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THEORETICAL ASPECTS OF RISK MANAGEMENT MODELS IN ECONOMICS, MARKETING, FINANCE AND ACCOUNTING

Abstract. The relevance of the study is determined by the objective need to model the processes and results of business entities in conditions of the internal and external environment uncertainty in order to identify and reduce risks. The aim of the research is to make systematization of the risk sources and its main types inherent in Economics, Marketing, Finance and Accounting, as well as to develop recommendations for the use of Risk Management Models. The source of information was the International Organization for Standardization Guidelines, International Financial Reporting Standards, Directives of the European Parliament and the Council, scientific articles. Research methods are: system approach, formalization, theory of risk and modeling, analysis and synthesis. The main scientific result is to generalize the principles, structure, processes, sources of risks, approaches to its modelling, monitoring, quantification, reflection in accounting and reporting. The content and purpose of Risk Management Models, requirements to the information base and methods of their construction, approaches to description, practical application and validation were formalized. Such Risk Management Models as: reflexive, simulation, scenario, Value-at-Risk (VAR), Expected Shortfall (ES), SWOT-analysis, gap-management were considered in details. Authors' contribution is mainly focused on the improvement of the modelling process based on the recommendation to apply an additional stage-model risk assessment, which will improve the quality of Risk Management Models and their further application. The practical significance of the obtained results is to increase the efficiency of economic, marketing, financial decision-making on the basis of Risk Management Models in conditions of uncertainty.

***Keywords*:** risk, management, model, economics, marketing, finance, accounting.
JEL Classifications C50, D81, G32, M00, O21
Formulas: 0; fig.: 1; tabl.: 0; bibl.: 15.

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ТЕОРЕТИЧНІ АСПЕКТИ МОДЕЛЕЙ РИЗИК-МЕНЕДЖМЕНТУ В ЕКОНОМІЦІ, МАРКЕТИНГУ, ФІНАНСАХ І БУХГАЛТЕРСЬКОМУ ОБЛІКУ

Анотація. Актуальність дослідження визначається об'єктивною потребою моделювання процесів і результатів діяльності суб'єктів господарювання в умовах невизначеності станів внутрішнього і зовнішнього середовища для виявлення і зниження ризиків. Метою дослідження є систематизація джерел ризику та його основних видів, притаманних економіці, маркетингу, фінансам і бухгалтерському обліку, а також розроблення рекомендацій щодо використання моделей управління ризиками. Джерелом інформації слугували Керівні принципи Міжнародної організації зі стандартизації, Міжнародні стандарти фінансової звітності, Директиви Європейського Парламенту і Ради, наукові статті. Методами дослідження є: системний підхід, формалізація, теорія ризикології і моделювання, аналіз і синтез. Основний науковий результат полягає в узагальненні принципів, структури, процесів, джерел виникнення ризиків, підходів до їх моделювання, моніторингу, кількісної оцінки, відображення в бухгалтерському обліку і звітності. Формалізовано зміст і призначення моделей ризик-менеджменту, вимоги до інформаційної бази і методів їх побудови, підходи до опису, практичного застосування і валідації. Більш докладно розглянуто сферу використання таких моделей ризик-менеджменту: рефлексивні, сценарні, вартості під ризиком, кредитного ризику і очікуваних втрат, SWOT-аналіз, геп-менеджмент. Наукова новизна спостерігається в удосконаленні процесу моделювання на основі виділення додаткового етапу — оцінки модельного ризику, який сприятиме підвищенню якості моделей ризик-менеджменту і адекватному їх застосуванню. Практична значущість отриманих результатів полягає у підвищенні ефективності економічних, маркетингових, фінансових рішень, що ухвалюються на основі моделей ризик-менеджменту в умовах невизначеності.

***Ключові слова*:** ризик, управління, модель, економіка, маркетинг, фінанси, бухгалтерський облік

Формул: 0; рис.: 1; табл.: 0; бібл.: 15.

Introduction. Globalization, a dynamic external environment, a combination of economic and non-economic factors, including a global pandemic crisis, are among factors that increase the level of risk and uncertainty in the activities of legal entities. As an economic category, risk is associated with the probability of negative consequences from different types of business activities, namely operating, financial, investment, marketing, etc.

It could be assessed qualitatively based on expert opinions as low, medium, high and quantitatively by determining losses or unearned incomes due to adverse events. Quantitative assessments allow to consider the risk as an object of accounting in terms of reflection in the accounts of actual losses, as well as the expected unearned income by creating reserves for doubtful debts, provisions for impairment of loans, securities, other assets and more.

ISSN 2306-4994 (print); ISSN 2310-8770 (online)

Economic risk could be also considered within the framework of a proactive approach to the management of economic entities which lead to a developing stable lexical construction «risk-management». Identification, modeling, risk assessment, stress testing, determination of risk appetites, setting risk limits should be used as risk-management tools. Herewith, the model is assumed as a numerical method, system or approach by which the input data are converted into quantitative estimates based on the use of mathematical, statistical, economic tools. From the standpoint of risk management, designing models of open systems that meet the needs of a wide range of their users should be the priority in the conditions of uncertainty.

Literature Review. Challenges of using Risk Management Models faced to companies in various spheres of social life and economic development are in the center of attention of many scholars. Vergara M. and Bonilla C. [1] argue that their «contribution establishes a more solid ground for analyzing policies in highly risky environments, such as the COVID-19 pandemic». Exploring marketing risks and patterns of consumer behavior, Nevo A. [2] focuses on two key factors in the demand system: a multilevel approach to budgeting and a model of discrete choice.

Herranz N., Krasa S. and Villamil A. [3] declared that entrepreneurs' risk appetite plays a significant role in forecasting the borrower's default. The high level of the credit burden reduces the need of entrepreneur's personal funds invested into business, but increases the liquidity risk of the firm. Taking into account this statement, the purpose of modeling is to optimize the return on equity (ROE) of the entrepreneur and his financial risk.

Zhang X., Ouyang R., Liao Xu D. [4] demonstrate that «leverage, liquidity, firm size are the key firm-specific factors in determining the default risk, along with macroeconomic factors like interest rate and stock return».

Baiardi D., Magnani M. and Menegatti M. [5] identified three simultaneous risks: labor income, interest rate risks, framework. Khandokar I., Serletis A. [6] in their findings used such categories as «mostly theoretical models and traditional risk/uncertainty measures (VIX index, panic, precaution, scary bad news, etc.)». Research results of Gopalakrishnan B., Mohapatra S. [7] confirmed that «a stronger insolvency regime moderates the adverse effects of economic shocks on firms' default risk».

Xu Q., Chen L., Jianga C., Yuc K. [8] applied «the MIDAS-ER model to estimate two popular financial risk measures, namely, Value at Risk and Expected Shortfall, with both simulated data and four stock indices, and compare the model's performance with those of several popular models». The paper Boubaker S., Cellier A., Manita R., Saeed A. [9] examined «how corporate social responsibility (CSR) affects the level of financial distress risk (FDR). The adoption of CSR practices comes with less distress and default risks, likely leading to a more attractive corporate environment, better financial stability and more crisis-resilient economies».

Financial crises are a significant source of risk, but the response of financial and non-financial corporations to them is very differentiated exemplified as financial corporations are more resilient to systemic risk through the diversification of assets and liabilities. Research findings of Cauwenberge A. V., Vancauteren M., Braekers R., Vandemaele S. [10] proved this statement on the basis of two facts: first, the active participation of a non-financial corporation in international trade reduces its systemic risk; secondly, the implementation of foreign direct investment, the development of international corporations contribute to the spread of systemic risk.

The aim of the article is to make systematization of the risk sources and its main types inherent in Economics, Marketing, Finance and Accounting, as well as to develop recommendations for the use of Risk Management Models.

Methodology and research methods. Risk management activities are the subject to standardization by The International Organization for Standardization. In 2009, the ISO 31000: 2009 standard Risk management — Principles and guidelines was adopted. It has been altered few times and nowadays the 2018 edition ISO 31000: 2018. Risk management — Guidelines is valid [11]. According to it risk is interpreted as the effect of uncertainty on the activities of the entity, which leads to a negative effect in achieving its goals and eliminating predictable threats.

Risk management is a coordinated activity in order to identify, analyze, assess, control the risks to which an entity is exposed. Sources of risk, potential events and their probability, the consequences of events could be attributed to the objects of risk management. The source of risk (an element of the internal or external environment) as well as a potential event (an expected action) can lead to losses, additional costs, unearned income and so on. A potential event may or may not occur with some defined level of probability.

Risk management could be considered as the most important strategic target of business management, it should be carried out iteratively with the involvement of new knowledge and methods. Legal entities should be involved in the process of implementation of risk management systems taking into account the state of the external and internal environment, socio-economic, cultural and national factors.

Special emphasis should be placed on taking into account the behavioristic aspect, which has led to the emergence of new areas — behavioral finance, system-reflexive marketing. This opens wide opportunities for the use of reflective risk models.

Business entities should develop Risk Appetite Statements with the detailed list of the risks they take, their assessment criteria, and management practices. According to the adopted risks, the risk-appetites should be calculated as the value of the acceptable level of retained risk. Within certain risk appetites, limits are set as a constraint to control the risk level. Risk modeling can be voluntary and imperative.

International Financial Reporting Standard (IFRS) 9 Financial Instruments [12] defines the mandatory nature of modeling for forecasting expected credit losses, the value of financial instruments and the risk situation of credit institutions and investment firms.

Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms defines the concept of modeling risk or model risk as the risk of non-performance or incorrect performance of tasks' models [13]. An entity may incur potential losses as a result of decisions based on the findings of the internal model due to errors in its construction, validation, use. The model validation presupposes a monitoring of its effectiveness. Back-testing methods are used regarding improvement of the models' quality, when the actual data are compared with the results obtained using the model.

Results. Model risk may have individual (risk of development and implementation of a single model) and aggregate nature (risk of development and implementation of a set of models, which are associated with common assumptions, initial data for construction, methodology and used by one entity or group of entities under joint control).

The model is a conditional image of the object, a simplified formalization of real phenomena and processes, consisting of three components: 1) input information, represented by assumptions, quantitative and qualitative data, expert opinions, etc.; 2) a computing component that converts input information into a result; 3) the result (quantitative estimates, algorithms, formulas, etc.) presented by the report, which determines the estimates required for decision-making. Sources of model risk are: low quality of input data, model errors (mathematical, logical, statistical), incorrect implementation of the model (accidental or intentional), inaccuracy of results (non-coincidence of design goal and expected use).

Business entities should to control the level of model risk, as its increase could lead to wrong management decisions, incorrect strategies' selection and choice of inappropriate competition methods, loss of business reputation and investment attractiveness, deterioration of financial results, etc.

The issue of model risk assessment is extremely important for risk models, as its underestimation is affected by the lack of precautionary measures aimed to eliminate and reduce risks, and overestimation — the implementation of conservative policies and income shortfall.

Fig. presents the formalization of risk management models in economics, marketing, finance and accounting.

ISSN 2306-4994 (print); ISSN 2310-8770 (online)

ISSN 2306-4994 (print); ISSN 2310-8770 (online)

Principles
Integrated, Structured and comprehensive, Customized, Inclusive, Dynamic, Best available information, Human and cultural factors
Framework
Integrating, Designing, Implementing, Evaluating, Improving risk management across the organization
Process
The systematic application of policies, procedures and practices to the activities of communicating and consulting, establishing the context and assessing, treating, monitoring, reviewing, recording and reporting risk
Description of risk models
The method used for modeling; type of model; basic assumptions and principles underlying the model; input data to the model and requirements to them; the process of using the model; predictive ability of the model; rules for making changes to the model; division of duties and responsibilities for the creation, implementation, validation and modification of the model; model risk assessment

Sources of risk		
Economics	**Marketing**	**Finance and Accounting**
- non-fulfillment of the production program; - rising prices of production resources; - structural changes in the product range; - loss of suppliers; - increase in wear of production capacity	- actions of competitors; - reduction of consumer loyalty; - change in market capacity, supply and demand; - unfavorable movement of prices for goods; - deterioration of competitive positions	- growth of the dollar exchange rate, inflation; - deterioration of stock indicators, creditworthiness and solvency; - increasing financial dependence; - reduction of profits; - transition to unprofitable activities
- balance models of production capacities; - optimization models; - simulation and scenario models	- pricing; - estimates of the capacity of the commodity market; - rating, ranking models; reflexive models; - SWOT- analysis	- valuations at risk; default forecasting; - calculation of reserves for possible losses on transactions; - gap-management

Fig. **Formalization of Risk Management Models in Economics, Marketing, Finance and Accounting**
Source: developed by authors.

The models can be used to analyze and develop business strategies of the legal entity, justify management decisions, identify and analyze risks and exposure to them, assess competitiveness in commodity and financial markets, determine the value of securities and business in general, formalize liquidity and capital adequacy, control of pricing and profitability. The designing of risk models takes into account the type and activity scale of the entity, its business strategy, risk profile, risk tolerance, assumptions about changes in internal and external factors, the availability of correct and complete source data, information system capabilities, experience and qualifications of staff.

The designing process of a model consists of the following stages: determining the main characteristics of the object of evaluation and assumptions; formation of correct and complete input data, checking their quality and sufficiency; formalization of the model; its testing, determination of prognostic ability, correctness of results; model description (documentation); model approval; its approbation and implementation; regular periodic validation of the model. The quality of the model largely depends on the preparation of input data, which must be relevant, consistent with market values, obtained from official or independent sources. It is important to exclude the situation when the collection of information for the models development is carried out by a structural unit, whose activities will be evaluated by the model to be designed.

Sources of risk can be universal, such as force majeure, non-performance of contractual obligations by the party due to negative internal and external factors. Specific sources of risk are: in the economy — non-fulfillment of the production program, rising prices for production resources, structural changes in the range of products, loss of suppliers, increasing wear and tear of production capacity; in marketing — unpredictable behavior of consumers and competitors, changes in the determinants of supply and demand in the commodity market, defects in pricing strategies, the inadequacy of the sales promotion system to the current situation; in finance — the devaluation of the national currency, rising interest rates, deteriorating stock indices, declining securities prices, creditworthiness and solvency, increasing financial dependence, reduced profits, unprofitability and more.

Risk Management Models used in economics, marketing and finance can be interdisciplinary. The most promising of them are: reflexive, simulation, scenario, Value-at-Risk (VAR), Expected Shortfall (ES), SWOT-analysis, gap-management.

1. Reflexive models are based on the use of recursive functions: cognitive (expectations of subjects) and influencing (thinking of decision-makers). Regarding the subject of research — cognitive functions are determined by the situation in commodity and financial markets, they are based on consumer expectations about the quality and quantity of goods, the movement of prices for them. Identification, evaluation and analysis of expectations for individual marketing segments allow sellers to reflect on the stages of decision-making by consumers, to identify the determinants of demand and influence it. Reflexive models have a wide range of uses in marketing to formalize consumer behavior in commodity markets, in finance — to determine the impact of expectations of participants in the foreign exchange, stock market on the dynamics of foreign exchange rates, securities, other exchange assets and more. Designing Reflexive models requires preliminary socio-economic, demographic, psychological segmentation, which allows to identify certain groups of consumers and other market participants that have similar characteristics in terms of forming expectations and making decisions about buying goods, financial and currency assets and more.

2. Simulation models are a kind of statistical, logical-mathematical and game models that describe dynamic processes in real systems based on their replacement by artificial ones and simulation — finding out the essence of phenomena without conducting experiments on a real object. Forms of simulation models in economics, marketing, finance, accounting can be: visualization of business processes; model time; random process; management of input parameters and work results. Simulation models are widely used in the organization of production process management and implementation of investment projects in conditions of risk and uncertainty, in the distribution of capital investment over time, in justifying the most effective options for manufacturing and marketing, in ensuring the rhythm of its production and sale; in the management of incoming material flows, as well as to optimize the size of the order and production stocks of the

ISSN 2306-4994 (print); ISSN 2310-8770 (online)

enterprise. In marketing, the construction of simulation models allows you to justify strategies for managing the competitive position of the enterprise based on the results of simulating the situation in the product market. In finance, on the basis of simulation experiments, actuarial calculations of insurance companies are carried out, liquidity management models of financial and credit institutions are developed, and the probability of bankruptcy is predicted.

3. Scenario models are based on the formalization of the impact of possible developments, circumstances, sources of risks (scenarios) on the resulting indicator. Scenarios can be developed on the basis of historical and hypothetical approaches, anticipate adverse events, take into account risk factors with the most negative impact. Depending on the accepted assumptions, scenarios can be pessimistic, most probable, optimistic, combined. Scenario models are actively used in the planning of production, marketing, financial and investment activities of economic entities. A partial case of using scenario models in risk management is stress testing — a method of measuring the ability of businesses to withstand the negative flow of environmental factors, shock changes in commodity and financial markets (prices, exchange rates, interest rates), which correspond to extreme but probable scenarios.

4. VAR-models allow to determine the impact of economic, marketing, financial risks on the Economic Value of Equity (EVE), in particular, the possible change in the net present value of assets and liabilities of legal entities. VAR-models are actively used to assess volatility risk, stock, currency and commodity risks, as well as to forecast exchange rates and the value of financial instruments.

The requirements of risk-oriented prudential regulation of banking institutions and other financial intermediaries, Basel Committee on Banking Supervision Standards in terms of calculating capital adequacy ratios were developed on the basis of VAR-models. The National Bank of Ukraine identifies the possibility of using VAR-models for a period determined by the bank with a confidence level of not less than 99% in total for all types of market risks with the distribution between trading and banking papers [14]. VAR-models are based on the following methods: analytical (variational-covariant), historical modeling, statistical tests (Monte Carlo method).

The advantages of VAR-models are: cost assessment of risks taking into account the probabilities of their occurrence, the availability of a single measure for a wide variety of risks, the possibility of their aggregation, use in consolidated financial statements preparation, hazard rating determination regarding possible EVE losses. The disadvantages of VAR-models are: significant impact on the calculation results based on assumptions about the volatility of financial markets, exchange rates, stock indices, accepted parameters of statistical distributions, hypotheses about the sensitivity of financial instruments, disregard for the impact of risks on cash flow and liquidity.

5. ES-models are used to determine the expected shortfall of economic entities in transactions with financial instruments, to predict defaults of plaintiffs, issuers of securities and to reflect the probability of their occurrence in accounting in accordance with the precautionary principle. The most common in the group of these risks are the models of Credit Risk, which is defined as the product of Probability of Default (PD), Loss Given Default (LGD), Exposure at Default (EAD). The obtained results are used to calculate credit impairment losses. According to Ukrainian law, the bank determines the credit risk on the asset from the date of its recognition in accounting until the date of termination of such recognition [15]. In order to calculate the amount of credit risk on the asset, the bank determines the value of the credit risk components (PD, LGD and EAD) depending on the type of debtor / counterparty [legal entity (except bank and budgetary institution), individual, budgetary institution, bank, debtor — issuer of securities], type of asset, type of collateral, currency of debt (national or foreign), method of valuation of the asset (on an individual or group basis).

Ukrainian banks independently choose the approach to VaR or ES assessment [14]: historical modeling, parametric model, Monte Carlo scenario modeling, ARCH-model (Autoregressive conditional heteroskedasticity) and GARCH-model (Generalized Autoregressive Conditional Heteroscedastic model). The ARCH-model uses a conditional, time-dependent variance, which is expressed in terms of the square of the indicators' values of past periods. The

GARCH-model is based on the assumption that the current variability of the variance is influenced by both previous changes in indicators and preliminary estimates of variance («old» news). Such properties allow to use these models in the conditions of uncertainty in commodity and financial markets, when traditional linear regression models do not work.

6. SWOT-analysis divides risk factors into four categories: Strengths, Weaknesses, Opportunities, Threats. The SWOT-model is represented by a matrix, or quadrant, which consists of four main fields. It allows to compare the internal strengths and weaknesses of the economic entity with market opportunities, taking into account the threats of the external environment. The universal nature of SWOT-models allows them to be used by a wide range of legal entities at the interstate, state, regional level as well as on the level of national economy sectors, economic and financial sectors (deposit-taking corporations, non-deposit-taking corporations) and even households. As a risk management tool, the SWOT-model allows to identify risks and ways of their neutralization, based on the competitive advantages of the legal entity in the market and its internal resources.

The strengths and weaknesses of the entity are assessed by the following components: management and administration of business processes, motivation and qualification of staff, financial condition, demand for products, marketing channels for its promotion in the market, sales system, logistics.

Sources of threats are the risks of the external environment (socio-economic, technical and technological, political, environmental), the actions of competitors. Therefore, PEST-analysis as a tool of risk management is closely related to the SWOT-model. The name of PEST-analysis comes from the first letters of the factors influencing the marketing position of the legal entity — Political, Economic, Social, Technological.

The main purpose of the SWOT-model is to identify and assess risks. Measures of managerial influence are developed within the TOWS-model, which consists of the same factors, but are placed in reverse order to justify risk-oriented strategies: counteracting external threats, using market opportunities, leveling weaknesses, creating conditions for maximizing the potential of strengths.

7. Gap-management is aimed to identify imbalance as a source of risk, assess their impact on the value of financial results and equity of legal entities. Imbalance forms are: physical indicators, amounts, terms, interest rates, exchange rates. For the overall assessment of the gap, it is reasonable to use absolute value and risk index, which is determined by the ratio of imbalance sum to a certain base (volume of production, sales, value of assets, equity, indicators of contractual obligations and requirements).

In economics, gap-analysis allows to identify the discrepancy between the need for material, labor, financial resources needed to implement the production program, and their actual availability. Imbalances are the deviation of production indicators from the norms and standards provided, in particular, international standards of quality, certification, safety, environmental friendliness.

In marketing, gap-analysis is a tool to study the risks associated with imbalances in quantitative indicators of supply and demand; inconsistency of the range with consumer tastes, prices of goods, works, services — their quality, individual producer prices — market prices and prices of competitors.

Gap-analysis has become widespread in the financial and credit sphere, in risk management of enterprises, banks and other financial intermediaries, which is confirmed by its diversity: liquidity gap, percentage gap, currency gap.

Liquidity gap is an imbalance between the terms of incoming and outgoing payments, time mismatch indicator of requirements and obligations (on-balance sheet and off-balance sheet). It is calculated at separate time intervals and cumulatively (cumulative gap).

Percentage gap is the imbalance between interest rates of attraction and placement of funds, which is a source of interest rate risk. In banking practice, the change in net interest income, the method of modified duration, or the impact on the economic value of the bank’s capital are used to measure percentage gap.

ISSN 2306-4994 (print); ISSN 2310-8770 (online)

Currency gap is the imbalance between assets and liabilities in foreign currency, which is a source of currency risk and is measured by the size of the currency position. If the currency position is zero, then the legal entity will receive neither profit nor loss due to the movement of exchange rates. An open currency position means that there is a positive or negative currency gap. In the case of a long currency position, the expected gains are associated with the depreciation of the national currency, in the case of a short — with its strengthening.

The rules of prudential supervision set clear requirements to the order and frequency of conducting gap-analysis of banking institutions and stress testing in accordance with the selected scenarios. The close relationship between gap-models, VAR-models, ES-models should also be emphasized.

Conclusions. Thus, the most significant risks are systematized by areas: economics — production, technical and technological, pricing, organizational; marketing — competitive risk, the risk of reducing consumer loyalty, the risk of changing market capacity, the risk of adverse price movements; finance and accounting — currency, credit, stock, interest, liquidity risk.

The main Risk Management Models are: in economics — balance models of production facilities, optimization models, simulation and scenario models; in marketing-models of substantiation of prices by commodity groups, estimation of commodity market capacity, analysis of competitive positions of the enterprise and competitiveness of goods (SWOT-model, rating and ranking models), formalization of communicative interaction (reflective models); in finance and accounting-models of valuation at risk, forecasting defaults of borrowers and issuers of securities, calculation of provisions for possible losses on credit and other operations, gap-management.

Development and use of Risk Management Models based on certain principles, framework, process, description will contribute to the sustainable operation of business entities in an unstable environment.

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Статтю рекомендовано до друку 15.04.21

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The article is recommended for printing 15.04.21

ISSN 2306-4994 (print); ISSN 2310-8770 (online)