,223	3,632	2,154	1,512
X3	-0,023	0,008	0,260	-0,620	-0,237
X4	-0,036	0,012	0,231	-1,119	-0,282
X5	0,162	0,119	0,134	0,323	0,263
X6	0,641	0,720	1,035	0,832	0,890
Z = 1,5X1 +0,08X2 + 10X3 + 5X4 + 0,3X5 + 0,1X6	0,117	0,969	5,856	-14,075	-3,888
Taffler and Tishaw model					
X1	-0,103	0,117	1,433	-2,738	-0,418
X2	0,999	1,094	1,562	1,214	0,697
X3	0,273	0,201	0,205	0,349	0,524
X4	0,641	0,720	1,035	0,832	0,891
Z = 0,53X1+ 0,13X2 + 0,18X3 + 0,16X4	0,227	0,355	1,165	-1,098	0,106
Beaver coefficient					
Beaver coefficient	0,14	0,31	1,11	-1,75	-0,27

Continuation of Appendix F

Metinvest					
	2019	2020	2021	2022	2023
Altman Z-score model					
X_1	0,081	0,121	0,037	-0,045	-0,030
X_2	0,608	0,683	0,673	1,115	1,064
X_3	0,023	0,063	0,309	-0,162	0,049
X_4	1,003	0,934	0,995	0,485	0,403
X_5	0,777	0,777	1,127	0,943	0,810
Z = 0,717X1+0,847X2+3,107X3+ 0,42X4+0,998X5	1,843	2,028	3,098	1,553	2,008
Springate model					
X1	0,081	0,121	0,037	-0,045	-0,030
X2	0,023	0,063	0,309	-0,162	0,049
X3	0,114	0,176	1,177	-0,571	-0,008
X4	0,777	0,777	1,127	0,943	0,810
Z = 1,03X1 + 3,07X2 + 0,66X3 + 0,4X4	0,541	0,745	2,213	-0,544	0,437
Tereshchenko's model					
X1	0,151	0,193	0,716	-0,266	0,032
X2	2,003	1,934	1,995	1,485	1,403
X3	0,027	0,039	0,324	-0,177	-0,022
X4	0,032	0,050	0,265	-0,265	-0,026
X5	0,110	0,090	0,086	0,110	0,107
X6	0,777	0,777	1,127	0,943	0,810
Z = 1,5X1 +0,08X2 + 10X3 + 5X4 + 0,3X5 + 0,1X6	0,929	1,187	5,934	-3,247	-0,074
Taffler and Tishaw model					
X1	0,096	0,238	1,025	-0,397	0,106
X2	0,654	0,744	0,674	0,541	0,600
X3	0,246	0,264	0,301	0,409	0,458
X4	0,777	0,777	1,127	0,943	0,810
Z = 0,53X1+ 0,13X2 + 0,18X3 + 0,16X4	0,304	0,395	0,865	0,084	0,346
Beaver coefficient					
Beaver coefficient	0,15	0,19	0,72	-0,27	0,03

Continuation of Appendix F

Interpipe					
	2019	2020	2021	2022	2023
Altman Z-score model					
X_1	0,156	0,254	0,335	0,380	0,339
X_2	0,814	1,339	0,962	1,642	1,421
X_3	0,065	0,229	0,125	0,347	0,324
X_4	0,549	1,277	0,592	0,346	0,920
X_5	0,885	0,932	0,968	1,227	0,893
Z = 0,717X1+0,847X2+3,107X3+ 0,42X4+0,998X5	2,119	3,496	2,658	4,111	3,730
Springate model					
X1	0,156	0,254	0,335	0,380	0,339
X2	0,065	0,229	0,125	0,347	0,324
X3	1,924	1,317	0,479	1,002	1,330
X4	0,885	0,932	0,968	1,227	0,893
Z = 1,03X1 + 3,07X2 + 0,66X3 + 0,4X4	1,986	2,208	1,433	2,608	2,578
Tereshchenko's model					
X1	1,092	0,614	0,203	0,405	0,478
X2	1,549	2,277	1,592	1,346	1,920
X3	0,738	0,178	0,087	0,207	0,265
X4	0,738	0,226	0,081	0,208	0,256
X5	0,174	0,178	0,189	0,177	0,187
X6	0,885	0,932	0,968	1,227	0,893
Z = 1,5X1 +0,08X2 + 10X3 + 5X4 + 0,3X5 + 0,1X6	12,977	4,155	1,858	4,007	4,947
Taffler and Tishaw model					
X1	0,196	1,233	0,634	1,260	1,635
X2	0,759	1,003	0,849	0,883	1,032
X3	0,334	0,186	0,198	0,275	0,198
X4	0,885	0,932	0,968	1,227	0,893
Z = 0,53X1+ 0,13X2 + 0,18X3 + 0,16X4	0,404	0,966	0,637	1,028	1,179
Beaver coefficient					
Beaver coefficient	1,09	0,61	0,20	0,40	0,48

Continuation of Appendix F

KVBZ					
	2019	2020	2021	2022	2023
Altman Z-score model					
X_1	0,634	0,736	0,559	0,638	0,535
X_2	0,181	0,032	-0,027	-0,016	-0,031
X_3	0,228	0,023	-0,046	0,016	-0,039
X_4	2,601	5,586	1,924	2,643	1,512
X_5	1,801	0,834	0,519	0,782	0,393
Z = 0,717X1+0,847X2+3,107X3+ 0,42X4+0,998X5	4,207	3,806	1,561	2,385	1,264
Springate model					
X1	0,634	0,736	0,559	0,638	0,535
X2	0,228	0,023	-0,046	0,016	-0,039
X3	1,127	0,255	-0,160	0,074	-0,070
X4	1,801	0,834	0,519	0,782	0,393
Z = 1,03X1 + 3,07X2 + 0,66X3 + 0,4X4	2,818	1,331	0,536	1,070	0,543
Tereshchenko's model					
X1	0,742	0,267	-0,086	0,099	-0,034
X2	3,601	6,586	2,924	3,643	2,512
X3	0,202	0,016	-0,051	0,009	-0,029
X4	0,102	0,021	-0,090	0,012	-0,069
X5	0,240	0,387	0,682	0,397	0,631
X6	1,801	0,834	0,519	0,782	0,393
Z = 1,5X1 +0,08X2 + 10X3 + 5X4 + 0,3X5 + 0,1X6	4,185	1,391	-0,600	0,782	-0,259
Taffler and Tishaw model					
X1	1,108	0,277	-0,155	0,072	-0,107
X2	3,025	5,399	2,504	3,150	2,251
X3	0,206	0,084	0,298	0,227	0,362
X4	1,801	0,834	0,519	0,782	0,393
Z = 0,53X1+ 0,13X2 + 0,18X3 + 0,16X4	1,306	0,997	0,380	0,614	0,364
Beaver coefficient					
Beaver coefficient	0,74	0,27	-0,09	0,10	-0,03

Continuation of Appendix F

AZOT					
	2019	2020	2021	2022	2023
Altman Z-score model					
X_1	-0,765	-0,688	-0,967	-1,088	-0,965
X_2	-0,754	-0,721	-0,980	-1,124	-1,070
X_3	0,107	-0,099	0,004	-0,299	-0,063
X_4	-0,387	-0,384	-0,466	-0,509	-0,493
X_5	0,235	0,148	0,172	0,124	0,204
Z = 0,717X1+0,847X2+3,107X3+ 0,42X4+0,998X5	-0,782	-1,426	-1,534	-2,752	-1,798
Springate Model					
X1	-0,765	-0,688	-0,967	-1,088	-0,965
X2	0,107	-0,099	0,004	-0,299	-0,063
X3	0,074	-0,078	0,002	-0,155	0,076
X4	0,235	0,148	0,172	0,124	0,204
Z = 1,03X1 + 3,07X2 + 0,66X3 + 0,4X4	-0,315	-1,006	-0,913	-2,093	-1,056
Модель Терещенка					
X1	0,076	-0,072	0,005	-0,148	0,073
X2	0,613	0,616	0,534	0,491	0,507
X3	0,141	-0,136	0,003	-0,332	0,134
X4	0,497	-0,825	0,021	-2,463	0,679
X5	0,149	0,172	0,191	0,209	0,189
X6	0,235	0,148	0,172	0,124	0,204
Z = 1,5X1 +0,08X2 + 10X3 + 5X4 + 0,3X5 + 0,1X6	4,122	-5,482	0,263	-15,742	4,959
Taffler and Tishaw model					
X1	0,067	-0,064	0,002	-0,152	-0,035
X2	0,515	0,537	0,455	0,433	0,438
X3	1,605	1,560	1,820	1,970	1,830
X4	0,235	0,148	0,172	0,124	0,204
Z = 0,53X1+ 0,13X2 + 0,18X3 + 0,16X4	0,429	0,341	0,416	0,350	0,401
Beaver coefficient					
Beaver coefficient	0,08	-0,07	0,01	-0,15	0,07

Source: calculated by the author

Appendix G

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ
БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ
ЕКОНОМІЧНИЙ ФАКУЛЬТЕТ

03041, м. Київ, вул. Героїв Оборони, 11, навчальний корпус № 10, *тел./факс: (044) 527-85-40*, тел.: (044) 527-85-43
E-mail: economy_dean@nubip.edu.ua

Вих. від 10.03.26 № 145

ДОВІДКА

Видана Ван Ї про участь в науковій темі «Трансформація публічних фінансів в умовах сучасних викликів» (номер державної реєстрації 0124U002538) Національного університету біоресурсів і природокористування України, Міністерства освіти і науки України.

Матеріали досліджень Ван Ї використано при підготовці рекомендацій із оцінки макроекономічного ризику підприємств та розробці на основі цього інструментарію заходів із управління ризиками виробничих підприємств, зокрема фінансовими ризиками, що сприятиме підвищенню фінансової стійкості підприємств та удосконаленню системи управління ризиками суб'єктів господарювання.

Довідка видана для подання за місцем вимоги.

Заступник декана економічного факультету
з наукової роботи, к.е.н., доцент **Тетяна КУЦЬ**

Керівник теми, д.е.н., професор **Юлія НЕГОДА**

Appendix H

Україна
Приватне підприємство «ПОЛІМЕТ» ПП «ПОЛІМЕТ»
код ЄДРПОУ 24456420 інн 244564205141
49051, Дніпропетровська область, м.Дніпро, вул.Журналістів, буд.9а
e-mail: polimet@ex.ua

№ 2026/3 від 12 січня 2026 р.

ДОВІДКА
про впровадження результатів дисертаційного дослідження

Даною довідкою підтверджується, що результати дисертації Ван Ї на тему: «Формування системи ризик-менеджменту виробничих підприємств», що представлено на здобуття ступеня доктора філософії зі спеціальності 073 «Менеджмент» галузі знань 07 «Управління та адміністрування» впроваджено у діяльність ПП «ПОЛІМЕТ».

Результати дисертаційного дослідження в частині запропонованої методики оцінювання макроекономічного ризику та ризику фінансової неплатоспроможності підприємства та подальшої побудови матриці ризиків використано та запроваджено у діяльність підприємства, що дозволить підвищити ефективність управління ризиками в частині врахування реальної оцінки ймовірності настання як зовнішніх, так й внутрішніх ризиків.

Директор
ПП «ПОЛІМЕТ» **Максим ТІЩЕНКО**

Appendix J

ЄДНІСТЬ ГРОМАДИ
ЗАМОЖНЕ СЕЛО

08170, с. Віта-Поштова, вул. Боярська 4
+38 (098) 187 12 34
e-mail: egzsvp@gmail.com

Спеціалізованій вченій раді
по захисту дисертації

Довідка
про впровадження результатів дисертаційного дослідження
Ван Ї

Даною довідкою Громадська організація «Єдність громади – заможне село» підтверджує, що пропозиції Ван Ї наведені в дисертаційному дослідженні «Формування системи ризик-менеджменту виробничих підприємств», поданої на здобуття наукового ступеня доктора філософії за спеціальністю 073 «Менеджмент», відрізняються науковою новизною, мають значну практичну цінність та впроваджені в роботі Громадської організації.

У процесі реалізації статутної діяльності ГО було використано окремі положення та аналітичні висновки дисертаційного дослідження, в частині ідентифікації та оцінювання ризиків діяльності виробничих підприємств, рекомендацій з формування системи ризик-менеджменту виробничих підприємств різних рівнів.

Зазначені результати було використано при підготовці рекомендацій та консультацій щодо підтримки виробничого підприємництва в територіальних громадах, наданих підприємствам виробничого профілю з боку ГО.

Керівник ГО **Ольга МАЗУРЕЦЬ-МАКСИМЧУК**

УКРАЇНА
ГРОМАДСЬКА ОРГАНІЗАЦІЯ
«ЄДНІСТЬ ГРОМАДИ-ЗАМОЖНЕ СЕЛО»
№39334305
Київська обл., Києво-Святошинський р-н

Appendix K

ПОГОДЖЕНО
Проректор з наукової роботи та інноваційної діяльності Національного університету біоресурсів і природокористування України, доктор сільськогосподарських наук, професор

_____ Оксана ТОНХА

« » _____ 2026 р.

ЗАТВЕРДЖУЮ
Проректор з науково-педагогічної роботи та цифрової трансформації Національного університету біоресурсів і природокористування України, доктор педагогічних наук, професор

_____ Олена ГЛАЗУНОВА

« » _____ 2026 р.

АКТ
про впровадження/використання
результатів дисертації здобувача ступеня
доктора філософії у навчальний процес

Цим актом стверджується, що результати дисертації на тему: «Формування системи ризик-менеджменту виробничих підприємств», яку представлено на здобуття ступеня доктора філософії зі спеціальності 073 «Менеджмент» галузі знань 07 «Управління та адміністрування», виконаної Ван Ї, впроваджено у навчальний процес під час підготовки курсу лекцій з дисципліни «Антикризове управління» для здобувачів першого (бакалаврського) рівня вищої освіти зі спеціальності 281 «Публічне управління та адміністрування» у Національному університеті біоресурсів і природокористування України в частині визначення методів та стратегій ризик-менеджменту як превентивних заходів з попередження криз.

Директор навчально-наукового інституту неперервної освіти, д.е.н., професор **Юлія НЕГОДА**

В.о. завідувача кафедри публічного управління, менеджменту інноваційної діяльності та дорадництва, д.е.н., професор **Ольга ВИТВИЦЬКА**

Appendix L

LIST OF PUBLISHED WORKS ON THE THESIS TOPIC

Articles in scientific publications included in the international scientometric databases Scopus and/or Web of Science Core Collection

1. Dielini M., Nesterova M., **Wang Yi.** Peculiarities of forming an enterprise risk management system in the context of modern transformations: the experience of European countries and Ukraine. *Baltic Journal of Economic Studies.* 2025. Vol. 11, №2, pp. 67-79. https://doi.org/10.30525/2256-0742/2025-11-2-67-79 *(Dielini M. carried out scientific and methodological support for the study, analyzed modern trends in risk management and the emergence of new risks, Nesterova M. investigated the features of the formation of the enterprise risk management system in the conditions of modern transformations in Ukraine, formed the introductory part, Wang Yi conducted a literature search, formed the concept of the study, determined the importance of transforming traditional risk management as reactive into proactive enterprise risk management (ERM), compared the results obtained in EU countries with Ukraine, formed conclusions).*

Articles in scientific publications included in the List of Scientific Professional Publications of Ukraine

1. Дєліні М.М., **Ван Ї**. Теоретичні засади формування системи ризик-менеджменту підприємств. *Інвестиції: практика та досвід.* 2024. №20. С. 40-46. DOI : https://doi.org/10.32702/2306-6814.2024.20.40 *(Delini M.M. carried out scientific and methodological support of the research, formulated interim and final conclusions. Wang Yi carried out an analysis of scientific sources and their generalization, formed a research concept, developed a phasing of the risk management process at the enterprise).*

2. **Ван Ї**, Дєліні М.М. Методи оцінки ризиків виробничих підприємств: методологічні підходи, особливості вибору та використання. *Науково-виробничий журнал "Бізнес-навігатор"*. 2025. Випуск 6 (83). С. 343-349. https://doi.org/10.32782/business-navigator.83-56 *(Wang Yi developed a research*

plan, identified the main methodological approaches to risk assessment. Delini M.M. provided scientific and methodological support for the study, formulated general conclusions).

3. Ван Ї. Цифрові інструменти забезпечення ефективності ризик-менеджменту виробничих підприємств. *Цифрова економіка та економічна безпека.* 2025. №6 (21). С. 279-285. https://doi.org/10.32782/dees.21-41

4. Ван Ї. Оцінка макросередовища в ризик-менеджменті виробничих підприємств України. *Актуальні проблеми економіки.* 2026. №1 (295). С. 18 – 25. DOI: 10.32752/1993-6788-2026-1-295-18-25

Abstracts of scientific reports

1. Wang Yi. Enterprise Internal Control Management and Measures for Financial Risk Response. *Education, Technology, and Management – The Future of Teaching and Learning:* proceedings of the ISIETM 2023, California, USA, May 17-19, 2023. California, USA, pp. 170-176.

2. Wang Yi. Towards a more prosperous future for Ukraine. *Інклюзивний розвиток національної економіки: глобальні тенденції, можливості України та роль агропродовольчого сектору*: матеріали VII міжнар. наук.-практ. конф., м. Київ, 16-17 лист. 2023 р. Київ: НУБіП України, 2023. С.10-12.

3. Wang Yi. Threats and risk management under the war conditions. *Інклюзивний розвиток національної економіки: глобальні тенденції, можливості України та роль агропродовольчого сектору, досвід і співпраця з ЄС*: матеріали VIII міжнар. наук.-практ. конф., м. Київ, 23-24 жов. 2024 р. Київ: НУБіП України, 2024. С.52-53.

4. Ван Ї. Можливості ризик-менеджменту підприємств України в умовах невизначеності. *Scientific Exploration : Bridging Theory and Practice*: proceedings of the 1st International Scientific and Practical Conference, Berlin, Germany, October 14-16, 2024, Berlin, Germany, 2024. С. 96-97.

5. Wang Yi. Business interest in risk evaluation in crisis conditions. *Роль молоді у розвитку АПК*: матеріали IX міжнар. наук.-практ. конф. здобувачів вищої

освіти, аспірантів і молодих вчених, м. Київ, 15-16 квіт. 2025 р. Київ: НУБіП України, 2025. С. 18-20.

6. Ван Ї. Сучасні цифрові інструменти в ризик-менеджменті підприємств: інклюзивний аспект. *Інклюзивний розвиток національної економіки: глобальні тенденції, можливості України та роль агропродовольчого сектору, досвід і співпраця з ЄС*: матеріали IX міжнар. наук.-практ. конф., м. Київ, 21-22 жов. 2025 р. Київ: НУБіП України, 2025. С. 81-83.

7. Ван Ї. Інноваційні підходи в ризик-менеджменті підприємств. *Розвиток економічних систем в умовах глобалізації*: матеріали II Міжнар. наук.-практ. конф., м. Харків, 20-22 лист. 2025 р, м. Харків. С. 322-323.