МАТЕМАТИЧНА ЕКОНОМІКА

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JUSTIFICATION OF THE CHOICE OF INDICATORS IN MODELS FOR ASSESSING THE LEVEL OF ECONOMIC SECURITY OF INNOVATIVE AND ACTIVE ENTERPRISES IN CONDITIONS OF UNCERTAINTY OF THE INTERNAL AND EXTERNAL ENVIRONMENT

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The article is devoted to substantiating the choice of financial indicators for discriminant and neural network models for diagnosing the economic security of innovative and active enterprises in the field of telecommunications in conditions of uncertainty of the internal and external environment. The importance of assessing the economic security of the system at any level is unquestionable, such assessments are the basis for decision-making not only on ensuring economic security, but also opportunities for system development, determination of necessary resources, creation and use of system reserves, evaluating the effectiveness of the economic security system and the activities of the relevant division of the enterprise. It is established that due to a completely different tool base, the available approaches to assessing the economic security of the enterprise do not compete with each other. We can only talk about the different degree of development of approaches and their dissemination. It shows the importance of taking into account the phenomenon of "uncertainty" in the economic activity of innovative-active enterprises, which is closely related to the concept of "economic risk", since any economic or economic activity of an enterprise is characterized by incompleteness of information about the presence of patterns, unpredictability of many economic phenomena and processes, the influence of a large number of interrelated and difficult to identify factors. The latest methodological foundations for assessing the economic security of innovative and active enterprises, which are based on the tools of Fuzzy Logic and neural networks, are proposed and shown. The fuzzy set method makes it possible to use the data selected for assessing the economic security of enterprises in their dynamics, which makes it possible to take them into account when making strategic management decisions. In addition, the use of modern analytical platforms allows for deep data preprocessing in order to check them for multicoleniarity, exclude random data, which takes into account the uncertainty of input and output variables as much as possible.

Keywords: digitalization, economic security of the enterprise, clusterization, neural networks, financial condition of the enterprise, probability of bankruptcy, neural network algorithm, discriminant model, fuzzy logic.

Problem statement

According to the Industry 4.0 program, which has been discussed since 2011, the German government has set a task to expand the use of information technologies in production. The movement "Industry 4.0 in Ukraine" has been created in Ukraine, and the Association of industrial automation enterprises of Ukraine pays great attention to these issues. According to the consulting company Deloitte Consulting, there are five ways to bring digital initiatives of the enterprise to the level corresponding to the digital enterprise, one of these

means is cybersecurity. Cybersecurity refers to the application of a structured approach to risk identification and response methods in complex and changing systems and technologies. Among the main types of enterprise security is its economic security, and among the main methods for identifying the state of economic security is the use of modern digital tools, in particular, analytical platforms that take into account the uncertainty of the internal and external environment of the enterprise to the maximum extent.

Analysis and research of publications

A significant number of leading domestic and foreign economists paid attention to the study of the issue of assessing the level of economic security of enterprises, in particular: G. Kozachenko [1], O. Rossoshanska [2], M. Maksimyuk [3], L. Gnilitskaya [4]. The founder of the theory of uncertainty in economics is considered to be J. R. R. Tolkien. Keynes [5], who formulated the definition of this concept. A significant contribution to the theory of uncertainty was made by F. Knight [6], who considered uncertainty from a philosophical point of view and founded the concept of "ambiguity". These researchers have separated the categories of "uncertainty" and "risk", which is very relevant for the study of economic security of enterprises.

Many aspects of the problem of assessing the level of economic security of an enterprise in our time are debatable, especially the issue of improving the accuracy and adequacy of models in conditions of uncertainty in the internal and external environment of enterprises in the context of an economic crisis needs to be considered.

The purpose of the article

The purpose of the work is to substantiate the choice of indicators in modern neural network and fuzzy-logical models for assessing the level of economic security of innovative enterprises in conditions of uncertainty of the internal and external environment.

Statement of the main material

The issue of assessing the level of economic security of the enterprise is now ambiguous and debatable. Thus, L. Voloshchuk [7] offers two-level, three-level, four-level, five-level and seven-level approaches to the gradation of the level of economic security of the enterprise (ESE). For all approaches, this author offers the following methods: cluster analysis, scales and alternative values.

In linguistic terms for the two-level approach the author suggests the terms «safe» and «dangerous», for the three-level approach the author suggests the terms «above the norm», «in the range from normative to critical value», «below the critical level».

Our research [8, 9, 10] further led to the construction of a neural network model for diagnosing the economic security of domestic innovative industrial enterprises, which shows the prospects of using neural networks to determine the probability of their bankruptcy.

The founder of the theory of uncertainty in economics is considered to be J. Keynes [5], who formulated the definition of this concept. A significant contribution to the theory of uncertainty was made by F. Knight [6], who considered uncertainty from a philosophical point of view and introduced the concept of «ambiguity». These researchers separated the categories of «uncertainty» and «risk».

Thus, the American economist F. Knight in his famous fundamental work «Risk, Uncertainty and Profit» identified a special kind of risk – uncertainty, which is not insured.

The origin of the phenomenon of «uncertainty» in the economy is closely related to the concept of «economic risk», as any economic activity is characterized by incomplete information about the existence of patterns, unpredictability of many economic phenomena and processes, the influence of many interrelated and difficult to identify factors.

Uncertainty in risk assessment can be of two different types: first, randomness due to the inherent variability of the socio-economic system and, second, inaccuracy due to lack of knowledge and information about the socio-economic system.

The apparatus of fuzzy logic allows the use of inaccurate and approximate data, which are usually available when assessing not only the level of risk, but also other economic indicators, most of which are characterized by uncertainty. It is possible to notice that the device of fuzzy logic is genetically adapted to modeling of uncertain or probabilistic economic processes.

Fuzzy logic was created on the basis of classical, clear, ambiguous logic. Its founder, Lotfi Zade, pointed out the shortcomings of classical logic in relation to the modeling of real-world phenomena. Introducing the concept of fuzzy set, he provided opportunities to improve models that contain logical connections. Zade defined the operation of the intersection of fuzzy sets as an extension of the corresponding operation over ordinary sets. This means that the intersection of ordinary sets must be a special case of intersection of fuzzy sets.

Fuzzy logic is also widely used in risk assessment based on fuzzy numbers or fuzzy rules, in fuzzy extension of some typical probabilistic risk level estimates, and in an orderly linguistic approach to risk level assessment and similar cases [3].

Thus, with the help of fuzzy sets we proposed a fuzzy-logical approach to risk assessment in developing a strategy for innovative development of industrial enterprises [8], provided an assessment of

the financial component of the innovative potential of machine-building enterprises [9], reviewed modern methods of assessing the financial condition of domestic innovation. industrial enterprises [10] in conditions of uncertainty of the external and internal environment.

Since vagueness is often confused with probability, we consider it appropriate to touch on the differences between the two concepts. Among the existing types of uncertainty are the following two:

− stochastic uncertainty;

− lexical uncertainty.

For example, in the statement "probability of winning a large sum in the lottery" 5 out of 36 "there are two linguistic concepts:

− a large amount of winnings;

− low probability.

Both of these concepts are vague, inaccurate, and depend on the subjective perceptions of those who express them. Yes, a person with average wealth will consider a large sum to be the one that can be won by guessing four or five numbers, a person with wealth above average will include here only the winnings with guessed six numbers. Precisely defining the concept of «low probability» in this case is also a difficult task, because most lottery players do not think not only about the exact numerical value of the probability of winning the grand prize, but even about its approximate value, estimating this value intuitively, based on the degree of their confidence in winning.

From the considered examples it is seen that the lack of accurate information about the surrounding economic reality is not an obstacle to human activity and economic decision-making. For many years, accurate mathematical models of various phenomena have been developed, including in the economic sphere, but we can talk about successful modeling results only for a small part of them, because building a model of the phenomenon requires a lot of information about it.

At the same time, a person, regardless of the level of his education, is able to effectively model in his imagination reality, including the work of enterprises, industries, the economy as a whole, etc. Such models are based on the use of, for example, such linguistic concepts in economics as:

− innovative potential of the enterprise − large or small;

− economic security of the region − low, moderate, high;

− financial stability of the enterprise − unstable, moderately stable, stable;

− the probability of bankruptcy of the enterprise − very low, low, moderate, high, very high.

All of them are inaccurate lexical concepts, and their assessment depends on the way a person describes economic reality. The wider a person's vocabulary, the more precise the wording he uses, in particular for the subjective description of economic objects.

The above can be summarized as follows:

− stochastic uncertainty means the uncertainty of the occurrence of an event, which in itself is accurately described;

− lexical uncertainty means uncertainty in the description of the event.

Uncertainty of description means its vagueness, and the theory of fuzzy systems deals with the method of constructing models using fuzzy concepts used by man, including in economics. Note here that, in addition to lexical fuzzy concepts, a person also uses intuitive concepts and images that have no verbal description at all.

The current trend in the study of modern enterprises is a comprehensive assessment of their economic security. The topical issue is the methods of assessing the economic security of the enterprise, which include in general the selection, evaluation and ranking of indicators, the mathematical model of a comprehensive assessment of the level of economic security of the enterprise. Based on this study is devoted to the analysis of modern trends and tendencies to determine the indicator of economic security of modern enterprises.

Today there are several approaches to assessing the economic security of the enterprise: functional, indicator, expert, etc. [7]. Researchers understand the approach to assessing the economic security of the enterprise as a set of techniques and methods for measuring the level of economic security. Each of the available approaches is based on the use of appropriate tools, each of the approaches has its advantages and disadvantages, but none of them is considered more perfect than others. Due to a completely different tool base, the existing approaches to assessing the economic security of the enterprise do not compete with each other. It is possible to state only about different degree of development of approaches and their distribution.

Well-known experts in the field of economic security G.V. Kozachenko and Yu.S. Pogorelov [1] believe that the most common in assessing the economic security of the enterprise is a functional approach. Chronologically, he was the first, largely repeating and copying the existing approaches to the qualification and quantification of other phenomena or processes in the enterprise. The method of assessing the economic security of the enterprise by its functional components involves: 1) the selection of components of economic security of the enterprise, the list of which there is no unity of views; sometimes they repeat the functional

subsystems of enterprise management; 2) the choice (or design) of indicators that characterize the economic security of the enterprise for each functional component (there is no consolidated unity of opinion on the list of indicators, the description of their use is the economic security of the enterprise is often in doubt); 3) scaling of different in nature (absolute and relative) and measuring indicators to bring them to the same dimension; 4) determination of complex indicators of economic security for each of the selected functional components by convolution of normalized unit indicators; 5) determination of the integrated indicator of economic security of the enterprise by convolution of complex indicators for each of the selected functional components.

The method described by these authors [1] is most common in the study of economic security of the enterprise, but according to these authors, this method, having obvious advantages, at the same time has significant disadvantages.

First, a significant drawback is the difficulty of determining the impact on the level economic security of qualitative characteristics, such as the reputation of the enterprise, the level of trust of contractors, loyalty of staff, etc.

Second, the aggregation of features is based on the so-called «additive value» theory, according to which the value of a whole is equal to the sum of the values of its components. If the features of the set have different units of measurement, then additive aggregation requires bringing them to one basis, ie preliminary normalization, which, according to the authors, complicates the calculation of the integral index.

Third, the methodology uses retrospective values of indicators as a result, the received assessments of economic security are of interest for analytical activities, but practically unsuitable for making current management decisions and recommendations of the service (department) of economic security on the activities of the enterprise.

Considering the list of shortcomings expressed by the authors, it is necessary to note the following. Recently, mathematical tools have emerged to address the shortcomings of the functional approach discussed above. Thus, the method of fuzzy logic allows you to simultaneously take into account both numerical variables and linguistic. This method does not require a data normalization operation, which greatly simplifies their preparation. In addition, the method of fuzzy sets allows to involve data in their dynamics, which makes it possible to take them into account when making strategic management decisions. In addition, the use of modern analytical platforms allows for in-depth pre-processing of data to verify data for multicollenarity, the exclusion of random data, etc.

M.A. Maksymyuk [3] used three groups of indicators to determine the level of economic security of enterprises, in particular, agricultural enterprises. The first of them characterizes each enterprise as a production system and is formed on the basis of indicators of production volume and cost of production. The second group of indicators characterizes enterprises in terms of efficiency of operating and marketing activities, including profitability and sales share. The third group of indicators, which characterizes the resilience of enterprises to future threats, is represented by indicators of the structure of the cost of production, which can cause significant changes in costs, and is a reflection of dependence on individual market changes.

The state of the production system by this author [4] proposed to reflect as the ratio of products (harvested grain) to the cost of production (1 quintal of grain) (coefficient A), as between the volume of production and the state of the enterprise as a production system there is a direct relationship products is the inverse characteristic of this condition, because its higher level is a negative circumstance.

It is not enough for an enterprise to grow (produce) products, and it is necessary to carry out its further sale, therefore without effective system of sale the enterprise cannot consider itself and the activity economically safe. Indicators of profitability and sales share are taken into account in the differentiation of enterprises by the level of their economic efficiency. The product of these indicators is formed by the coefficient B proposed by the author. This approach takes into account the need not only to obtain the highest profitability, but also to sell agricultural products, because one of its specific characteristics is the shelf life, which also has additional dependence on storage conditions.

The third component of assessing the economic security of enterprises is the assessment of their protection from probable market fluctuations. The latter are largely related to fluctuations in the level of prices for goods, works and services that manufacturers use in the course of their activities. Therefore, the assessment of resilience to such threats is based on the analysis of the cost of production, the overall assessment of which reflects the coefficient C. It reflects the completeness of the company's costs, the impact of significant factors (including cost of fuels, works and services, wages) products and the degree of their deviation for the analyzed period and is calculated by adding the reflected in the reporting share of the cost of production and distributed by cost items of the enterprise in relation to their standard deviation.

Thus, this paper substantiates three indicators that are indicators of economic security of enterprises,

but the calculation of the integrated indicator of economic security of the enterprise is not developed by the author. To compare the level of economic security of enterprises, only the method of relative indicators was used.

O.V. Rossoshanska [2] offers the latest methodological principles for assessing the economic security of innovative project-oriented enterprises. In particular, this researcher proposed using the tools of fuzzy logic: 1) graphical display of membership functions of the variable «safety zone» in the form of a nonlinear fuzzy scale of linguistic assessment of the level of danger of activity, where the zones of intersection of membership functions 2) to assess the strategic economic security of enterprises according to the indicators of the reference dynamics to use a fuzzy criterion scale, on which to indicate the level of danger the author used fuzzy thresholds; 3) fuzzy criterion scale for assessing the level of strategic economic security of enterprises by indicators of the state of the environment, which is improved by presenting thresholds in the form of intervals between the terms «critical − high − high − low», and which are determined by safety of activity, while the mutual location of the functions of ownership reflects the patterns of change in the values of the indicator of comfort of the environment from the number of positive evaluations of employees in relation to seven indicators that characterize the environment of the enterprise.

Conclusions

In general, modern methods of assessing the economic security of the enterprise the following algorithm: 1) selection of components of economic security of the enterprise, the list of which there is no unity of views, sometimes they repeat the functional subsystems of enterprise management; 2) selection or construction of indicators that characterize the economic security of the enterprise for each functional component; 3) scaling of different in nature (absolute and relative) and measuring indicators to bring them to the same dimension; 4) determination of complex indicators of economic security for each of the selected functional components by convolution of normalized unit indicators; 5) determination of the integrated indicator of economic security of the enterprise by convolution of complex indicators for each of the selected functional components. At all stages of this algorithm, attempts are made to use modern mathematical tools that take into account the elements of uncertainty of the internal and external environment of enterprises.

Further research of the authors will be aimed at improving models for assessing the economic security of enterprises in the uncertainty of the internal and external environment, obtained using modern tools for modeling economic processes − fuzzy logic and neural networks − to increase their accuracy.

REFERENCES

1. Kozachenko, H.V., & Pohorelov, Yu.S. (2015). Pro deiaki problemy u suchasnii ekonomichnii bezpekolohii [About some problems in modern economic security]. *Upravlinnia proektamy ta rozvytok vyrobnytstva − Project management and production development, 3(55),* 8-18 [in Ukrainian].

2. Rossoshanska, O.V. (2015). *Otsiniuvannia ekonomichnoi bezpeky innovatsiinykh proektno-oriientovanykh pidpryiemstv [Assessment of the economic security of innovative project-oriented enterprises].* Sievierodonetsk : vyd-vo SNU im. V. Dalia [in Ukrainian].

3. Maksymiuk, M. M. (2016). Metodychni pidkhody do vyznachennia ekonomichnoi bezpeky pidpryiemstv [Methodological approaches to determining the economic security of enterprises]. *Visnyk Khmelnytskoho natsionalnoho universytetu − Bulletin of Khmelnytskyi national University, 4(1),* 58-162 [in Ukrainian].

4. Gnilitskaya, L.V. (2010). Oblikovo-analitychne zabezpechennia funktsionuvannia systemy ekonomichnoi bezpeky pidpryiemstva [Accounting and analytical support for the functioning of the enterprise's economic security system]. *Doctor's thesis.* Kyiv. [in Ukrainian].

5. Keynes, J.M. (1948). *Obshchaya teoriya zanyatosti, procenta i deneg [General theory of employment, interest and money].* Moscow: Hos. yzd. ynostr. lyt. [in Russian].

6. Knight, F.H. (2003). *Risk, neopredelennost' i pribyl' [Risk, uncertainty and profit].* Moscow: Delo [in Russian].

7. Voloshchuk, L.O. (2015). *Innovatsiinyi rozvytok ta ekonomichna bezpeka promyslovykh pidpryiemstv: problemy kompleksnoho upravlinnia: monohrafiia [Innovative development and economic security of industrial enterprises: problems of integrated management: monograph].* Odesa: Bondarenko M. O. [in Ukrainian].

8. Dubnitsky, V.I., Myachin, V.G., Zybaylo, S.M., & Myroshnichenko, O.V. (2020). Building a neural network model for diagnosing the probability of bankruptcy of innovative-active enterprses and checking its adequacy. *Ekonomichnyi visnyk DVNZ UDKhTU − Economic Herald of SHEI USUCT, 1(11),* 16-23 [in English].

9. Dubnytskyi, V.I., & Miachyn, V.H. (2019). Neiromerezheva model diahnostyky finansovoho stanu ti imovirnosti nastannia bankrutstva innovatsiino-aktyvnykh pidpryiemstv [Neural network model of diagnostics of financial condition and probability of bankruptcy of innovative-active enterprises]. *Problemy systemnoho pidkhodu v ekonomitsi. Zbirnyk naukovykh prats − Problems of the system approach in Economics. Collection* of proceedings, *1(69),* 134-139 [in Ukrainian].

10. Miachyn, V.H., & Yefymov, O.V. (2018). Obgruntuvannia vyboru pokaznykiv dlia diahnostyky finansovoho stanu pidpryiemstv ta imovirnosti nastannia yikh bankrutstva [Justification of the choice of indicators for diagnosing the financial

ОБҐРУНТУВАННЯ ВИБОРУ ПОКАЗНИКІВ В МОДЕЛЯХ ОЦІНЮВАННЯ РІВНЯ ЕКОНОМІЧНОЇ БЕЗПЕКИ ІННОВАЦІЙНО-АКТИВНИХ ПІДПРИЄМСТВ В УМОВАХ НЕВИЗНАЧЕНОСТІ ВНУТРІШНЬОГО І ЗОВНІШНЬОГО СЕРЕДОВИЩА

Дубницький В.І., М'ячин В.Г., Зибайло С.М., Мирошниченко О.В.

Статтю присвячено обґрунтуванню вибору фінансових показників для дискримінантних та нейромережевих моделей діагностики економічної безпеки інноваційно-активних підприємств у сфері телекомунікацій в умовах невизначеності внутрішнього і зовнішнього середовища. Важливість оцінювання економічної безпеки системи будь-якого рівня безсумнівна, саме такі оцінювання виступають підставою прийняття рішень не лише щодо забезпечення економічної безпеки, а й можливостей розвитку системи, визначення необхідних ресурсів, створення та використання резервів системи, оцінювання ефективності системи економічної безпеки та діяльності відповідного підрозділу підприємства. Встановлено, що внаслідок абсолютно різної інструментальної бази наявні підходи до оцінювання економічної безпеки підприємства не конкурують між собою. Можна говорити лише про різний ступінь розробленості підходів та їх поширення. Показано важливість врахування феномена "невизначеності" в економічній діяльності інноваційно-активних підприємств, яка тісно пов'язана з поняттям "економічного ризику", оскільки будь-яка економічна або господарська діяльність підприємства характеризується неповнотою інформації про наявність закономірностей, непередбачуваністю багатьох економічних явищ і процесів, впливом великої кількості взаємопов'язаних і важко ідентифікованих факторів. Запропоновано і показано новітні методологічні засади щодо оцінювання економічної безпеки інноваційно-активних підприємств, які базуються на інструментарії нечіткої логіки та нейронних мереж. Метод нечітких множин дозволяє залучати обрані для оцінки економічної безпеки підприємств дані у їх динаміці, що дає можливість враховувати їх при прийнятті стратегічних управлінських рішень. Окрім того, використання сучасних аналітичних платформ дозволяє виконувати глибоку попередню обробку даних з метою їх перевірки на мультиколеніарність, виключення випадкових даних, що максимально враховує невизначеність вхідних і вихідних змінних.

Ключові слова: цифровізація, економічна безпека підприємства, кластеризація, нейронні мережі, фінансовий стан підприємства, імовірність настання банкрутства, нейромережевий алгоритм, дискримінантна модель, нечітка логіка.

ОБОСНОВАНИЕ ВЫБОРА ПОКАЗАТЕЛЕЙ В МОДЕЛЯХ ОЦЕНКИ УРОВНЯ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ ИННОВАЦИОННО-АКТИВНЫХ ПРЕДПРИЯТИЙ В УСЛОВИЯХ НЕОПРЕДЕЛЕННОСТИ ВНУТРЕННЕЙ И ВНЕШНЕЙ СРЕДЫ

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Статья посвящена обоснованию выбора финансовых показателей для дискриминантных и нейросетевых моделей диагностики экономической безопасности инновационно-активных предприятий в сфере телекоммуникаций в условиях неопределенности внутренней и внешней среды. Важность оценок экономической безопасности системы любого уровня несомненна, именно такие оценки выступают основанием принятия решений не только по обеспечение экономической безопасности, но и возможностей развития системы, определение необходимых ресурсов, создания и использования резервов системы, оценки эффективности системы экономической безопасности и деятельности соответствующего подразделения предприятия. Установлено, что в результате совершенно разной инструментальной базы имеющиеся подходы к оценке экономической безопасности предприятия не конкурируют между собой. Можно говорить лишь о различной степени разработанности подходов и их распространение. Показана важность учета феномена "неопределенности" в экономической деятельности инновационно-активных предприятий, которая тесно связана с понятием "экономического риска", поскольку любая экономическая или хозяйственная деятельность предприятия характеризуется неполнотой информации о наличии закономерностей, непредсказуемостью многих экономических явлений и процессов, воздействием большого количества взаимосвязанных и трудно идентифицируемых факторов. Предложены и показаны новейшие методологические основы оценки экономической безопасности инновационно-активных предприятий, которые базируются на инструментарии нечёткой логики и нейронных сетей. Метод нечётких множеств позволяет привлекать для оценки экономической безопасности предприятий данные в их динамике, что дает возможность учитывать их при принятии стратегических управленческих решений. Кроме того, использование современных аналитических платформ позволяет проводить глубокую предварительную обработку данных с целью их проверки на мультиколлинеарность, исключение случайных данных, что максимально учитывает неопределенность входных и выходных переменных.

Ключевые слова: цифровизация, экономическая безопасность предприятия, кластеризация, нейронные сети, финансовое состояние предприятия, вероятность наступления банкротства, нейросетевой алгоритм, дискриминантная модель, нечёткая логика.

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JUSTIFICATION OF THE CHOICE OF INDICATORS IN MODELS FOR ASSESSING THE LEVEL OF ECONOMIC SECURITY OF INNOVATIVE AND ACTIVE ENTERPRISES IN CONDITIONS OF UNCERTAINTY OF THE INTERNAL AND EXTERNAL ENVIRONMENT

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The article is devoted to substantiating the choice of financial indicators for discriminant and neural network models for diagnosing the economic security of innovative and active enterprises in the field of telecommunications in conditions of uncertainty of the internal and external environment. The importance of assessing the economic security of the system at any level is unquestionable, such assessments are the basis for decision-making not only on ensuring economic security, but also opportunities for system development, determination of necessary resources, creation and use of system reserves, evaluating the effectiveness of the economic security system and the activities of the relevant division of the enterprise. It is established that due to a completely different tool base, the available approaches to assessing the economic security of the enterprise do not compete with each other. We can only talk about the different degree of development of approaches and their dissemination. It shows the importance of taking into account the phenomenon of "uncertainty" in the economic activity of innovative-active enterprises, which is closely related to the concept of "economic risk", since any economic or economic activity of an enterprise is characterized by incompleteness of information about the presence of patterns, unpredictability of many economic phenomena and processes, the influence of a large number of interrelated and difficult to identify factors. The latest methodological foundations for assessing the economic security of innovative and active enterprises, which are based on the tools of Fuzzy Logic and neural networks, are proposed and shown. The fuzzy set method makes it possible to use the data selected for assessing the economic security of enterprises in their dynamics, which makes it possible to take them into account when making strategic management decisions. In addition, the use of modern analytical platforms allows for deep data preprocessing in order to check them for multicoleniarity, exclude random data, which takes into account the uncertainty of input and output variables as much as possible.

Keywords: digitalization, economic security of the enterprise, clusterization, neural networks, financial condition of the enterprise, probability of bankruptcy, neural network algorithm, discriminant model, fuzzy logic.

REFERENCES

1. Kozachenko, H.V., & Pohorelov, Yu.S. (2015). Pro deiaki problemy u suchasnii ekonomichnii bezpekolohii [About some problems in modern economic security]. *Upravlinnia proektamy ta rozvytok vyrobnytstva − Project management and production development, 3(55),* 8-18 [in Ukrainian].

2. Rossoshanska, O.V. (2015). *Otsiniuvannia ekonomichnoi bezpeky innovatsiinykh proektno-oriientovanykh pidpryiemstv [Assessment of the economic security of innovative project-oriented enterprises].* Sievierodonetsk : vyd-vo SNU im. V. Dalia [in Ukrainian].

3. Maksymiuk, M. M. (2016). Metodychni pidkhody do vyznachennia ekonomichnoi bezpeky pidpryiemstv [Methodological approaches to determining the economic security of enterprises]. *Visnyk Khmelnytskoho natsionalnoho universytetu − Bulletin of Khmelnytskyi national University, 4(1),* 58-162 [in Ukrainian].

4. Gnilitskaya, L.V. (2010). Oblikovo-analitychne zabezpechennia funktsionuvannia systemy ekonomichnoi bezpeky pidpryiemstva [Accounting and analytical support for the functioning of the enterprise's economic security system]. *Doctor's thesis.* Kyiv. [in Ukrainian].

5. Keynes, J.M. (1948). *Obshchaya teoriya zanyatosti, procenta i deneg [General theory of employment, interest and money].* Moscow: Hos. yzd. ynostr. lyt. [in Russian].

6. Knight, F.H. (2003). *Risk, neopredelennost' i pribyl' [Risk, uncertainty and profit].* Moscow: Delo [in Russian].

7. Voloshchuk, L.O. (2015). *Innovatsiinyi rozvytok ta ekonomichna bezpeka promyslovykh pidpryiemstv: problemy kompleksnoho upravlinnia: monohrafiia [Innovative development and economic security of industrial enterprises: problems of integrated management: monograph].* Odesa: Bondarenko M. O. [in Ukrainian].

8. Dubnitsky, V.I., Myachin, V.G., Zybaylo, S.M., & Myroshnichenko, O.V. (2020). Building a neural network model for diagnosing the probability of bankruptcy of innovative-active enterprses and checking its adequacy. *Ekonomichnyi visnyk DVNZ UDKhTU − Economic Herald of SHEI USUCT, 1(11),* 16-23 [in English].

9. Dubnytskyi, V.I., & Miachyn, V.H. (2019). Neiromerezheva model diahnostyky finansovoho stanu ti imovirnosti nastannia bankrutstva innovatsiino-aktyvnykh pidpryiemstv [Neural network model of diagnostics of financial condition and probability of bankruptcy of innovative-active enterprises]. *Problemy systemnoho pidkhodu v ekonomitsi. Zbirnyk naukovykh prats − Problems of the system approach in Economics. Collection* of proceedings, *1(69),* 134-139 [in Ukrainian].

10. Miachyn, V.H., & Yefymov, O.V. (2018). Obgruntuvannia vyboru pokaznykiv dlia diahnostyky finansovoho stanu pidpryiemstv ta imovirnosti nastannia yikh bankrutstva [Justification of the choice of indicators for diagnosing the financial condition of enterprises and the probability of their bankruptcy]. *Naukovyi visnyk Khersonskoho derzhavnoho unyversytetu. Seriia "Ekonomichni nauky" − Scientific Bulletin of Kherson state University. Series «Economic Sciences», 32,* 94-99 [in Ukrainian].