INDERSCIENCE PUBLISHERS
Linking academia, business and industry through research

International Journal of Environmental Technology and Management

ISSN online: 1741-511X - ISSN print: 1466-2132
https://www.inderscience.com/ijetm

Economic security and enterprise management in the conditions of an environmental economy as a basis for sustainable development

Svitlana Tiutchenko, Maryna Ivanova, Viktoriia Smiesova, Olena Tryfonova, Vasyl Shvets, Alla Dudnyk

DOI: 10.1504/IJETM.2023.10054092

Article History:

Received:	06 July 2022
Last revised:	17 October 2022
Accepted:	07 December 2022
Published online:	18 December 2023

Economic security and enterprise management in the conditions of an environmental economy as a basis for sustainable development

Svitlana Tiutchenko, Maryna Ivanova, Viktoriia Smiesova*, Olena Tryfonova, Vasyl Shvets and Alla Dudnyk

Dnipro University of Technology,
Dnipro, Ukraine
Email: tiutchenkosvetlana@gmail.com
Email: ma_riva@ukr.net
Email: smesova_vl@ukr.net
Email: elenatriphonova@gmail.com
Email: vasil-shvetc@ukr.net
Email: alvikd@ukr.net
*Corresponding author

Abstract: The paper addresses the features of management of enterprises in an environmental economy to ensure their economic security. It has been stated that currently there is a need to define criteria that would improve the procedure for assessing the economic security of enterprises and take into consideration the transition to an environmental economy. The authors have proposed a method for determining a three-component index for assessing the economic security and a matrix of security zones for enterprises. It has been stated that economic succession, which combines the results of economic, social and ecological development, should be determined by a three-component index of decoupling, which would combine indicators of financial-, social- and ecodecoupling. The paper presents calculations of the integral three-component index of economic succession for a currently operating metallurgical enterprise as well as the conclusions about the state of its economic security in the transition to environmental development.

Keywords: enterprise management; environmental economy; economic security; decoupling; nature management; sustainable development.

Reference to this paper should be made as follows: Tiutchenko, S., Ivanova, M., Smiesova, V., Tryfonova, O., Shvets, V. and Dudnyk, A. (2024) 'Economic security and enterprise management in the conditions of an environmental economy as a basis for sustainable development', *Int. J. Environmental Technology and Management*, Vol. 27, Nos. 1/2, pp.110–128.

Biographical notes: Svitlana Tiutchenko received her PhD at Classic Private University, Zaporizhzhia, in 2020. Currently, she is an Associate Professor of the Department of Applied Economics, Entrepreneurship and Public Administration in Dnipro University of Technology. Her research interests include business optimisation methods, economic security, and business modelling.

Maryna Ivanova received her Doctor of Economics at Kryvyi Rih National University in 2018. Currently, she is a Professor of the Department of Management in Dnipro University of Technology. Her research interests include economics and business management, business optimisation methods, economic security, and business modelling.

Viktoriia Smiesova received her Senior Doctorate of Doctor of economic sciences in Dnipro University of Technology in 2020. Currently she is a Full Professor of Dnipro University of Technology. Her research direction includes investment, management, economic security, business, and economics.

Olena Tryfonova received her Doctor of Economics at the Institute of Industrial Economics of the National Academy of Sciences of Ukraine in 2015. Currently, she is the Dean of the Faculty of Management in Dnipro University of Technology. Her research interests include economics and business management, business optimisation methods, economic security, and business modelling.

Vasyl Shvets received his Doctor of Economics at the Institute of Industrial Economics of the National Academy of Sciences of Ukraine in 2004. Currently, he is the Head of the Department of Management in Dnipro University of Technology. His research interests include economics and business management, business optimisation methods, economic security, and business modelling.

Alla Dudnyk received her PhD at Dnipro University of Technology in 2020. Currently, she is an Associate Professor of the Department of Management at Dnipro University of Technology. Her research interests include economics and business management, business optimisation methods, economic security, and business modelling.

1 Introduction

The financial and economic crisis, which is currently being observed in most countries, has brought to the fore the need to develop new approaches to managerial decision-making in the field of improving and/or ensuring economic security at both the state and enterprise levels. This situation requires consistent adherence to a clear research methodology and development of concepts and categories. Despite the significant achievements in the study of theoretical and methodological aspects of ensuring the enterprise economic security, the need for further productive research is due to the lack of a unanimous opinion on the essence of the concept and the existence of numerous approaches to interpreting its content.

Among the existing approaches to the study of enterprise economic security in economics, two groups can be distinguished:

1 a highly specialised approach which provides analysis of certain aspects of security of economic entities (certain types of security)

2 an extended interpretation that investigates activities of social subjects, first, as a sphere of relations between them; second, as a subject of theoretical and empirical cognition; third, as an object of analysis from the standpoint of politics, law, morality (Rohatina, 2015).

Some scholars only view economic security as a state of being protected that requires minimising the impact of risks and threats (Panchenko, 2017; Neustroev, 2021). We argue that this concept should be considered as a time-space harmonisation of economic interests in ensuring the enterprise performance and its further efficient development. Today, an urgent problem of man-kind is the environmental problem. Therefore, the priority interests of the enterprises in the field of economic growth should be based on the implementation of environment protection strategies, i.e., compliance with the national strategy of environmentalisation of the economy. Given the today's focus on Euro integration and due to global changes in economy, this concept should be formed taking into account the European regulations and principles of enterprise operation in terms of environmentalisation. The study by Saadat et al. (2020) addresses the issues of environmental economy. The study is mainly focused on the unpredictable environmental aspects of COVID-19 and identification of socio-economic factors that affect safety under these conditions (population density, urban and rural conditions, education, lifestyle, household size).

A group of authors (Mofijur et al., 2021) pursued their study of the COVID-19 impact on social, economic, environmental and energy security. Among other things, the socio-economic crisis has changed investment in the power industry and significantly affected the energy sector, as most investment activities have been disrupted by mobility restriction. It is expected that reduced investment in new energy sources will be the basis for uncertainty in the coming years. This factor, in turn, has a direct impact on the economic security of enterprises in many countries. Li and Kimura (2021) consider probable scenarios for the enhancement of hydrogen energy use and its impact on economic competitiveness as well as possible environmental con-sequences.

Onyshchenko et al. (2022) found out that the biggest threat to business security is productive, industrial, political, economic, financial, innovation and legal risks. The subject of the authors' separate study was systemic threats to the enterprise security. These are the market, state and political threats, and resources. To determine the dominant factors and conditions that cause threats to economic activities, the researchers have constructed a model that makes it possible to manage and eliminate threats at the initial stage, minimise their negative impact on the enterprise economic security given the shortcomings of economic regulations and impact of external factors, and to take preventive measures to eliminate them in a timely manner.

The generalisation of approaches to the definition of environmental economy and economic security of enterprises, the study of the existing methodological approaches to assessing the enterprise economic security revealed the absence of an approach that would take into account the environmental aspects of enterprise economic security. Therefore, the purpose of this article is to substantiate the methodological tools for assessing the economic security of enterprises, taking into account their ability to environmental development.

2 Research method: analysis of approaches to the definition of environmental economy and ensuring the economic security of enterprises

The issue of ensuring the enterprise economic security has constantly encouraged researchers to study various theoretical, methodological and practical aspects of the economic security assessment together with the totality of methodological tools, such as approaches, methods, techniques and procedures that are used for gaining a deeper insight into the issue. The vast majority of the methodological tools for assessing the enterprise economic security are based on models that use the provisions of deterministic causality and cause-and-effect unidirectional relationships. Yet, these models have shown their ineffectiveness under the current conditions of transition of national economies to the environmental development. All this requires the search for new models based on existing scientific facts and today's challenges, "the provisions of general scientific theory of assessment and the latest models of its implementation, which are continuously being developed in response to changes in the external environment" (Rososhans'ka, 2011).

At the same time, there are a number of scientific works in which ecological security is being considered as one of the components of ensuring economic security. Environmental safety is based on the capability of an enterprise and the territory within which it operates to solve the problem of limited economic resources and ensuring their rational use, development of eco-friendly and high-tech production, reduction of a negative impact of the enterprise on the environment, etc. (Akberdina et al., 2017). Therefore, it is environmental safety that is one of the factors for achieving sustainable economic development of the enterprise and maintaining its ability to function in conditions of risk and uncertainty. It is the environmental approach that these scholars use to form the methodical foundations they propose for assessing economic security.

The authors of this article support the above point of view and believe that the enterprise economic security should be ensured taking into account the principle of environmentalisation, and approaches to assessing the economic security of the enterprise should take into consideration this important aspect.

The concept of 'environmentalisation of the economy' has not been widely used in the works of today's researchers. But some theoretical justifications and interpretations of the con-tent of environmentalisation of the economy can be analysed. This concept is interpreted by scientists as: a kind of neo-industrial economy aimed at generating economic growth while pre-serving the environment (Vatchenko and Svystun, 2019); scientifically substantiated rationalisation of nature management in order to provide current and future generations with a healthy environment and sufficient natural resources; a complex, multilateral, targeted and manageable process of social development (Sidenko and Veklych, 2016); the process of transition to a model of economy aimed at generating economic growth on condition of efficient distribution of nature resources (Sokolova, 2016; Danylyshyn and Veklych, 2008; Balaniuk and Maksymiuk, 2016; Dejneko, 2018). These are: a kind of neo-industrial economy aimed at generating economic growth while preserving the environment (Vatchenko and Svystun, 2019); scientifically substantiated rationalisation of nature management in order to provide current and future generations with a healthy environment and sufficient natural resources; a complex, multilateral, targeted and manageable process of social

development (Sidenko and Veklych, 2016); the process of transition to a model of economy aimed at generating economic growth on condition of efficient distribution of nature resources (Sokolova, 2016; Danylyshyn and Veklych, 2008; Balaniuk and Maksymiuk, 2016; Dejneko, 2018).

Having analysed the researchers' interpretations of the process of environmentalisation of the economy, we generalise the characteristic features: long-term economic growth based on rational and environment-friendly management and highly efficient use of natural resources; saving resources and reduction of anthropogenic pressure on the environment; stimulating the introduction of innovation low-carbon, resource- and energy-saving technologies; ensuring economic growth while reducing the level of nature-intensive production and its nature load; reproduction and improvement of the quality of the environment, natural and resource opportunities, improvement of the living standards of all generations.

In our view, the enterprise economic security formed according to the principle of environmentalisation will, firstly, be determined by its ability to resist the influence of factors (exogenous and endogenous) that may cause adverse changes in the environmental protection, rational use of economic resources, use of technologies (increasing the share of 'low' technologies), results of the enterprise's economic activity and, correspondingly, cause a decrease in the level of its environmental and economic security. This capability of the enterprise, in our opinion, is characterised by such an indicator as resistance, i.e., the property of resisting and effectively responding to the negative influence of external and internal environment factors.

Secondly, the capability of the enterprise to reduce, minimise, mitigate the risks of violation of environmental and economic security, that is, the ability to risk reduction. In our opinion, the ability to reduce the risk of environmental pollution, non-compliance with environmental norms of the enterprise's functioning, making ineffective management decisions, localisation of possible ecological and economic threats is a guarantee of the economic security of the enterprise and its ecological component.

Thirdly, we consider the enterprise's capability to environmental development, i.e., to economic succession, to be an important component of the enterprise economic security in the specified context. Economic succession involves changes in economic security, based on increasing the enterprise's capability for ecological and economic recovery and development, achieving order and balance in its ecological and economic system, which in turn forms the basis for innovative development of production and sustainable environmental development. The socio-cultural dimension is of great importance, which determines the behavioural patterns of economic actors, which in turn either encourage or discourage the adoption of new models of development (Pylypenko, 2013; Pylypenko et al., 2019). Informal institutions, shaped by a particular culture, very often limit innovation and the use of other people's experiences, which requires consideration of their influence.

Based on this position of the authors, the enterprise economic security in the context of the environmental approach is understood as the capability of enterprises for resistance, risk reduction and economic succession in the conditions of uncertainty and variability of the operating environment, and, thus, their ability for environmental development.

The purpose of the article is the approbation of the author's approach to assessing the enterprise economic security in terms of ensuring environmental development on the example of enterprises of the metallurgical complex in Ukraine, the development of

managerial measures to ensure their economic security, forecasting changes in the level of economic security of the metallurgical enterprises based on the authors' proposed methodological approach to its assessment.

3 Methods for assessing the enterprise economic security

Economic security is a rather complex, specific category. It not only characterises the internal processes that take place within the enterprise, but also depends on the external environment, since each enterprise is an open system. The direct calculation of the integral index of economic security is carried out using partial indicators for each identified component, taking into account their weight. The partial indicators provide information on the development of individual components of economic security, while the general integral index provides information on the level of economic security of the enterprise as a whole.

A detailed analysis of the current methodological tools for assessing the enterprise economic security shows an increasing use of a toolkit for an integral assessment which is based on criteria and numerous approaches. The latter, in our opinion, need to be conditionally divided into traditional approaches, which have been most widely used in foreign and domestic practice (Table 1), and the non-traditional approaches that are gaining ground in the context of an environmental economy (Table 2).

The prevalence of traditional approaches is conditioned by their advantage of aggregating large amounts of information into easily understandable formats – integral indices. Among the disadvantages of traditional approaches, the following can be distinguished:

- Lack of initial information, its poor quality and long period of accumulating and processing.
- Retrospective nature. In assessing the level of the enterprise economic security, it is important to apply not only a retrospective, but also a prospective assessment, since the results of a prospective assessment can serve as a basis for developing the enterprise development strategy (Prus, 2013).
- A significant dependence on the reliability of the results obtained, accuracy and definition of the indicator list, accuracy of determining the basis of comparison, and in addition, difficulty making decisions using the results (Blyzniuk, 2013; Ovcharenko et al., 2021, 2022).

Regarding the non-traditional approaches to assessing the enterprise economic security, their use is specified by certain current changes in the economy (Table 2).

In our opinion, the non-traditional approaches to the assessment of the enterprise economic security, which were proposed by Kozachenko and Ponomar'ov need to be clarified in terms of adding some new evaluation criteria to the environmental approach. This need is primarily called for by the adoption of the Paris Agreement on climate change and other international legal acts and commitments regarding the implementation of energy saving technologies and environmental protection, which necessitates an assessment of the enterprise's compliance with these requirements. On the other hand, some scientists put forward ideas about the need to take into account the degree of

rationality in the use of resources by enterprises when assessing the enterprise economic security.

Table 1 Traditional approaches to assessing the enterprise economic security

Traditional approaches	*Content of the approach*
Resource approach	Considers economic security as the state of the most efficient use of resources so that to prevent threats and ensure the sustainable functioning of the organisation now and in the future.
Cyclical approach	Is based on the assessment of economic security using the theory of economic cycles associated with the rise and fall of the enterprise's business activity over a period of time.
Systems approach	Involves the study of the enterprise economic security from the standpoint of interconnected and interdependent elements and the processes that occur between them.
Targeted approach	Involves the study of economic security by the capability of the enterprise to achieve certain goals related to the quality of products (services), market size, competitive advantage, risk minimisation, etc.
Process approach	Characterises the level of economic security in terms of the effect obtained from activities by increasing the beneficial result and reducing the cost of achieving it by rationally combining various resources.
Situational approach	Involves assessing economic security by the capability of the enterprise to respond promptly to changes in the situation or circumstances that arise in its operating environment.
Financial approach	Involves assessing economic security in terms of the enterprise's financial condition, financial stability and financial self-sufficiency, as well as its capability to service and repay debt.
Investment approach	Involves assessing economic security in terms of the enterprise's gross investment and the amount of investment resources necessary to maintain the conditions that ensure the enterprise economic security.
Emission approach	Involves a study of economic security in terms of the level of threats that joint-stock companies may experience in issuance and offering of shares.

Source: Adapted from Lipkan (2003)

For example, Stoeck (2016) pointed out that the use of reverse logistics will allow the movement of products and materials to be organised in the opposite direction, which will ensure their reuse and contribute to savings and more rational use of resources. Although the scientist did not state that the above directly affects the enterprise economic security, which was not the subject of his research, such a cause-and-effect relationship exists according to other scientists (Akberdina et al., 2017). Akberdin et al. carried out an economic security assessment based on the traditional approach; however, they also analysed the environmental aspects of security.

Based on the above, we consider this approach to be the most productive in the context of our study. At the same time, we believe that it would be expedient to supplement the environmental approach to the assessment of the enterprise economic security by assessing the level of resistance, risk reduction and economic succession of the enterprise. This will make it possible to complement the research methodology for the economic security of environmentally oriented enterprises by analysing their capability to

resist internal and external threats, the ability to mitigate existing risks, restore viability and ensure their further development.

Table 2 The non-traditional approaches to the integral assessment of the enterprise economic security

Non-traditional approaches	*Content of approach*
Digital approach	Involves assessing the economic security of enterprises by the level of their security in the information and communication environment.
Beneficial approach	Involves assessing the enterprise economic security by the integral index of financial condition, obtained by multifactor discriminant analysis of the financial statements of the beneficiary.
Stakeholder approach	Involves assessing the enterprise economic security by the shortfall in the amount of unused costs, which is the difference between the liminal (threshold) amount that should (preferably) be incurred to meet the economic interests of stakeholders and the actual amount of costs incurred.
Reputational approach	Characterises the economic security of the enterprise in terms of risks associated with an unusual asset, i.e., reputation which is assessed by the expert method according to a scoring system.
Environmental approach	Characterises the enterprise economic security by the enterprise's capability to increase production while reducing the environmental load and nature consumption.

Source: Adapted from Kozachenko and Ponomar'ov (2001)

Table 3 Plan and stages of the study

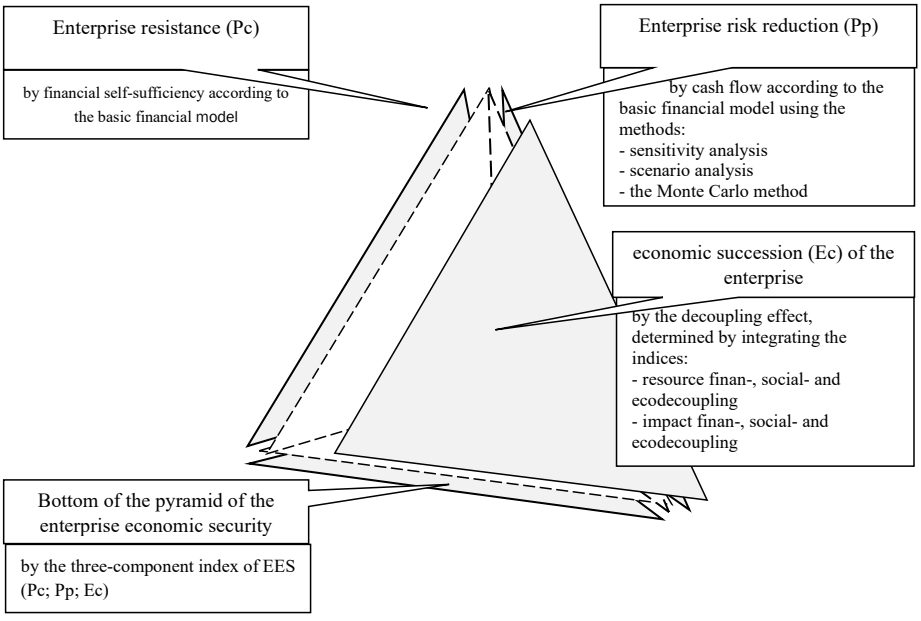
Stages	*Research plan*
1	Analyse and compare the existing methodological approaches to the integral assessment of the economic security of enterprises.
2	Assess the state of economic security of metallurgical enterprises according to the 'pyramid of economic security' in 2010–2020, based on the calculation of integral indicators of resistance, risk reduction and economic succession, as well as the construction of a matrix for determining the zones of economic security of the enterprise.
3	Propose a system of management measures in the field of ensuring the economic security of enterprises in the future period.
4	Forecast economic succession indicators in the next two years.

Source: Compiled by the authors

The authors of this article conducted the research in several stages. The first stage of the research proposed an approach to calculating the integral index of the enterprise economic security. This part of the study was reported in the authors' article cited in Ivanova et al. (2021). At the second stage of the research, the authors tested the proposed methodological approach: an analysis of the economic security of Ukrainian metallurgical enterprises in 2010–2020 was conducted, management measures have been proposed to ensure their economic security, and the changes in the components of the integral index of the economic security for these enterprises have been forecasted for the next two years (see Table 3).

Having analysed and assessed the advantages and disadvantages of the existing methodological tools for integral assessment of the enterprise economic security, and given the transition to an environmental economy, we consider it appropriate to propose a methodology for assessing it by the 'pyramid of the enterprise economic security' (Figure 1).

Figure 1 Schematic representation of assessment of the enterprise economic security using the 'pyramid of economic security'



Source: Compiled by authors

The faces of the pyramid are planes that characterise the ability of enterprises to resistance, risk reduction and economic succession. The bottom of the pyramid is a plane that connects the above parameters so that to assess the enterprise economic security.

The 'economic security pyramid' proposes the use of a three-component integral index of economic security (EES), which is a function of the integral index of resistance (Pc), integral index of risk reduction (Pp) and integral index of economic succession (Ec) (Ivanova et al., 2021).

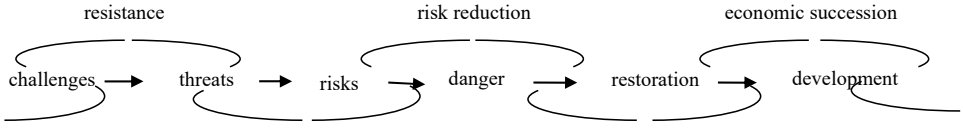
Criteria for enterprise economic security should be based not only on financial performance, but they also take into account potential external threats. According to this approach, the assessment of economic security of enterprises should be carried out according to the following criteria: the ability of enterprises to resist, the ability of enterprises to reduce risk, the ability of enterprises to economic succession.

The resistance indicator shows the ability of enterprises in the conditions of changing operating environment to withstand destabilisation through resistance to challenges accompanied by threats to the economic security of enterprises. According to the criterion of resistance, the indicator of Pc will be equal to one, if the results of calculating the indices demonstrate that the enterprise is financially self-sustaining. If not, Pc will be equal to zero.

The risk reduction index Pp shows the capability of the enterprise to minimise or level the existing risks and threats to business. This index should be calculated based on the cash flow by the basic financial model using the methods of sensitivity analysis or scenario analysis. The Pp index will be equal to 1, if according to the results of the calculation, the enterprise is capable of minimising or levelling the existing risks and threats. If not, it will be equal to zero.

The economic succession index shows the capability of enterprises to restore viability and advance in their development despite the impacts of internal and external risks. The relationship between resistance, risk reduction, and economic succession is schematically represented by a chain (Figure 2).

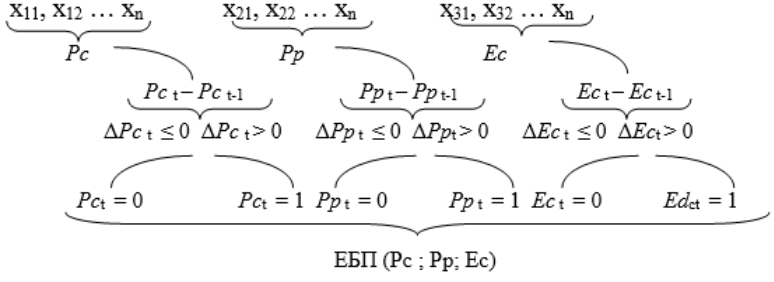
Figure 2 Chain of economic security assessment



Source: Compiled by the authors

Figure 3 shows the methodology and sequence for calculating the integral indices of resistance, risk reduction and economic succession. The schematic shows that, first of all, integral indices Pc, Pp and Ec should be determined on the basis of partial indicators. If the value of each integral i-index over the t-period exceeds 0, then there is a tendency for its growth relative to the base indicator over the (t – 1) period. To assess each i-index in the t-period, a score is assigned, which is based on the value of the index relative to its base level in the period of (t – 1).

Figure 3 Method and sequence for calculating the integral indices of resistance, risk reduction and economic succession



Source: Compiled by the authors

If the value of any integral i-index of economic succession in the t-period exceeds 0, this indicates a trend of its growth relative to the base indicator in the (t – 1) period, which is scored as 1. If the value of any integral i-index of economic succession in the t-period is below or equal to 0, this indicates a tendency to a decrease relative to the base indicator over the (t – 1) period, which is scored as zero. Therefore, the value of the EES is considered sufficient if the values of Pc, Pp and Ec are equal to 1:

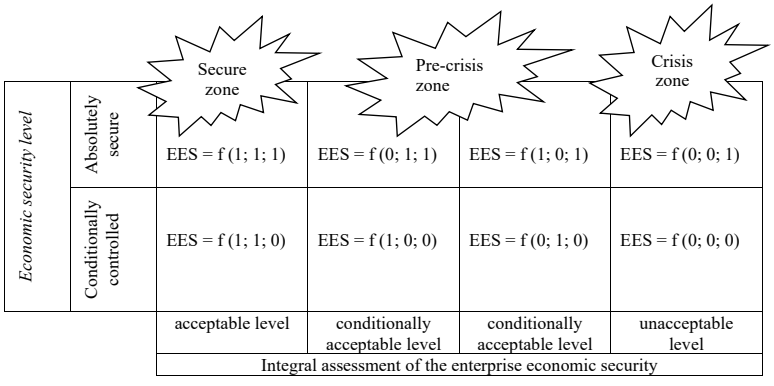
$$EES = f(1; 1; 1) \quad (1)$$

In the case when the actual value of the indices Pc, Pp and Ec is zero, the value of the EES is considered dangerous:

$$EES = f(0; 0; 0) \quad (2)$$

For the index of enterprise economic security, there are eight possible situations which conditionally correspond to four security zones (Figure 4).

Figure 4 Matrix of the enterprise economic security zones according to the three-component EES index



Source: Compiled by the authors

The absolutely secure zone is characterised by the capability of environmentally oriented enterprises to withstand internal and external threats and the capability to minimise existing risks. The pre-crisis and crisis zones include enterprises that manifest economic instability and financial dependence. In the event that an economically unstable and financially dependent enterprise is additionally characterised by non-compliance with the standards of corporate social responsibility or environmental protection, this enterprise belongs to the crisis zone. To the secure zone belong enterprises, which cannot be recovered even by reorganisational measures.

The adequacy of attribution of an enterprise to the above zones of economic security should be checked by a thorough and high-quality assessment of the risk levels and on condition of full information support. Considering the structure of the chain, we can clearly see not only the interrelations of the above criteria for assessing the enterprise economic security, but also their relationships with the stages of danger emergence, balance restoration and development. For example, at the stages of challenges and threats to the economic security of the enterprise, it is enough to assess its capability to resist. With the emergence of risks, it is possible to assess the capability of the enterprise to minimise or level the risks using the indices of risk reduction. In the event of danger, the capability of restoring balance in the enterprise operating environment and its ability to further develop can be assessed by indices of economic succession. Therefore, the expediency of assessing the enterprise economic security according to the proposed criteria is first of all justified by their compliance with the staging of the danger emergence.

Given the results of our analysis, the capability of the enterprise for economic succession can be determined using the three-component index Ec:

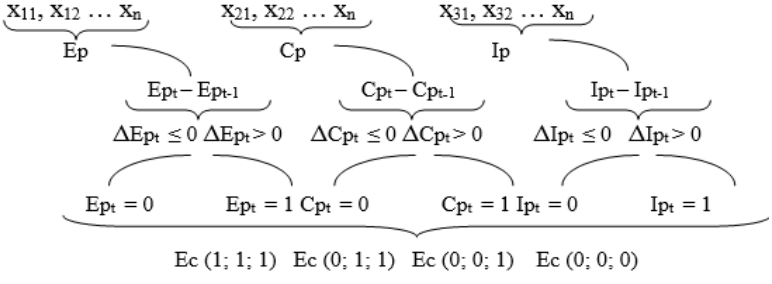
$$Ec\begin{cases} Ep \to 1; \\ Cp \to 1; \\ Ip \to 1, \end{cases} \tag{3}$$

where

- Ec is a three-component index of economic succession
- Ep is an integral index that characterises changes in economic development of the enterprise
- Cp is an integral index that characterises changes in social development of the enterprise
- Ip is an integral index that characterises changes in the environmental development of the enterprise.

Figure 5 shows the sequence of calculating the indices of economic succession. Integral indices Ep, Cp and Ip are determined from partial indicators. Each i^{th} index of economic succession in period t is scored as 1 if its value exceeds 0. If any integral index in the t-period is lower than or equal to 0, then it is scored as 0.

Figure 5 The sequence of calculating the indices of economic succession



Source: Compiled by the authors

Thus, the triune index of economic succession may take the form:

- Es (1; 1; 1) – indicates the current trend of environmental development at the enterprise
- Es (0; 0; 0) – indicates a decline trend that has developed at the enterprise
- Es (0; 1; 1) – indicates the current trend of social and environmental development at the enterprise
- Es (1; 0; 1) – indicates the current trend of economic and environmental development at the enterprise
- Es (1; 1; 0) – indicates the current trend of economic and social development at the enterprise
- Es (0; 0; 1) – indicates the current trend of ecological development at the enterprise
- Es (0; 1; 0) – indicates the current trend of social development at the enterprise

- Es (1; 0; 0) – indicates the current trend of economic development at the enterprise.

Thus, after a thorough study of existing scientific and methodological tools for assessing economic security, the authors propose a modified methodological approach to forming a system of criteria for assessing economic security of enterprises, based on the company's ability to resistance, risk reduction and economic succession. Economic succession, in turn, is determined by a three-component index, which is calculated on the basis of functional components of economic, social and environmental development of the enterprise. Therefore, the proposed system of criteria for assessing the enterprise economic security meets the conditions of the transition to an environmental economy.

4 Research and results

Having defined economic succession as the ability of the enterprise to environmental development, which involves the simultaneous combination of economic, social and ecological development, we argue that it necessary to assess this index by a three-component index of decoupling, which has to combine indicators of *finan-*, *social-* and *ecodecoupling*. Decoupling is a disruption in the relationship between economic growth rates and the rate of anthropogenic pressure on the environment and human health (Vitlins'kyj and Velykoivanenko, 2004). The effect of decoupling is manifested when, with positive dynamics of economic growth, the indices of negative impact on the environment remain stable or show a downward trend over the same period. Achieving the decoupling effect is one of the vital goals for countries moving towards sustainable development and building a 'green' economy, since it allows minimising the negative consequences of economic growth, such as depletion of resources and the social consequences of anthropogenic pressure on the environment, such as an increase in the incidence of diseases associated with the environmentally destructive development of the economy (Vatchenko and Svystun, 2019). Decoupling is a phenomenon that involves using fewer resources per unit of production and reducing a negative environmental impact of the resources used or the economic activities performed. Hence, it is common to distinguish between decoupling by environmental impact factors and decoupling by resource factors.

Decoupling by factors of impact (or pressure) on the environment is observed in the case of an increase in production volumes combined with a reduction of the negative impact on the environment from any economic activity (reducing groundwater pollution, land degradation, air emissions, waste generation, etc.), i.e., an increase in eco-efficiency. Resource decoupling means reducing the rate of resource use per unit of economic result, and it is a result of increased resource productivity (Vatchenko and Svystun, 2019). A sound approach with using an economic-mathematical model of assessing the effectiveness of investing in the creation of social values by the decoupling approach was considered in Tkachenko et al. (2021).

The first international organisation to propose the concept of environmental decoupling was the Organization for Economic Co-operation and Development (OECD) that defines decoupling as breaking the link between 'negative environmental impacts' and 'economic benefits' (The OECD Environment Programme, 2022). Thus, decoupling according to the OECD methodology is characterised by the following indicators: *resource decoupling* is decoupling by the nature intensity of production (the level of

natural resources use in production); *impact decoupling* is decoupling by environmental load (the level of production impact on the environment (Litvak, 2016). Resource decoupling is calculated using the method that was described in detail and tested in (Ivanova et al., 2021).

Table 3 Summary integral indices of the three-component index of economic succession of a metallurgical enterprise

Years	*Indicators*		
	Integral index of financial decoupling (Fd)	*Integral index of social decoupling (Sd)*	*Integral index of environmental decoupling (Ed)*
2010	18.40	–15.03	10.74
2011	72.41	35.47	29.87
2012	–3.77	–17.60	–21.02
2013	6.51	–11.37	–12.49
2014	–21.46	–8.51	–18.01
2015	–31.18	4.22	7.81
2016	16.00	–12.19	2.39
2017	23.27	–15.13	6.78
2018	28.30	–9.22	4.06
2019	31.28	–3.21	5.62
2020	34.56	–2.11	7.13

Source: Compiled by the authors

The generalisation of *resource* and *impact decoupling factor* indices will give a three-component Ec index, which is a function of an integral index of financial decoupling (Fd), an integral index of social decoupling (Sd), and an integral index of environmental decoupling (Ed) (Ivanova et al., 2021). Since there may be situations when the components of the three-component index Ec do not coincide in values, we consider it expedient to take its final value on the majority of its component values. For example, if Ec is characterised as (1; 0; 1), then its final value should be taken as 1; however, if Ec is characterised by (0; 0; 1), then the final value should be taken as 0. Table 3 shows the summary integral indices of the three-component index of economic succession for the period of 2010–2020.

In 2020, the metallurgical enterprise showed Ec = (1; 0; 1). Consequently, the integral index of economic succession is taken as one. Based on the theoretical study carried out in this article, the level of economic security of the enterprise EES = f (Pc; Pp; Ec). It should be clarified that a preliminary analysis has revealed the financial self-sufficiency of the metallurgical enterprise; therefore, we can assume that the integral index of resistance (RS) will be equal to one. However, the metallurgical enterprise has not shown the capability to minimise or level the existing risks and threats to current business processes, so the integral index of risk reduction (PP) will be zero.

Therefore, the EES has the form of EES = (1; 0; 1) and, guided by the schematic (Figure 6), we state that the metallurgical enterprise falls into the zone of 'pre-crisis condition'. When developing the measures, we recommend to take into consideration the stages of the enterprise development and to use one of the directions for further development or a combination of them (Table 4). In designing the strategies aimed at

avoiding a crisis, it is necessary to take into account various combinations of production, economic, organisational, financial, and other factors that determine a particular model of economic activity. When making the choice of the final option, it is advisable to take into consideration the interests of the enterprise's stakeholders.

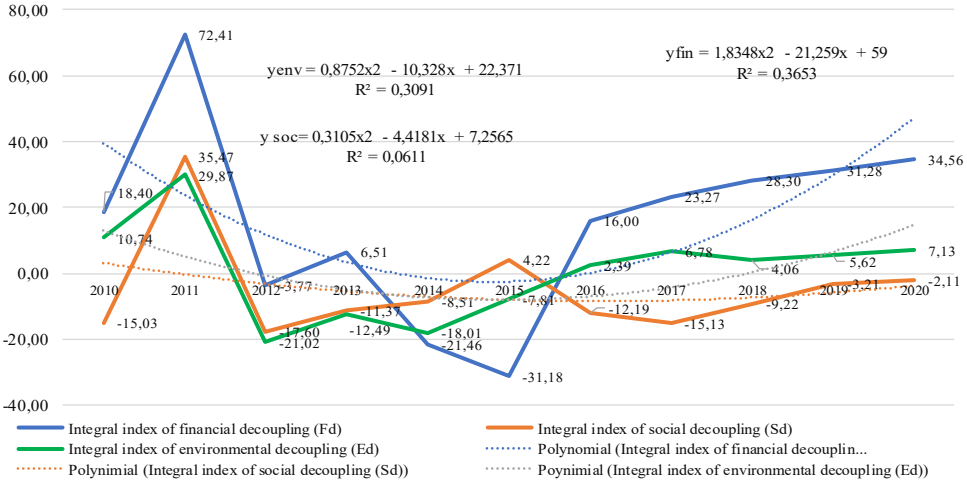
Table 4 Development of measures to ensure the economic security of the metallurgical enterprise in the future

Stage	*Current actions*	*Strategic actions*	*Formation of competitive advantages*
Enterprise launch and development	• A detailed overview of the market for upcoming products • Study of existing competitors • Use of the services of experienced marketers in the promotion of the product to the market	Eliminate the crisis by forming a strategy for entering the market.	Find a target customer, determine the price limit that they can pay for the product.
Upturn	• Effective use of working capital, which should be directed to the creation of products with a promising growth in demand • Determining the prospects for sales of the enterprise's current range of products	Improve the quality of goods, penetrate into new market segments, use new distribution channels, attract an additional number of consumers; create and introduce the new product into the market so that the losses borne in this connection are offset by the profit of a product that is 'on the rise'.	Rank the enterprise's entire range of products according to the prospects for sales; clarify the supply of resources needed for the production, assess the opportunities for stable marketing of the new products and provide the necessary raw materials for their manufacture.
Downturn	• Development of programs for more efficient use of resources available to the enterprise • Sale of unused equipment and materials • Full or partial re-profiling of the production • Introduction of advanced forms and methods of labour organisation	Reorganise the enterprise by creating a new company through a merger with a financially stable business entity; take the profitable areas of production out of the existing enterprise.	Minimise the accounts payable, increase stability and liquidity.

Source: Compiled by the authors

Since forecasting the level of economic security is the major issue that enterprise managers need to solve, we will consider the trend lines of indices (Figure 6), which affect the economic succession of the metallurgical enterprise, using the calculations in Table 3.

Figure 6 Forecasting the components of economic succession of the metallurgical enterprise (see online version for colours)



Source: Compiled by the authors

It is evident that an integral index of financial decoupling (Fd) will grow with a probability of 36.53% in the next two years, an integral index of social decoupling (Sd) – 6.11%, and an integral index of environmental decoupling (Ed) – 30.91%. Thus, it has been proved that ensuring the economic security of metallurgical enterprises in the conditions of continuous transformational changes in the economy is defined as the resistance of enterprises to challenges and threats, as well as their ability to environmental development.

5 Conclusions

An analysis of the existing methodological tools for assessing the enterprise economic security has shown that the vast majority of scholars' approaches are based on the models of deterministic causality and cause-and-effect unidirectional relationships. According to the authors' approach, economic security is interpreted as a system of ensuring resistance, risk reduction and economic succession of enterprises in the face of challenges and threats in the process of implementing the strategy of transition to an environmental economy. Accordingly, the current traditional and non-traditional approaches to the integral assessment of the enterprise economic security have been supplemented by the environmental method based on indices of resistance, risk reduction and economic succession. A methodical approach has been proposed for assessing the enterprise economic security based on calculating a three-component EES index and a matrix of security zones for enterprises. Economic succession, as the ability of the enterprise to environmental development, has been recommended to determine by a three-component index of decoupling, which combines the results of economic, social and environmental development (financial-, social- and ecodecoupling). Calculations for the integral three-component index of economic succession were done at an operating metallurgical enterprise and conclusions were made about the state of its economic security in the

conditions of environmental development. The use of the proposed methodical approach in an environmentally oriented enterprise will in practice provide an assessment of its security level and creating.

References

Akberdina, V., Grebenkin, A. and Smirnova O. (2017) 'Kompleksnyy instrumentariy otsenki ekonomicheskoy bezopasnosti otrasley ekonomiki: regionalnyy aspekt', *Ekonomika Regiona*, Vol. 13, No. 4, pp.1264–1279, in Ukrainian [online] https://elar.urfu.ru/bitstream/10995/89998/1/10.17059-2017-4-23.pdf (accessed 20 June 2022).

Balaniuk, I. and Maksymiuk, M. (2016) 'Vydy ekonomichnoi bezpeky [types of economic security]', *Naukovyj Visnyk Uzhhorods'koho Universytetu. Seriia: Ekonomika*, Vol. 1, No. 2, pp.142–145.

Blyzniuk, A.A. (2013) 'Analiz metodyk otsiniuvannia ekonomichnoi bezpeky pidpryiemstva [analysis of methods for assessing the economic security of the enterprise]', *Vcheni Zapysky Universytetu «KROK»*, No. 34, pp.240–247.

Danylyshyn, B.M. and Veklych, O.O. (2008) 'Efekt dekaplinhu iak faktor vzaiemozv'iazku mizh ekonomichnym zrostanniam i tyskom na dovkillia [the effect of decoupling as a factor in the relationship between economic growth and environmental pressure]', *Visnyk NAN Ukrainy*, No. 5, pp.12–18.

Dejneko, L.V. (2018) 'Rozvytok promyslovosti dlia zabezpechennia zrostannia ta onovlennia ukrains'koi ekonomiky: naukovo-analitychna dopovid [development of industry to ensure the growth and renewal of the Ukrainian economy: a scientific and analytical report]', *Kyiv: NAN Ukrainy, DU 'In-t Ekon. Ta prohnozuv. NAN Ukrainy'*, p.158.

Ivanova, M., Tiutchenko, S., Grosheleva, O., Fonarova, T. and Ryzhkov, E. (2021) 'Managing economic security of metallurgical enterprises under the conditions of transformation changes in the economy', *Estudios de Economía Aplicada*, Vol. 39, No. 5 [online] http://ojs.ual.es/ojs/index.php/eea/article/view/5116 (accessed 20 June 2022).

Kozachenko, H. and Ponomar'ov, V. (2001) 'Ekonomichna bezpeka pidpryiemstv: sutnist' i peredumovy formuvannia [economic security of enterprises: essence and preconditions of formation]', *Teoriia ta Praktyka Upravlinnia u Transformatsijnyj Period*, Vol. 3, pp.3–7.

Li, Y. and Kimura, S. (2021) 'Economic competitiveness and environmental implications of hydrogen energy and fuel cell electric vehicles in ASEAN countries: the current and future scenarios', *Energy Policy*, Vol. 148, No. B [online] https://doi.org/10.1016/j.enpol.2020.111980.

Lipkan, V.A. (2003) 'Bezpekoznavstvo [security]', *Kyiv: Yevrop*, Vol. 208.

Litvak, O.A. (2016) 'Dekaplinh-analiz ekonomichnoho zrostannia ta ratsional'noho sil's'kohospodars'koho zemlekorystuvannia v ahrarnomu sektori [decapping analysis of economic growth and rational agricultural land use in the agricultural sector]', *Naukovyj Visnyk Khersons'koho Derzhavnoho Universytetu*, Vol. 15, No. 4, pp.40–41.

Mofijur, M., Fattah, R.I.M., Alam, A.M., Islam, S.A.B.M., Ong, C.H., Rahman, A.S.M., Najafie, G., Ahmed, S.F., Udding, A.M. and Mahlia, T.M.I. (2021) 'Impact of COVID-19 on the social, economic, environmental and energy domains: lessons learnt from a global pandemic', *Sustainable Production and Consumption*, Vol. 26 [online] https://doi.org/10.1016/j.spc.2020.10.016 (accessed 20 June 2022).

Neustroev, Y.H. (2021) 'Do problemy vyznachennia kryteriiv ekonomichnoi bezpeky [to the problem of determining the criteria of economic security]', *Ekonomika ta Derzhava*, Vol. 2, pp.118–122 [online] https://doi.org/10.32702/2306-6806.2021.2.118.

Onyshchenko, S., Hlushko, A., Maslii, O. and Skryl, V. (2022) 'Risks and threats to economic security of enterprises in the construction industry under pandemic conditions', *Proceedings of the 3rd International Conference on Building Innovations, CBI 2020*, Vol. 181, pp.711–724 [online] https://link.springer.com/chapter/10.1007/978-3-030-85043-2_66 (accessed 20 June 2022).

Ovcharenko, O., Korotka, L., Smiesova, V., Kuchkova, O. and Karpenko, R. (2022) 'Economic security of regions: a methodological approach to assessment, management, and legal regulation', *Region*, Vol. 9, No. 1, pp.83–100, DOI: 10.18335/region.v9i1.375.

Ovcharenko, O., Smiesova, V., Ivanova, M., Kovtun, N. and Zolotukhina, L. (2021) 'Economic security management at the meso-level: methodological and legal approach', *Regional Science Inquiry*. Vol. 13, No. 1, pp.201–216 [online] http://www.rsijournal.eu/ARTICLES/June_2021/14.pdf (accessed 20 June 2022).

Panchenko, V.A. (2017) 'Systematyzatsiia pidkhodiv do traktuvannia poniattia 'ekonomichna bezpeka pidpryiemstv' [systematization of approaches to the interpretation of the concept of 'economic security of enterprises']', *Efektyvna Ekonomika*, Vol. 11, in Ukrainian [online] http://www.economy.nayka.com.ua/?op=1&z=6512 (accessed 12 February and 20 June 2022).

Prus, N.V. (2013) 'Metodychni pidkhody do otsinky rivnia ekonomichnoi bezpeky pidpryiemstva [methodical approaches to assessing the level of economic security of the enterprise]', *Vcheni Zapysky Universytetu «KROK»*, Vol. 34, pp.276–283 [online] https://library.krok.edu.ua/media/library/category/zhurnali/vcheni-zapiski-universitetu-krok/vcheni-zapiski-universitetu-krok-n34.pdf.

Pylypenko H., Lytvynenko N. and Barna T. (2019) 'Socio-cultural context of innovative development', *Philosophy and Cosmology*, Vol. 23, pp.98–111, DOI: 10.29202/phil-cosm/23/9.

Pylypenko, H.M. (2013) 'Vplyv kultury na spivvidnoshennia derzhavnoi i rynkovoi koordynatsii v Ukraini', *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, 20 June, Vol. 3, No. 135, pp.118–126, in Ukrainian.

Rohatina, L.P. (2015) 'Metodolohichni zasady vyznachennia katehorij bezpeky sub'iektiv hospodariuvannia [methodological principles for determining the security categories of business entities]', *Efektyvna Ekonomika*, Vol. 12, in Ukrainian [online] http://www.economy.nayka.com.ua/pdf/12_2015/59.pdf (accessed 12 February and 20 June 2022).

Rososhans'ka, O.V. (2011) ''Bezpeka ta bezpechnist' iak kharakterystyky komfortnoho stanu tsiloho [safety and security as characteristics of the comfortable state of the whole]', *Visnyk Skhidnoukrains'koho Natsional'noho Universytetu im. V. Dalia*, Vol. 3, No. 157, pp.211–215.

Saadat, S., Rawtani, D. and Hussain, C.M. (2020) 'Environmental perspective of COVID-19', *Science of the Total Environment*, Vol. 728 [online] https://doi.org/10.1016/j.scitotenv.2020.138870.

Sidenko, V.R. and Veklych, O.O. (2016) 'Ukraina i polityka protydii zmini klimatu: ekonomichnyj aspekt: analitychna dopovid [ukraine and the policy of combating climate change: economic aspect: analytical report]', *Kyiv: Zapovit*, Vol. 208.

Sokolova, L.V. (2016) 'Teoretyko-metodolohichna platforma rozrobky systemy adaptatsii pidpryiemstv do zmin zovnishn'oho seredovyscha [theoretical and methodological platform for developing a system of adaptation of enterprises to changes in the environment]', *Problemy Ekonomiky*, Vol. 3, pp.206–211, in Ukrainian [online] https://www.problecon.com/export_pdf/problems-of-economy-2016-3_0-pages-206_211.pdf (accessed 20 June 2022).

Stoeck, T. (2016) 'Aspects of implementing the principles of sustainability in automotive companies', *Economics and Organization of Enterprise*, Vol. 6, No. 797, pp.56–66.

The OECD Environment Programme (2022) 'Indicators to measure decoupling of environmental pressure from economic growth', *Executive Summary* [online] http://www.oecd.org/dataoecd/0/52/1933638.pdf (accessed 20 June 2022).

Tkachenko, A., Levchenko, N., Shyshkanova, G., Shvets, V. and Ivanova, M. (2021) 'Evaluation of the efficiency of social investments of metallurgical enterprises according to the decoupling approach', *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, Vol. 5, pp.147–153 [online] https://doi.org/10.33271/nvngu/2021-5/147.

Vatchenko, O.B. and Svystun, K.O. (2019) 'Dekaplinh v ekonomitsi – sutnist', vyznachennia i vydy [decapping in economics – essence, definitions and types]', *Ekonomichnyj Prostir*, Vol. 141, pp.5–24, in Ukrainian [online] http://www.prostir.pdaba.dp.ua/index.php/journal/article/view/3/1 (accessed 20 June 2022).

Vitlins'kyj, V.V. and Velykoivanenko, H.I. (2004) 'Ryzykolohiia v ekonomitsi ta pidpryiemnytstvi [riskology in economics and entrepreneurship]', *Kyiv: KNEU*, Vol. 480.