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FINANCIAL AND SECURITY DESIGN OF MANAGEMENT ACCOUNTING OF INNOVATIVE AGRICULTURAL ENTERPRISES IN CONDITIONS OF DIGITALIZATION AND MIGRATION RISKS

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Abstract
Modeling of the financial and security design of management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks is proposed. It was determined that Ukraine is currently in the most difficult conditions of its socio-economic, political and social development, and therefore needs to adjust the management accounting policy, especially in the agricultural sector. A system of methods, tools and mathematical models was used for modeling. In particular, in the process of modeling, we used mathematical analysis of nonlinear dependencies of the second order parabolic, hyperbolic and semi-logarithmic functions, coefficients of determination and elasticity, and to check the reliability of the models, Fisher's F-criterion analysis was performed. Modeling the system of financial and security design of management accounting of innovative agricultural enterprises in conditions of digitization and migration risks proved the need to emphasize management policy on several key aspects: increasing business innovation, stimulating the digitalization of economic processes, and accumulating a critical mass of human capital capable of generating innovative projects under crisis conditions and taking into account limited resources. The proposed modeling will be useful for all business entities that take care of effective management accounting and increasing innovative activity in the conditions of digitization and active population migration.

Keywords: *financial stability, security, management accounting, innovation, digitalization, migration, solvency, strategy.*

JEL codes: *O13, M40, Q19.*

Introduction

Currently, Ukraine is in the most difficult conditions of its socio-economic, political and social development. The unprecedented and unjust invasion of Russia caused a complete breakdown of the institutional matrix and, in general, the paradigm of the existence of the entire

productive and non-productive sector of the economy. Financial and security management accounting design for innovative agricultural enterprises is a key element of their successful functioning and development. Such a design combines in-depth analysis of risks and opportunities, effective budgeting and forecasting, as well as ensuring reliable control over financial flows. In today's conditions, when digitalization and cyber security are gaining more and more importance, innovative agricultural enterprises must implement modern information systems for monitoring and data analysis, which allows timely detection of potential threats and prompt response to them. One of the important components is the development of investment strategies aimed at introducing the latest technologies and increasing production efficiency. It is also necessary to ensure the transparency of financial transactions and regular audits, which promotes the trust of investors and partners. In addition, constant training of personnel, especially in the field of financial management and the use of the latest technologies, allows maintaining a high level of professional competence. Thus, the financial and security design of management accounting creates a basis for the sustainable development of innovative agricultural enterprises, ensuring their ability to adapt to changes in the market environment and effectively manage resources. The design of management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks requires an integrated approach that combines modern technologies with the flexibility of management strategies. In the era of digital transformation, agricultural enterprises should make the most of automation and analytics to improve the efficiency of their operations. This allows not only to reduce costs, but also to provide prompt access to accurate and up-to-date data necessary for making strategic decisions. Migration risks, for their part, affect the availability of labor and the stability of production processes. In the conditions of constant population mobility, it is important to develop strategies that include both attracting new personnel and developing training and retraining programs for existing employees. Thus, an innovative approach to management accounting, which takes into account the challenges of digitalization and migration risks, allows agricultural enterprises to remain competitive, effectively manage resources and ensure sustainable development.

The scientific literature reviewed by us on our topic highlights various approaches and strategies aimed at increasing the efficiency and safety of management. Modern studies emphasize the importance of integrating digital technologies to optimize management processes and increase the transparency of financial transactions (Onyshchenko, V., 2023; Yukhnovsky, I., 2010; Yezhakova, N., 2011). One of the key topics is the use of automated accounting systems that allow real-time monitoring of financial flows, expenses and income of the enterprise (Ivashchuk, O., 2008; Mushtai V. A.). Which is especially relevant in the conditions of growing migration risks, which affect the availability of labor and the stability of supplies. Another important aspect is ensuring cyber security, which includes protecting sensitive information and financial data from cyber threats. The researchers recommend the implementation of comprehensive security measures, such as the use of multi-factor authentication, regular security audits and staff training. Scientists (Zhyvko, Z. et al., 2024) emphasize the need to support institutional security in the process of managing innovative development, which will undoubtedly increase the profitability of the agricultural sector. In the scientific work (Kwilinski, A. et al., 2022), the management of the logistics activities of agricultural enterprises in the conditions of the digital economy is analyzed in depth. Scientists (Benyam, A. et al., 2021; Klerkx, L. et al., 2019) professionally determine the need for the introduction of digital technologies in the agricultural sector for the effective development of agriculture. Scientists (Gryshchenko, I. et al., 2023) propose directions for the management of innovative entrepreneurship in the conditions of the post-war reconstruction of the economy of Ukraine, which is absolutely necessary for improving management accounting and the

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work of the agricultural sector. The scientific work (Tyagi, P. et al., 2023) analyzes artificial intelligence and its management methods in the context of the spread of the digital economy. The article (Aranchiy, V. et al., 2022) proposed a comprehensive assessment of the effectiveness of management of the financial condition of economic entities, which can be used in the analysis of the solvency of agricultural enterprises. Studies (Niankara, I. and Traoret, R., 2023; Xu, Y. et al., 2022; Uyeh, D. et al., 2023) show that adaptation to digitalization requires not only technical changes, but also changes in management culture and approaches to management. Scientists (Prokopenko, O. et al., 2021) offer management models of state clustering, marketing and the labor market in the conditions of globalization, the risk of bankruptcy and the development of the service market, which can be adapted to agribusiness. Researchers (Annosi, M. et al., 2022) prove that innovative agricultural enterprises that actively implement digital solutions demonstrate greater resilience to external challenges and the ability to quickly recover from crises. Scientists (Prylipko, S. et al., 2021) propose methods of regional innovation management that are acceptable in the institutional transformation of agribusiness and its institutional environment. The papers (Abad-Segura, E. et al., 2020; Natanelov, V. et al., 2022; Brown, J. et al., 2013) propose new methods of financial technology management, blockchain development, and directions for risk management in modern conditions Based on the analysis of the literature, it is possible to identify risk management technologies, including diversification of investments and the creation of reserve funds to reduce the impact of external shocks. In the conditions of war and instability, these measures become critically important for maintaining the solvency and stable development of agricultural enterprises. In a scientific study (Mazur, N. et al., 2021) they propose an adaptive system for improving controlling in the management of the finances of enterprises, which are necessary for the management accounting of the agricultural sector. Scholars (Han, J. et al., 2021) conduct an analytical review of logistics for perishable agricultural products and suggest non-standard agricultural management tools that can be used to improve management accounting. Scientists (Semenov, A. et al., 2021) offer effective directions for managing energy- and resource-saving innovative projects at agro-food enterprises. Thus, the financial and security design of management accounting in the conditions of digitization and migration risks includes a set of measures aimed at increasing the transparency, efficiency and security of management processes. This provides innovative agricultural enterprises with the opportunity to successfully adapt to modern challenges and maintain competitiveness. However, the listed scientific sources require a review of methodologies, methods and tools for improving the management accounting of the agricultural sector in view of modernity.

Materials and Methods

We suggest that the financial and security design of management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks be carried out using a system of methods, tools and mathematical models. In particular, in the modeling process, we used mathematical analysis of nonlinear dependencies of second-order parabolic, hyperbolic, and semi-logarithmic functions. Coefficients of determination and elasticity were also calculated to characterize the interdependence of factor characteristics and performance indicators, and Fisher's F-criterion analysis was performed to check the reliability of the models.

Management accounting is influenced by the macro, meso, and mega system of entrepreneurship, which can be viewed through the prism of the innovative growth rate, which is an integral part of effective management and innovative development of business entities. The coefficient of innovative growth consists of a complex of production and non-production potentials, the ability to adapt and resource capabilities, which provide the enterprise with the ability to survive and diffuse innovations.

To determine it, we will analyze the quality rating of corporate reputation management (Fig. 1).

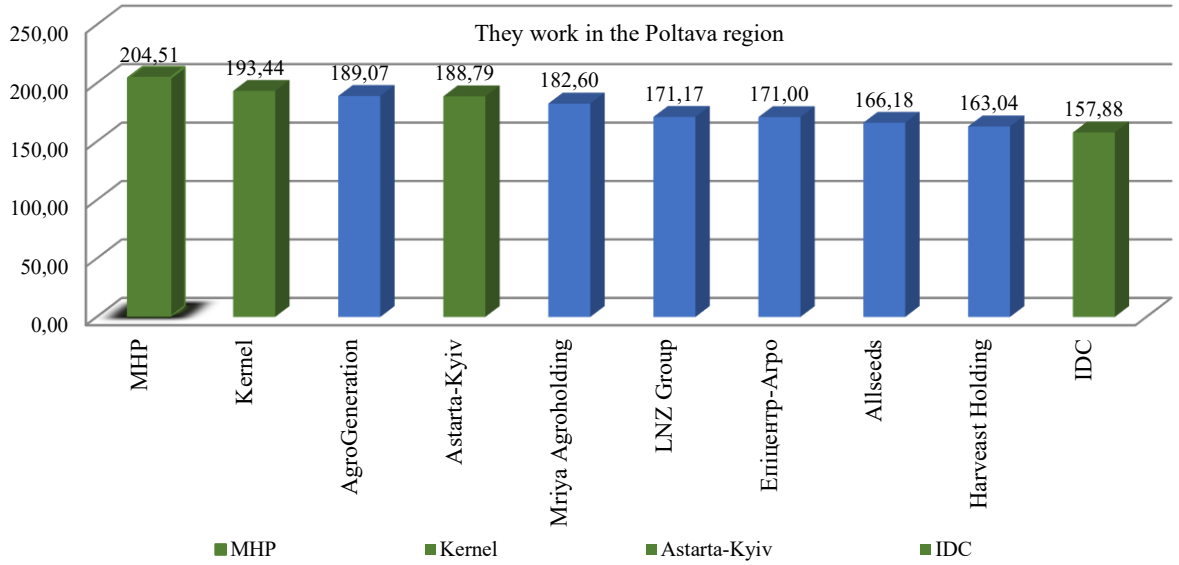

Figure 1. Rating of the quality of corporate reputation management in the field of "Agrosector-agroholdings-producers"

**Source: https://poltava.to/project/5257/.*

Thus, 10 entities of entrepreneurial activity (including four Poltava companies, namely: Novomoskovsk branch of PJSC "Oril-Leader" El. No. (PJSC Myronivskyi Hliboprodukt) - (hereinafter – "MHP"); PJSC Poltava Oil Extraction Plant - (hereinafter – "Kernel") LLC Globinsky processing plant of "Astarta-Kyiv" LLC - (hereinafter "Astarta-Kyiv"); and "Burat" LLC (IMC S.A. Group of Companies (Industrial Dairy Company)) - (hereinafter "IDC").

Management accounting, as an element of the financial and security design of the economic system, is affected by digital transformation or digitalization. The digitization index is a key indicator that reflects the level of implementation of digital technologies in various aspects of the enterprise's activities. It allows you to assess the company's ability to use modern digital solutions to optimize processes, improve efficiency and competitiveness. A high digitization index indicates the successful integration of the latest technologies, which contributes to the development and adaptation of the enterprise to rapidly changing market conditions. In relation to this factor, a comparative analysis and ranking of regional digitization, which is developed by the structural units of the Ministry of Digitalization of Ukraine, is also being conducted. Thus, according to the source "Kremenchutsky Telegraf", as of March 2023, Poltava Oblast was one of the five regions of Ukraine according to the index of digital transformation, which is one of the tools for measuring the processes of informatization and digitalization in the regions of the country. The digital transformation index for Poltava Oblast is 0.833. Ahead are Lviv (0.891) and Dnipropetrovsk (0.908) regions. In general, the average value of the digital transformation index for Ukraine is 0.632.

And finally, in the study of the financial and security design of management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks, the coefficient of migration intensity should be taken into account. The coefficient of migration intensity is an important indicator reflecting the level of population mobility. It helps to assess the scale of migration processes and their impact on the socio-economic situation in a country or region. A high ratio indicates a significant number of people who change their place of residence, which can be due to various factors, such as the search for better living or working conditions. The dynamics of migration growth (decrease) of the population of Poltava region over the past five years is presented in the table. 1.

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Table 1. Dynamics of migration growth (decrease) of the population of Poltava region, 2019-2023

Years	Migration growth (reduction) of the population, persons
2019	-16 470
2020	-14 610
2021	-11 000
2022	-28 740
2023	-22 120

**Source: https://www.telegraf.in.ua/around/10125047-poltavschina-posila-tretye-misce-sered-oblastej-za-indeksom-cifrovoji-transformaciji.html.*

Therefore, having characterized the main factors influencing the effectiveness of the financial and security design of the management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks, it is necessary to select the research objects. Previously, the rating of the quality of corporate reputation management in the field of "Agrosector-agroholdings-producers" in the agro-industrial sector was presented, among them four enterprises operating in the territory of the Poltava region: "MHP"; "Kernel"; "Astarta-Kyiv"; "IDC" (https://poltava.to/project/5257/). Namely, we will investigate the management accounting of these innovative agricultural enterprises in the conditions of digitalization and migration risks in the future. Next, we will use the statistical and financial data of the presented business entities to model the financial and security design of the management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks. We will also conduct research, analysis, modeling and forecasting of a component of management accounting - the solvency ratio (financial stability) of economic entities, in particular innovative agricultural enterprises in the conditions of digitalization and migration risks using economic and mathematical methods and models. In our study of the influence of digitization coefficients and migration risks on the management accounting of innovative agricultural enterprises, we use non-linear economic and mathematical models, in particular parabolic, hyperbolic and semi-logarithmic models.

Results and Discussion

On the basis of the financial statements of Form No. 1 "Balance (Report on financial condition)", the work report, primary documents, we will analyze the state of management accounting using the solvency ratio (financial stability) depending on the innovative growth rate, the index of digital transformation and digitization (according to of the information resource "Index of digital transformation of the regions of Ukraine, results 2023" and the coefficient of migration intensity of four innovative agricultural enterprises: "MHP"; "Kernel"; "Astarta-Kyiv"; "IDC" with the help of non-linear economic and mathematical models, in particular second-order parabolic, hyperbolic and semi-logarithmic models over the past five years (Table 2).

Table 2. Dynamics of the impact of digitization factors and migration risks on the performance indicator of management accounting of four innovative agricultural enterprises of the Poltava region, 2019-2023

Years	Solvency ratio (financial stability), Y	Coefficient of innovative growth, X_1	Characteristic	Index of digital transformation (digitalization), X_2	Coefficient of migration intensity, X_3
	"MHP"				
2019	0,523	0,37	innovative follower strategy	0,2020	1,12%
2020	0,502	0,38	innovative follower strategy	0,2060	1,00%
2021	0,511	0,41	innovative follower strategy	0,2110	0,75%
2022	0,504	0,37	innovative follower strategy	0,2140	1,96%
2023	0,538	0,40	innovative follower strategy	0,2185	1,51%
	"Kernel"				
Years	Solvency ratio (financial stability), Y	Coefficient of innovative growth, X_1	Characteristic	Index of digital transformation (digitalization), X_2	Coefficient of migration intensity, X_3
2019	0,690	0,52	innovative follower strategy	0,6420	1,12%
2020	0,668	0,51	innovative follower strategy	0,6500	1,00%
2021	0,611	0,55	the strategy of the innovative leader	0,6580	0,75%
2022	0,604	0,55	the strategy of the innovative leader	0,6668	1,96%
2023	0,619	0,57	the strategy of the innovative leader	0,7330	1,51%
	"Astarta-Kyiv"				
Years	Solvency ratio (financial stability), Y	Coefficient of innovative growth, X_1	Characteristic	Index of digital transformation (digitalization), X_2	Coefficient of migration intensity, X_3
2019	0,536	0,22	innovative follower strategy	0,4480	1,12%
2020	0,518	0,28	innovative follower strategy	0,4500	1,00%
2021	0,522	0,24	innovative follower strategy	0,4510	0,75%
2022	0,501	0,26	innovative follower strategy	0,4519	1,96%
2023	0,518	0,28	innovative follower strategy	0,4524	1,51%
	"IDC"				
Years	Solvency ratio (financial stability), Y	Coefficient of innovative growth, X_1	Characteristic	Index of digital transformation (digitalization), X_2	Coefficient of migration intensity, X_3
2019	0,588	0,18	innovative follower strategy	0,3264	1,12%
2020	0,564	0,21	innovative follower strategy	0,3282	1,00%
2021	0,540	0,24	innovative follower strategy	0,3300	0,75%
2022	0,532	0,20	innovative follower strategy	0,3318	1,96%
2023	0,538	0,21	innovative follower strategy	0,3324	1,51%

**Source: developed by the authors based on https://clarity-project.info/; https://zvitnist.com/; https://astartaholding.com/wp-content/uploads/2022/07/finansova-zvitnist-tov-globynskyj-pererobnyj-zavod-2020.pdf;https://imcagro.com.ua/ua/dlya-investorov/zvitnist-pidpryiemstv-v-ukraini/tov-burat*

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For further modeling, we adapt the factor and result indicators to a mathematical and statistical form, denoting them with an abbreviation: coefficient of innovative growth, X_1; index of digital transformation (digitalization), X_2; coefficient of migration intensity, X_3; solvency ratio (financial stability), Y. Further calculations are carried out using spreadsheets, built-in statistical and mathematical functions, arrays and using nonlinear dependencies of second-order parabolic, hyperbolic and semi-logarithmic functions. Modeling is also based on the linearization of non-linear production functions, which consists in transforming complex relationships between production variables into linear forms to simplify analysis and modeling. This allows you to use linear methods of optimization and statistics, facilitating the process of making management decisions and increasing the efficiency of production planning. This transformation made it possible to obtain the main parameters of the equations, the coefficients of determination and elasticity to characterize the interdependence of the factor characteristics and the performance indicator (Table 3).

Table 3. Data processing results of the dependence of the solvency ratio (financial stability) on the innovation growth rate, the digital transformation (digitalization) index, and the migration intensity rate of four innovative agricultural enterprises of the Poltava region, 2019-2023 (calculation fragment for "Astarta-Kyiv")

Manufacturing nonlinear regression	Parameters of production nonlinear regression			Coefficient of determination	Characteristic	Coefficient of elasticity	Characteristic
	a_0	a_1	a_2				
"Astarta-Kyiv"							
Parabolic nonlinear regression of the second order of the influence of the coefficient of innovative growth on the coefficient of solvency (financial stability)							
$\hat{Y}i=1,85-10,41\ X+20,10\ X^2$	1,85	-10,41	20,10	0,83	The general coefficient of determination indicates a close relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability) is determined by 83.36% of the studied factor entered into the correlation nonlinear model. The factor has a significant impact on the investigated indicator.	-6,10 3,30	If the factor indicator decreases by 1%, the effective indicator of the solvency ratio (financial stability) will decrease by 6.10 percentage points. and if the factor indicator increases by 1%, the effective indicator will increase by 3.30 %
Parabolic nonlinear regression of the second order of the influence of the index of digital transformation (digitalization) on the coefficient of solvency (financial stability)							
$\hat{Y}i=236,14--1041,24X+1150,33X^2$	236,14	-1041,24	1150,33	0,64	The general coefficient of determination indicates the average relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability), 64.41% is caused by the studied factor entered into the correlation nonlinear model. The factor has a moderate effect on the investigated indicator.	-882,37 443,44	If the factor indicator decreases by 1%, the effective indicator of the solvency ratio (financial stability) will decrease by 882.37 percentage points. and if the factor indicator increases by 1%, the effective indicator will increase by 443.44 %
Parabolic nonlinear regression of the second order of the influence of the coefficient of migration intensity on the coefficient of solvency (financial stability)							

$\hat{Y}i=0,48+8,62X-381,39X^2$	0,48	8,62	-381,39	0,74	The general coefficient of determination indicates a close relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability) is determined by 74.01% of the studied factor entered into the correlation nonlinear model. The factor has a significant impact on the investigated indicator.	0,24 -0,27	If the factor indicator increases by 1%, the effective indicator of the solvency ratio (financial stability) will increase by 0.24 percentage points. and if the factor sign decreases by 1%, then the effective indicator will decrease by 0.27 %
Hyperbolic nonlinear regression of the influence of the coefficient of innovative growth on the coefficient of solvency (financial stability)							
$\hat{Y}i=0,44+0,02*1/X$	0,44	0,02	-	0,41	The general coefficient of determination indicates the average relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability), 41.19% is caused by the studied factor entered into the correlation nonlinear model. The factor has a moderate effect on the investigated indicator.	0,11	If the factor indicator increases by 1%, the effective indicator of the solvency ratio (financial stability) will increase by 0.11 %
Hyperbolic nonlinear regression of the influence of the index of digital transformation (digitalization) on the solvency ratio (financial stab ility)							
$\hat{Y}i=-1,98+1,12*1/X$	-1,98	1,12	-	0,60	The general coefficient of determination indicates the average relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability), 60.16% is caused by the studied factor entered into the correlation nonlinear model. The factor has a moderate effect on the investigated indicator.	4,70	If the factor indicator increases by 1%, the effective indicator of the solvency ratio (financial stability) will increase by 4.70%
Hyperbolic nonlinear regression of the influence of the migration intensity coefficient on the solvency coefficient (financial stability)							
$\hat{Y}i=0,50+0,0002*1/X$	0,50	0,0002	-	0,50	The general coefficient of determination indicates the average relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability) is determined by 50.10% of the studied factor entered into the correlation nonlinear model. The factor has a moderate effect on the investigated indicator	0,03	If the factor indicator increases by 1%, the effective indicator of the solvency ratio (financial stability) will increase by 0.03%
Semi-logarithmic nonlinear regression of the influence of the coefficient of innovative growth on the coefficient of solvency (financial stability)							
$\hat{Y}i=0,42-0,17\log X$	0,42	-0,17	-	0,39	The general coefficient of determination indicates the average relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability), 39.22% is caused by the studied factor entered into the correlation nonlinear model. The factor has a	0,17	If the factor indicator increases by 1%, the effective indicator of the solvency ratio (financial stability) will increase by 0.17%

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					moderate effect on the investigated indicator		
Semi-log nonlinear regression of the influence of the index of digital transformation (digitalization) on the coefficient of solvency (financial stability)							
Ŷi=-1,47-5,75 logX	-1,47	-5,75	-	0,60	The general coefficient of determination indicates the average relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability), 60.44% is caused by the studied factor entered into the correlation nonlinear model. The factor has a moderate effect on the investigated indicator	3,74	If the factor indicator increases by 1%, the effective indicator of the solvency ratio (financial stability) will increase by 3.74%
Semi-logarithmic nonlinear regression of the influence of the migration intensity coefficient on the solvency coefficient (financial stability)							
Ŷi=0,43-0,05 logX	0,43	-0,05	-	0,38	The general coefficient of determination indicates the average relationship between the studied factor and the indicator, the variation of the solvency ratio (financial stability), 37.73% is caused by the studied factor entered into the correlation nonlinear model. The factor has a moderate effect on the investigated indicator	0,17	If the factor indicator increases by 1%, the effective indicator of the solvency ratio (financial stability) will increase by 0.17%

**Source: calculated by the authors.*

So, production nonlinear dependences of second-order parabolic, hyperbolic and semi-logarithmic functions were determined, calculations of the main parameters of the equations, coefficients of determination and elasticity were carried out, and the interdependence of factor characteristics and performance indicators was investigated. The result makes it possible to testify about the dependence of the solvency ratio (financial stability) on the innovation growth ratio, the index of digital transformation (digitalization) and the migration intensity ratio of four innovative agricultural enterprises of the Poltava region. The factors are selected successfully, the models are adequate and of high quality.

Regarding the adequacy of non-linear models, we consider Fisher's F-criterion analysis to be adequate experimental data, therefore, we conduct an economic analysis and forecast the effective indicator of the solvency ratio (financial stability) of four innovative agricultural enterprises of the Poltava region. The built-in TREND statistical function, which accurately calculates the factor characteristics in dynamics, is traditionally used for the factor characteristics of the innovation growth rate, the digital transformation (digitalization) index, and the migration intensity factor. To calculate the performance indicator, we use the calculated non-linear production regressions: second-order parabolic, hyperbolic and semi-logarithmic, parameters of their equations (Table 4).

Table 4. Forecasting of factor characteristics and the effective indicator of the solvency ratio (financial stability) of four innovative agricultural enterprises of the Poltava region, 2025 (calculation fragment for "Astarta-Kyiv")

"Astarta-Kyiv"								
Manufacturing nonlinear regression	Coefficient of innovative growth, X	Factors of influence					Effective indicator	
		Characteristic	Index of digital transformation (digitalization), X	Characteristic	Coefficient of migration intensity, X	Characteristic	Coefficient of plateau capability (financial cohesion), Y	Characteristic
Parabolic nonlinear regression of the second order of the influence of the coefficient of innovative growth on the coefficient of solvency (financial stability) Ŷi=1.85-10.41 X+ +20.10 X2	0,31	An increase of 0.03% compared to 2023.					0,522	An increase of 0.004% compared to 2023.
Parabolic nonlinear regression of the second order of the influence of the index of digital transformation (digitalization) on the coefficient of solvency (financial stability) Ŷi=236.14- - 1041.24X+1150.33X2			0,4549	An increase of 0.0025% compared to 2023.			0,537	An increase of 0.019% compared to 2023.
Parabolic nonlinear regression of the second order of the influence of the coefficient of migration intensity on the coefficient of solvency (financial stability) Ŷi=0.48+8.62X- -381.39X2					1,46%	A decrease of 0.05% compared to 2023.	0,531	An increase of 0.013% compared to 2023.
Hyperbolic nonlinear regression of the second order of the influence of the coefficient of innovative growth on the coefficient of solvency (financial stability) Ŷi=0.44+0.02*1/X	0,31	An increase of 0.03% compared to 2023.					0,576	An increase of 0.058% compared to 2023.
Hyperbolic nonlinear regression of the second order of the influence of the index of digital transformation (digitalization) on the coefficient of solvency (financial stability) Ŷi=-1.98+1.12*1/X			0,4549	An increase of 0.0025% compared to 2023.			0,525	An increase of 0.007% compared to 2023.
Hyperbolic nonlinear regression of the second order of the influence of the coefficient of					1,46%	A decrease of 0.05% compared to 2023.	0,525	Growth of 0.007% compared to 2023.

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migration intensity on the coefficient of solvency (financial stability) Ŷi=0.50+0.0002*1/X								
Semi-logarithmic nonlinear regression of the second order of the influence of the coefficient of innovative growth on the coefficient of solvency (financial stability) Ŷi=0.42-0.17 logX	0,31	An increase of 0.03% compared to 2023.					0,525	An increase of 0.007% compared to 2023.
Semi-logarithmic nonlinear regression of the second order of the influence of the index of digital transformation (digitalization) on the coefficient of solvency (financial stability) Ŷi=-1.47-5.75 logX			0,4549	An increase of 0.0025% compared to 2023.			0,525	An increase of 0.007% compared to 2023.
Semi-logarithmic nonlinear regression of the second order of the influence of the coefficient of migration intensity on the coefficient of solvency (financial stability) Ŷi=0.43-0.05 logX					1,46%	A decrease of 0.05% compared to 2023.	0,527	An increase of 0.009% compared to 2023.

**Source: calculated by the authors.*

Therefore, the growth of factor characteristics of the coefficient of innovative growth and the index of digital transformation (digitalization) in the forecast year 2025 will lead to an increase in the coefficient of solvency (financial stability) of the studied agricultural enterprises, and a decrease in the coefficient of migration intensity by 0.05% in the next period may lead to an increase in the effective management accounting indicator of the solvency ratio (financial stability). Graphically, the actual and forecast value of factors of innovative growth, digitalization and migration risks of four agricultural enterprises of the Poltava region using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2019-2023, 2025 are presented in Fig. 2-5.

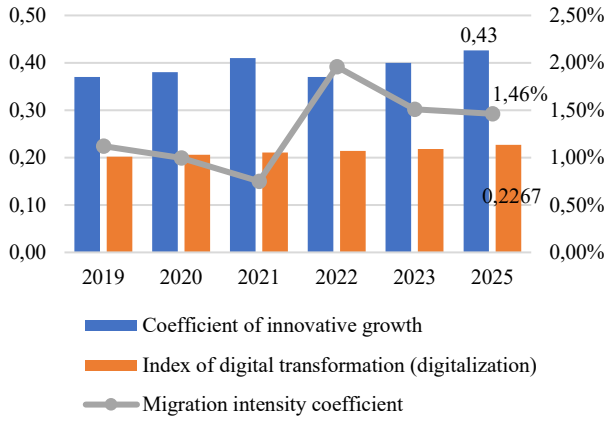

Figure 2. Actual and forecast value of the factors of innovative growth, digitalization and migration risks of "MHP" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2019-2023, 2025

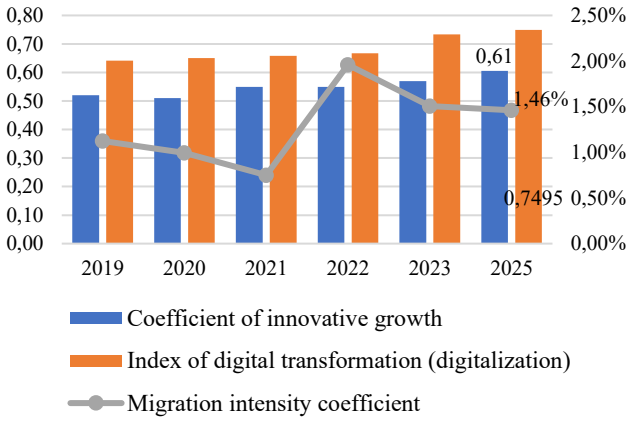

Figure 3. The actual and forecast value of the factors of innovative growth, digitalization and migration risks "Kernel" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2019-2023, 2025

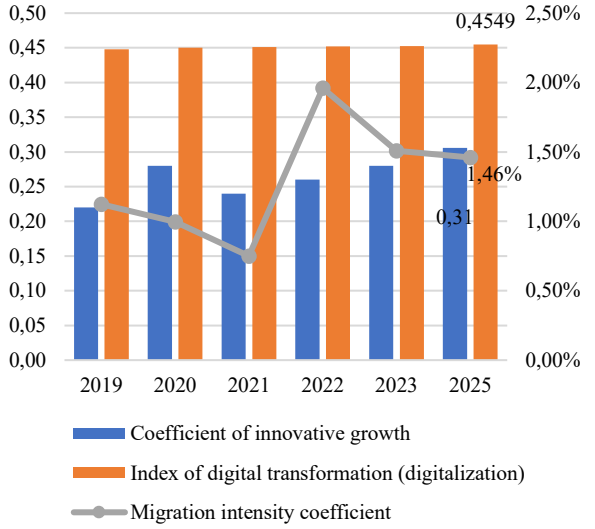

Figure 4. Actual and forecast value of factors of innovative growth, digitalization and migration risks of "Astarta-Kyiv" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2019-2023, 2025

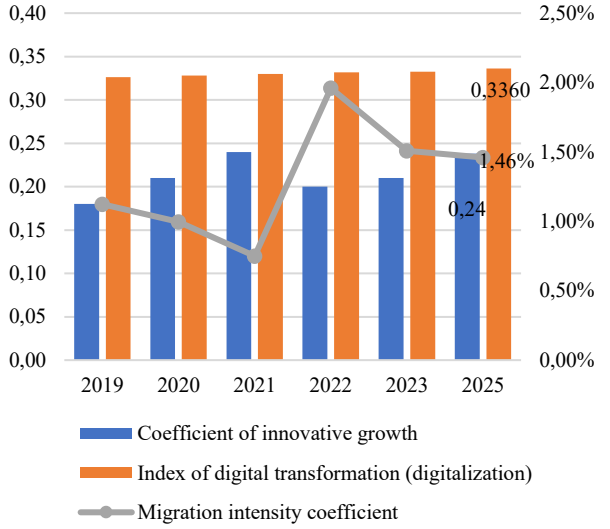

Figure 5. The actual and forecast value of the factors of innovative growth, digitalization and migration risks of "IDC" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2019-2023, 2025

**Source: calculated by the authors.*

Based on the table. 4, the maximum and minimum forecast values of the solvency ratio (financial stability) of the four investigated enterprises are determined, the best and worst performance indicators are summarized and compared depending on the influence of the factors of the innovation growth rate, the index of digital transformation (digitalization) and the migration intensity factor using parabolic, hyperbolic and semi-log nonlinear regressions (Table 5).

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Table 5. Maximum and minimum forecast values of the solvency ratio (financial stability) of four agricultural enterprises, 2025

"MHP"			
Value	The forecast value of the solvency ratio (financial stability) Ŷi, the influence of the innovative growth ratio	Predicted value of the solvency ratio (financial stability) Ŷi influence of the index of digital transformation (digitalization)	Predicted value of the coefficient of solvency (financial stability) Ŷi influence of the coefficient of migration intensity
Maximum value	0,556	0,559	0,569
Minimum value	0,546	0,542	0,541
"Kernel"			
Value	The forecast value of the solvency ratio (financial stability) Ŷi, the influence of the innovative growth ratio	Predicted value of the solvency ratio (financial stability) Ŷi influence of the index of digital transformation (digitalization	Predicted value of the coefficient of solvency (financial stability) Ŷi influence of the coefficient of migration intensity
Maximum value	0,636	0,646	0,634
Minimum value	0,627	0,621	0,623
"Astarta-Kyiv"			
Value	The forecast value of the solvency ratio (financial stability) Ŷi, the influence of the innovative growth ratio	Predicted value of the solvency ratio (financial stability) Ŷi influence of the index of digital transformation (digitalization	Predicted value of the coefficient of solvency (financial stability) Ŷi influence of the coefficient of migration intensity
Maximum value	0,576	0,537	0,531
Minimum value	0,522	0,525	0,525
"IDC"			
Value	The forecast value of the solvency ratio (financial stability) Ŷi, the influence of the innovative growth ratio	Predicted value of the solvency ratio (financial stability) Ŷi influence of the index of digital transformation (digitalization	Predicted value of the coefficient of solvency (financial stability) Ŷi influence of the coefficient of migration intensity
Maximum value	0,563	0,549	0,591
Minimum value	0,548	0,548	0,548

**Source: calculated by the authors.*

Graphically, the maximum and minimum forecast values of the solvency ratio (financial stability) of four agricultural enterprises are presented in Fig. 6-9.

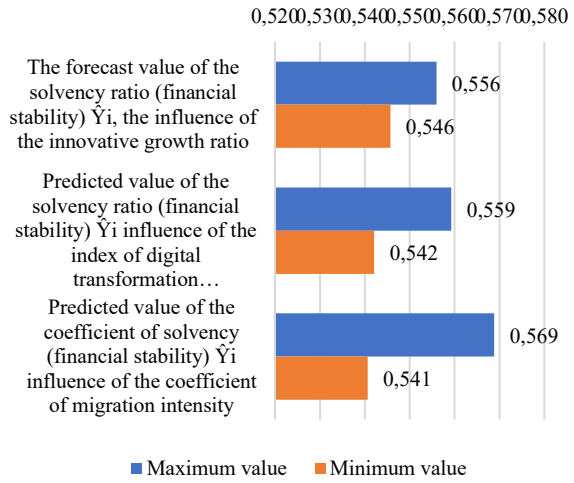

Figure 6. The maximum and minimum forecast value of the solvency ratio (financial stability) depending on the factors of innovative growth, digitalization and migration risks of "MHP" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2025

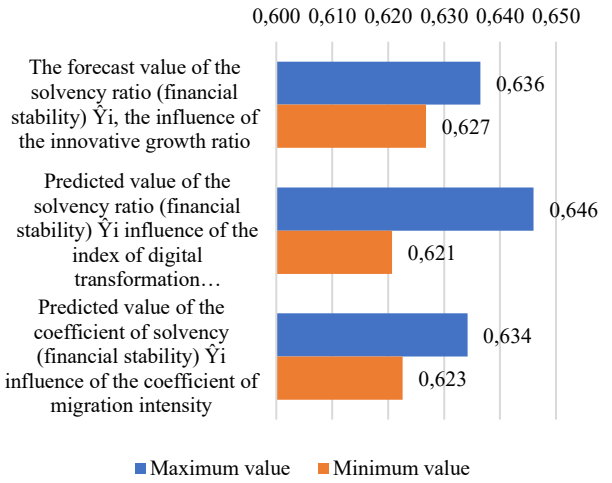

Figure 7. The maximum and minimum forecast value of the solvency ratio (financial stability) depending on the factors of innovative growth, digitalization and migration risks of "Kernel" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2025

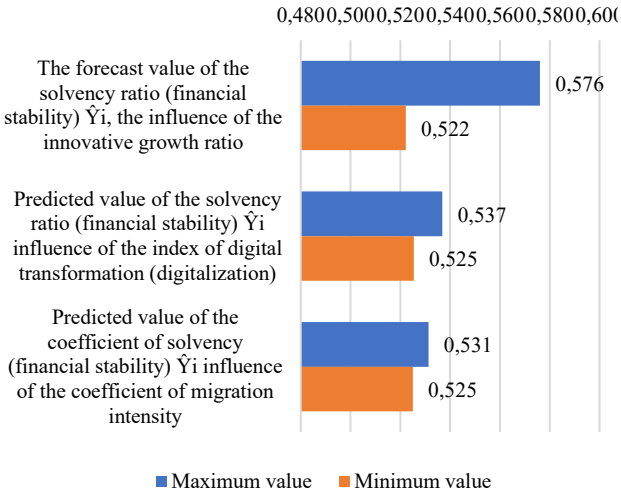

Figure 8. The maximum and minimum forecast value of the solvency ratio (financial stability) depending on the factors of innovative growth, digitalization and migration risks of "Astarta-Kyiv" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2025

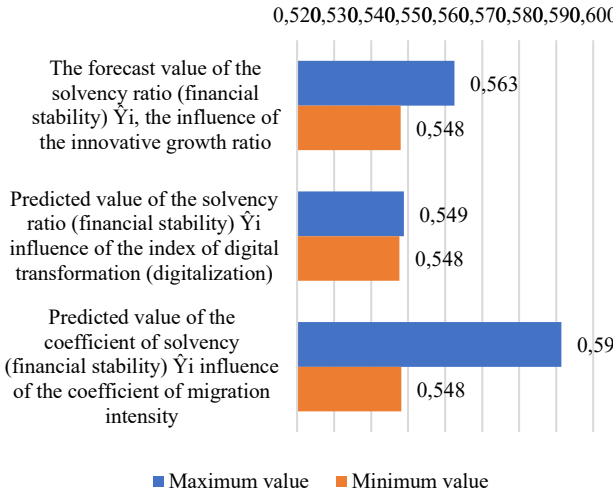

Figure 9. The maximum and minimum forecast value of the solvency ratio (financial stability) depending on the factors of innovative growth, digitalization and migration risks of "IDC" using parabolic, hyperbolic and semi-logarithmic nonlinear regressions, 2025

**Source: calculated by the authors.*

Summarizing the conducted research, it should be noted that the use of the used methods and models, in particular non-linear regressions, in modeling and forecasting the efficiency, safety and design of management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks gives a positive result, which should be used in the economic activities of enterprises.

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Conclusions

Modeling the system of financial and security design of management accounting of innovative agricultural enterprises in the conditions of digitalization and migration risks proves the need to emphasize management policy on several key aspects. Thus, modeling showed the need to develop measures to increase the solvency of "MHP", "Kernel", "Astarta-Kyiv" and "IMK". Increasing the solvency of agricultural enterprises in the conditions of war requires a strategic approach. Efforts to reduce costs and optimize resources, introduce innovative technologies, and diversify production to minimize risks are important. It is also necessary to actively search for new sales markets, expanding the geography of sales, and use state support and international assistance to ensure the stability and development of the enterprise. Fundamental attention needs to be paid to updating the innovative development strategy, especially for "MHP", "Astarta-Kyiv" and "IMK". Updating the strategy of innovative development for agricultural enterprises in the conditions of war involves adaptation to new challenges and threats. At the same time, the integration of modern technologies that increase production efficiency and ensure resistance to changes is relevant. An important aspect is the strengthening of cooperation with research institutions for the implementation of innovative solutions, as well as the active use of state and international support programs. Flexibility and prompt response to changes in the market and working conditions will help agricultural enterprises to remain competitive and ensure stable development. For MHP, there is a need to improve the digitalization of the company. Increasing the digitalization of the agricultural company requires the integration of modern technologies in all aspects of its activity. Implementation of automated production management systems will allow to optimize processes and increase efficiency. Using sensors and drones to monitor field and crop conditions will provide more accurate data for decision making. The development of e-commerce will help to expand sales markets, and the use of digital platforms for communication with suppliers and customers will increase the efficiency and reliability of cooperation. The listed measures will allow the agricultural company to remain competitive and successfully adapt to modern conditions.

References

Abad-Segura, E., González-Zamar, M. D., López-Meneses, E., & Vázquez-Cano, E. (2020). Financial technology: review of trends, approaches and management. *Mathematics*, *8*(6), 951.

Annosi, M. C., Ráez, R. M. O., Appio, F. P., & Del Giudice, T. (2022). An integrative review of innovations in the agricultural sector: The roles of agency, structure, and their dynamic interplay. *Technological Forecasting and Social Change*, *185*, 122035. https://doi.org/10.1016/j.techfore.2022.122035

Aranchiy, V., Ganushchak-Efimenko, L., Khrystenko, L., Shkoda, M., Hnatenko, I., & Fastovets, N. (2022). Modeling of integrated assessment of the effectiveness of management of the financial position of business entities. *Financial and Credit Activity Problems of Theory and Practice*, *1*(42), 259-270. https://doi.org/10.55643/fcaptp.1.42.2022.3526

Benyam, A. A., Soma, T., & Fraser, E. (2021). Digital agricultural technologies for food loss and waste prevention and reduction: Global trends, adoption opportunities and barriers. *Journal of Cleaner Production*, *323*, 129099. https://doi.org/10.1016/j.jclepro.2021.129099

Brown, J. K., Zelenska, T. V., & Mobarak, M. A. (2013). *Barriers to adoption of products and technologies that aid risk management in developing countries*. World Bank, Washington, DC.

Financial statements of Globinsky processing plant LLC. https://astartaholding.com/wp-content/uploads/2022/07/finansova-zvitnist-tov-globynskyj-pererobnyj-zavod-2020.pdf

Gryshchenko, I., Ganushchak-Efimenko, L., Hnatenko, I., Rębilas, R. (2023). Management of environment design of the development of innovative entrepreneurship at integrated structures under the conditions of post-war reconstruction. Financial & Credit Activity: Problems of Theory & Practice, *4*, 341. https://doi.org/10.55643/fcaptp.5.52.2023.4199

Han, J. W., Zuo, M., Zhu, W. Y., Zuo, J. H., Lü, E. L., & Yang, X. T. (2021). A comprehensive review of cold chain logistics for fresh agricultural products: Current status, challenges, and future trends. *Trends in Food Science & Technology*, *109*, 536-551. https://doi.org/10.1016/j.tifs.2021.01.066

Information and analytical resource Reporting of Ukrainian enterprises. https://zvitnist.com/

Informational and analytical resource «Clarity». https://clarity-project.info/

Informational and analytical resource of Innovation. Management. Team. https://imcagro.com.ua/ua/dlya-investorov/zvitnist-pidpryiemstv-v-ukraini/tov-burat

Internet resource. *Index of digital transformation of regions of Ukraine (2023 results).* https://thedigital.gov.ua/storage/uploads/files/page/community/reports/%D0%86%D0%BD%D0%B4%D0%B5%D0%BA%D1%81-%D1%86%D0%B8%D1%84%D1%80%D0%BE%D0%B2%D0%BE%D1%97-%D1%82%D1%80%D0%B0%D0%BD%D1%81%D1%84%D0%BE%D1%80%D0%BC%D0%B0%D1%86%D1%96%D1%97-%D1%80%D0%B5%D0%B3%D1%96%D0%BE%D0%BD%D1%96%D0%B2-%D0%A3%D0%BA%D1%80%D0%B0%D1%97%D0%BD%D0%B8-2023.pdf

Ivashchuk, O. (2008). *Economic and mathematical modeling*. Study guide. Ternopil: "Economic thought", 704 p.

Klerkx, L., Jakku, E., & Labarthe, P. (2019). A review of social science on digital agriculture, smart farming and agriculture 4.0: New contributions and a future research agenda. *NJAS-Wageningen journal of life sciences*, *90*, 100315. https://doi.org/10.1016/j.njas.2019.100315

Kwilinski, A., Hnatyshyn, L., Prokopyshyn, O., & Trushkina, N. (2022). Managing the logistic activities of agricultural enterprises under conditions of digital economy. *Virtual Economics*, *5*(2), 43-70. https://doi.org/10.34021/ve.2022.05.02(3)

Mazur, N., Khrystenko, L., Pásztorová, J., Zos-Kior, M., Hnatenko, I., Puzyrova, P., & Rubezhanska, V. (2021). Improvement of Controlling in the Financial Management of Enterprises. *TEM journal*, *10*(4). https://doi.org/10.18421/TEM104-15

Mushtai, V. A. (2024). *Lecture material on the discipline "Statistics*" https://cdn.snau.edu.ua/moodle/course/view.php?id=315#section-0

Naboka, R. M. (2009). *Lecture material on the discipline "Statistics*" https://studfile.net/preview/5226519/page:24/

Natanelov, V., Cao, S., Foth, M., & Dulleck, U. (2022). Blockchain smart contracts for supply chain finance: Mapping the innovation potential in Australia-China beef supply chains. *Journal of Industrial Information Integration*, *30*, 100389. https://doi.org/10.1016/j.jii.2022.100389

Niankara, I., & Traoret, R. I. (2023). Towards an encompassing concept of remittance in the digital era: Assessing the role of formal banking and mobile money accounting in its spatial flow. *Journal of Open Innovation: Technology, Market, and Complexity*, *9*(3), 100107. https://doi.org/10.1016/j.joitmc.2023.100107

Official website of the online publication "Poltavshchyna". https://poltava.to/project/5257/

Official website. Private newspaper. "Kremenchutsk Telegraph". *Poltava Oblast took third place among oblasts according to the index of digital transformation.* https://www.telegraf.in.ua/around/10125047-poltavschina-posila-tretye-misce-sered-oblastej-za-indeksom-cifrovoji-transformaciji.html

Onyshchenko, V. (2023). *Management accounting at the enterprise* https://buhplatforma.com.ua/article/8506-upravlnskiy-oblk-na-pdprimstv

Prokopenko, O., Martyn, O., Bilyk, O., Vivcharuk, O., Zos-Kior, M., & Hnatenko, I. (2021). Models of State Clusterisation Management, Marketing and Labour Market Management in Conditions of Globalization, Risk of Bankruptcy and Services Market Development. *International journal of computer science and network security: IJCSNS*, *21*(12), 228-234. https://doi.org/10.22937/ijcsns.2021.21.12.34

Prylipko, S., Vasylieva, N., Kovalova, O., Kulayets, M., Bilous, Y., & Hnatenko, I. (2021). Modeling of Regional Management of Innovation Activity: Personnel Policy, Financial and Credit and Foreign Economic Activity. *International Journal of Computer Science & Network Security*, *21*(11), 43-48. https://doi.org/10.22937/IJCSNS.2021.21.11.6

Semenov, A., Kuksa, I., Hnatenko, I., Sazonova, T., Babiy, L., & Rubezhanska, V. (2021). Management of Energy and Resource-Saving Innovation Projects at Agri-Food Enterprises. *TEM Journal*, *10*(2). https://doi.org/10.18421/TEM102-32

Tyagi, P., Grima, S., Sood, K., Balamurugan, B., Özen, E., & Eleftherios, T. (Eds.). (2023). *Smart analytics, artificial intelligence and sustainable performance management in a global digitalised economy*. Emerald Publishing Limited.

Uyeh, D. D., Gebremedhin, K. G., & Hiablie, S. (2023). Perspectives on the strategic importance of digitalization for Modernizing African Agriculture. *Computers and Electronics in Agriculture*, *211*, 107972. https://doi.org/10.1016/j.compag.2023.107972

Xu, Y., Peng, Z., Sun, Z., Zhan, H., & Li, S. (2022). Does digital finance lessen credit rationing?—Evidence from Chinese farmers. *Research in International Business and Finance*, *62*, 101712. https://doi.org/10.1016/j.ribaf.2022.101712

eISSN 2345-0355. 2024. Vol. 46. No. 3: 329-345
Article DOI: https://doi.org/10.15544/mts.2024.31

Yezhakova, N. (2011). Methodical approaches to management accounting and analysis of the effectiveness of innovative activity and innovative activity of enterprises. *Economy of industry*, *1*, pp. 135-139.

Yukhnovsky, I. (2010). The essence and structure of the innovation and investment potential of the economy: the main approaches and directions of formation. *Ukrainian society*, *2*, pp. 159-171. https://ukr-socium.org.ua/wp-content/uploads/2010/04/159-171__no-2__vol-33__2010__UKR.pdf

Zhyvko, Z., Morhachov, I., Zhelikhovska, M., Artiukh-Pasiuta, O., Hnatenko, I., Skrypnyk, V., & Yanechko, S. (2024). The Influence of the US Stock Market on the Institutional Security Strategy of the Management of Innovative Development. *Management Theory and Studies for Rural Business and Infrastructure Development*, *46*(1), 104-111. https://doi.org/10.15544/mts.2024.11