

# Regional Science Inquiry



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*The articles published in RSI Journal are in accordance with the approving dates by the anonymous reviewers.*



## **MODELING OF SYSTEM FACTORS OF FINANCIAL SECURITY OF AGRICULTURAL ENTERPRISES OF UKRAINE**

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### **Abstract**

The article considers the process of modeling of systemic factors of financial security of agricultural enterprises of Ukraine. The methodology of complex, systematic assessment of fiscal security and mathematical tools in the deterministic space of the financial system of enterprises are substantiated. A systematic approach is used, which determines the quantitative and qualitative parameters of external and internal threats, identifies the threshold interval of stable financial condition and stable development of agricultural enterprises. Systemic factors of stimulating and disincentive character for an estimation of financial safety of the agricultural enterprises are developed. A set of indicators for the analysis of the state of the functional components of financial security, provided by the process of neutralization of real and potential threats to the stable potential of financial security of enterprises is determined. The expediency of normalization of indicators is substantiated, their threshold values, weights and capital structure are taken into account when calculating the integrated level of financial security. It is proved that the introduction of systemic factors in the general level of financial security allows increasing the level of financial stability and reliability of agricultural enterprises.

**Keywords:** financial security, potential of financial security, efficiency, threats, agricultural enterprises, financial condition, financial balance.

**JEL classification:** G01, G21, G32, H12, Q14

### **1. Introduction**

Financial instability, economic contradictions and objective inevitable transformation processes that have arisen in the agricultural sector of the economy require in-depth study of financial security of agricultural enterprises, the determined level of financial condition of which does not provide stable protection from external and internal threats. Accordingly, the financial philosophy of sustainable growth of agricultural entities needs to reconsider the priorities of their financial security to strengthen the national and food security of the state.

In the period of formation of regularities of natural connection between components of financial safety of subjects of agricultural development, the material basis of their financial

potential in the form of system, which consists of finite number of elements and has accurately expressed properties of financial resources, is allocated. This proves that the interconnected and interdependent specific features of the systemic factors of financial security determine the formation of the total amount of financial resources for the continuous movement of financial flows and ensure the reproduction process of the financial cycle. The study of financial security of agricultural enterprises is provided within the framework of several theories that use the systematization of knowledge and ways to transfer this knowledge to the multidisciplinary stages of the reproduction process of stable financial condition of economic entities. Fixation of stages in this context embodies the cognitive process of building a stable model of financial development of economic entities.

The theoretical foundations of financial security were researched by O. Baranovskiy (2004), A. Gukova and I. Anikina (2006), I. Komarnytskyi (2010), A. Sukhorukov and O. Ladiuk (2007), F. Fafurida, A.B. Setiawan and S. Oktavilia (2019); development of measures to ensure financial security in the agricultural sector of the economy was studied by V. Arefiev (2010), O. Vdovenko (2014), O. Hryvkivska (2012), O. Hudz (2013), N. Davydenko (2013), M. Demianenko and O. Zuieva (2010) and others. The concept of formation of financial security of agriculture in the context of financial activity of agrarian enterprises is considered W. Coleman, G. Skogstad and M. Atkinson (1996), C.-H. Ling, H.-L. Yang and D.-Y. Liou (2009), W. Moyer and T. Josling (2002), M. Petrick (2003) as a regulatory function of economic entities development with a justification of the principles of protection of their livelihoods; O. Zhydyak (2013), V. Korneyev (2009), T. Kuzenko (2010) as an assessment of the sectoral level of financial support for the industry and the development of a strategy for financial security of agrarian enterprises in the regions; O. Baranovskiy (2004), M. Yermoshenko (2001), S. Frunza (2010) as a priority of ensuring the national and individual interests of the subjects through overcoming financial contradictions, the formation of effective capital and state control over its use, the formation of macro and microfinance stability.

Financial security is often studied from the prognostic point of view of the possible influence of the external and internal environment on the formation of a stable financial condition and ensuring the financial stability of business entities that have developed in the works of C. Balomenou and M. Maliari (2013), V. Boronos (2011), V. Heyts (2009), H. Kramarenko (2003), H. Chesbrough (2010), A. Pantazis and T. Pelagidis (2017), L. Leyfer (2003), J. Gaspar, P. Vasconcelos and O. Afonso (2014). However, the scientific views of these researchers do not fully cover the current risks of transformational trends in the agricultural sector of the economy, based on the principles and patterns of strengthening the financial security. This complex and multifaceted issue is considered by individual elements and levels (Dovgal et al., 2017; Mohammad Aliha et al., 2019). This complicates its comprehensive study as a single system and the establishment of existing intersectoral correlations.

The priority of our study is to substantiate the methodology and mathematical tools for modeling the systemic factors of financial security of agricultural enterprises, which based on a systematic approach, determine quantitative and qualitative parameters of external and internal threats to identify the threshold interval of their stable financial condition and stable development.

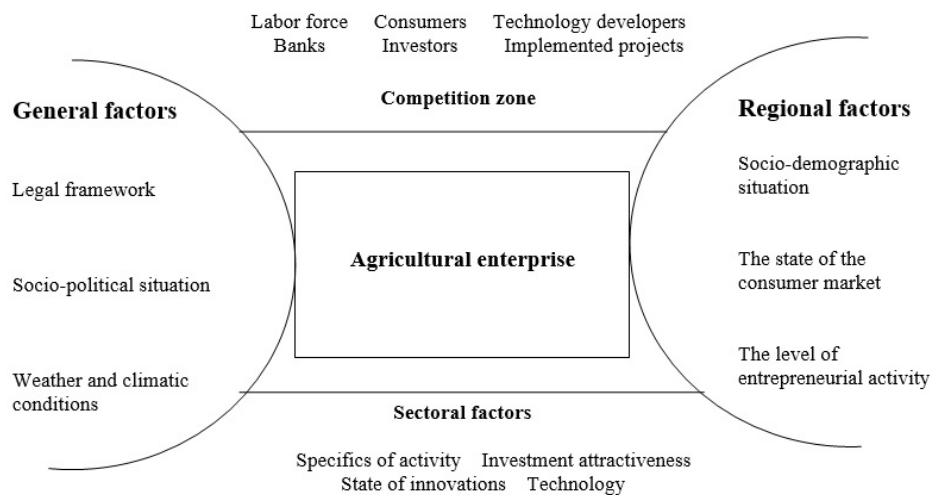
## **2. Materials and Methods**

Financial security is a platform for the mechanism of stable development of the entity, which identifies protective tools and measures for the rational use of financial resources, enhanced by the high dynamism of market relations, the constant generation in this process of new information about the nature of risk. Naturally, in the conditions of formation of a new model of financial security of agricultural enterprises, most of them did not show the ability to systemic changes in future development, financial opportunities and strengthening of a stable financial condition. Accordingly, external and internal risk factors that disrupt the normal functioning of the process of reproduction of financial resources cause uncertainty and threats of loss of positive results, irrational use of equity and debt capital, violation of dividend and depreciation policy, communication management of financial flows, financial reserves, receivables and payables, profit distribution. The lack of methods of normalization of

financial security subsystems in this aspect does not allow generating sufficient financial resources and ensuring the restoration of important economic and financial relations.

The level of financial security of economic entities should be considered in terms of a systematic approach, which embodies a number of elements of an arbitrary set that interact as a whole and function in accordance with certain patterns inherent in this complex. From the standpoint of emergence, financial security is characterized by the quality of synergy, which in the general theory of systems forms the interdependence of the elements of the system, providing a comprehensive effect. That is, the level of financial security has all the properties of a cybernetic system, in particular the presence of information channels between its individual elements; multivariate behavior of the system; controllability and purposefulness of the system, which in some way interacts with the aggressive environment (Fig. 1).

**Figure 1: Interaction of financial security of the agricultural enterprise and the external environment**



To improve the financial security of agricultural enterprises, we have proposed a model system of factors that, through analyzing and summation of individual functional criteria  $k_i$ , ((as the ratio of the possible value of the entity  $z_i$  (liquidity, financial stability, business activity and profitability) to the value of the components of financial security), prevents the emergence of threats to a stable financial condition  $s_i$ , i.e. (Korneyev, 2009; Marta-Costa et al., 2012):

$$k_i = \frac{z_i}{s_i}, \quad i = \overline{1, n}. \quad (1)$$

where,  $n$  – the number of functional components of the financial security of the agricultural enterprise.

In this case, the integrated indicator of the level of financial security of any business entity  $I$  will be calculated as (Hreshchak et al., 1999; Kim et al., 1989):

$$I = \sum_{i=1}^n \lambda_i k_i, \quad (2)$$

where,  $\lambda_i$  – the share of significance of the  $i$ -th functional component.

Systemic factors may differ depending on the specifics of the operation of the business entity, as well as change for the same entity at different stages of its life cycle. Accordingly, the level of financial security will have the following functional dependence (Oleynikova, 1997):

$$I = \alpha_1 f(x_1) + \alpha_2 f(x_2) + \dots + \alpha_n f(x_n), \quad (3)$$

where,  $x_1, x_2, \dots, x_n$  – performance indicators of the agricultural enterprise (financial security indicators);  $f(x_1), f(x_2), \dots, f(x_n)$  – local functions of dependence of the level of financial security on the relevant indicators of the agricultural enterprise;  $\alpha_1, \alpha_2, \dots, \alpha_n$  – systemic factors that reflect the importance of each indicator to ensure the financial security of the entity.

It is proposed to determine the system factors  $\alpha_i$  for the degree of achievement by the business entity of such an “ideal” state, which is the best in terms of development dynamics and performance. This “ideal” state is set by the limit values of indicators of financial condition, exceeding or underestimating of which negatively affects the ability of agricultural

enterprises to develop. That is, indicators of the level of financial security are normalized values of indicators of financial condition (stability) (Shlemko and Binko, 1997):

$$z_i = \left( \frac{P_{if}}{P_{ig}} \right)^b, \quad (4)$$

where,  $P_{if}$ ,  $P_{ig}$  – respectively, the actual and limit values of the  $i$ -th indicator;  $b$  – an indicator of the degree.

The exponent  $b$  in model (4) takes two values: for stimulatory factors it is equal to 1, for destimulatory factors it is equal to -1. The limit values of the indicators are determined based on the condition of the minimum permissible level of safety. The range of possible values of each indicator is divided into 5 intervals (Reverchuk, 2004):

$$[x_{gr}^n, x_{por}^n), [x_{por}^n, x_{opt}^n), [x_{opt}^n, x_{opt}^v), [x_{opt}^v, x_{por}^v), [x_{por}^v, x_{gr}^v), \quad (5)$$

where,  $x_{gr}^n$ ,  $x_{gr}^v$  – the minimum and maximum value (or lower and upper limit) of the indicator of financial security of the agricultural enterprise;  $x_{por}^n, x_{por}^v$  – respectively lower and upper threshold values of the indicator;  $x_{opt}^n, x_{opt}^v$  – minimum and maximum interval of optimal values of the indicator. The value  $x_{opt}^n$  can be equal to  $x_{opt}^v$ , then the interval  $[x_{opt}^n, x_{opt}^v]$  turns into a point  $x_{opt}$ . The values  $x_{gr}^n, x_{por}^n, x_{opt}^n, x_{gr}^v, x_{por}^v, x_{opt}^v$  in model (5) are determined by the expert method. Normalized values of financial security level indicators are calculated as follows (Reverchuk, 2004):

$$z_i = \begin{cases} \frac{x_i - x_{gr}^n}{x_{por}^n - x_{gr}^n}, & x_{gr}^n \leq x_i \leq x_{por}^n; \\ \frac{(x_i - x_{por}^n) + x_{opt}^n (x_{opt}^n - x_i)}{x_{opt}^n - x_{por}^n}, & x_{por}^n \leq x_i \leq x_{opt}^n; \\ 1, & x_{opt}^n \leq x_i \leq x_{opt}^v; \\ \frac{x_{opt}^v (x_i - x_{opt}^v) + (x_{por}^v - x_i)}{x_{opt}^v - x_{por}^v}, & x_{opt}^v \leq x_i \leq x_{por}^v; \\ \frac{x_{gr}^v - x_i}{x_{gr}^v - x_{por}^v}, & x_{por}^v \leq x_i \leq x_{gr}^v, \end{cases} \quad (6)$$

where,  $x_n^* = 0$  and  $x_v^* = 0$ .

After finding the normative value of indicators, a comprehensive rating indicator of the level of financial security of the enterprise is calculated (Sheremet and Sayfulin, 1995):

$$I = \sqrt{\sum_{i=1}^m (1 - z_i)^2}, \quad (7)$$

where,  $m$  – the number of indicators of the financial condition of the enterprise;  $z_i$  – normalized values of indicators of the financial condition of the enterprise.

In this case, we propose to consider the financial condition of the enterprise  $S(t)$  at the time  $t$  as a set of such indicators (diamond of the financial condition of the enterprise) (Kyzym et al., 2003):

$$S(t) = \{O(t), L(t), D(t), H(t)\}, t \in [0, T], \quad (8)$$

where,  $O(t)$  – the value of the turnover of capital of the enterprise (turnover ratio of current assets);  $L(t)$  – the value of the liquidity ratio of the capital of the enterprise (total coverage ratio);  $D(t)$  – the value of the rate of return on capital of the enterprise (profitability ratio);  $H(t)$  – the value of the capital independence of the enterprise (the ratio of equity and borrowed capital).

To assess the dynamics of the financial condition of the enterprise it is necessary to compare the actual indicators of the diamond of the financial condition with their base platform (values of past periods). Then the model of the dynamics of the financial condition of the enterprise  $I(t)$  will look like (Kyzym et al., 2003):

$$I(t) = \left\{ \frac{O_f(t)}{O_b(t)}, \frac{L_f(t)}{L_b(t)}, \frac{D_f(t)}{D_b(t)}, \frac{H_f(t)}{H_b(t)} \right\}, \quad (9)$$

where,  $O_f(t)$ ,  $L_f(t)$ ,  $D_f(t)$ ,  $H_f(t)$  – the actual values of indicators that characterize the financial condition of the enterprise at the time  $t$ ;  $O_b(t)$ ,  $L_b(t)$ ,  $D_b(t)$ ,  $H_b(t)$  – basic values of indicators that characterize the financial condition of the enterprise at the time  $t$ .

The set of indicators of financial condition, which are included in the model design of system factors must contain an integral limit distance of the real level of financial security of the enterprise in relation to the “reference”, which should be equal to (Trusova et al., 2019):

$$d(A_i, A_0) = \sqrt{\sum_{j=1}^n (x_{ij} - x_{0j})^2}, \quad (10)$$

where,  $d(A_i, A_0)$  – the integral marginal distance of the level of financial condition of the enterprise in relation to the “reference”;  $x_{ij}$  – the value of the  $j$ -th indicator for the  $i$ -th enterprise;  $x_{0j}$  – the value of the  $j$ -th indicator, which corresponds to the “reference” (normative value of the indicator).

The integrated indicator  $d(A_i, A_0)$  shows the level of deviation of the financial condition of the  $i$ -th enterprise from the “reference” level of financial security. If  $d(A_i, A_0) = 0$ , it means that the company has achieved the optimal value of security. An increase in the distance from the “reference” value in the dynamics indicates deterioration in financial condition and a decrease in the level of financial security. Values  $x_{0j}$  are critical and are determined by the principle of deviation of the indicator of the level of financial security of the enterprise (liquidity, financial stability and profitability) from the “reference”.

This methodological approach makes it possible to model the systemic factors that provide a stable level of financial security in order to form the total value of gross investment of the enterprise and the resources needed for investment support and development of economic entities (Kozachenko et al., 2003):

$$I_t = \frac{BI_t}{IP_t}, \quad (10)$$

where,  $BI_t$  – gross investment of the enterprise at the time  $t$ ;  $IP_t$  – investment of the enterprise at the time  $t$ , necessary to ensure financial security.

In the case when the value  $I_t$  is close to one, it indicates a high level of financial security of the enterprise. In this case, the overall financial security potential of agricultural enterprises will be manifested as the competitive status of the total amount of financial investments ( $KSP$ ) (Gukova and Anikina, 2006):

$$KSP = \frac{(I_f - I_k)}{(I_o - I_k)} \times \left(\frac{S_f}{S_o}\right) \times \left(\frac{C_f}{C_o}\right), \quad (11)$$

where,  $I_f$  – the actual level of strategic financial investment of the enterprise;  $I_o$  – the optimal amount of strategic financial investment of the enterprise;  $I_k$  – the minimum critical level of strategic financial investments of the enterprise;  $S_f, S_o$  – parameters of the current and optimal strategy of the enterprise;  $C_f, C_o$  – parameters of the existing and optimal potential of financial security of the enterprise.

In addition, a characteristic feature of the overall potential of financial security is the diagnosis of the functionality of the enterprise through the indicators of compliance of the  $i$ -th element of financing (Gukova and Anikina, 2006):

$$P = \sqrt[m]{\prod_{i=1}^m PV_i}, \quad (12)$$

where,  $P$  – the state of financial capabilities of the enterprise;  $PV_i$  – indicator of compliance of the  $i$ -th element of financing of functional capabilities and stable development (investment) of the enterprise;  $m$  – the number of functional capabilities of the enterprise.

The indicator of compliance of the  $i$ -th element of financing to the functionality and stable investment of the enterprise  $PV_i$  is determined as follows (Shkarlet, 2007):

$$PV_i = \sqrt[n]{\prod_{j=1}^n R_{ij}}, \quad (13)$$

where,  $R_{ij}$  – indicator of the  $i$ -th element of financing of functional capabilities and stable development (investment) of the enterprise, compliance with the provision of its  $j$ -th financial resource;  $k_i^s$  – the coefficient of significance of the  $i$ -th element of financing the functionality of the financial security potential of the enterprise;  $k_j^v$  – the coefficient of compliance of the  $j$ -th resource with the requirements that meet the stable development (investment) of the enterprise;  $k_{ij}^z$  – the coefficient of security of the  $i$ -th element of financing of functional capabilities of  $j$ -th financial resource.

$$R_{ij} = k_i^s \cdot k_j^v \cdot k_{ij}^z \quad (14)$$

A quantitative feature of estimating the total value of the financial security potential of the enterprise is the difference between the consolidated value of the total amount of income and expenses (Shkarlet, 2007):

$$V = \frac{D}{R_{mr} \cdot K_d} - (V_{na} + V_{ma}), \quad (15)$$

where,  $V$  – a generalized assessment of the potential of financial security;  $D$  – income (net financial (cash) flow) of the enterprise;  $R_{mtr}$  – the average industry level of profitability of economic activity;  $K_a$  – the coefficient of profitability of economic activity of the enterprise;  $V_{na}$  – the total value of all assets of the enterprise less tangible assets;  $V_{ma}$  – the total value of all tangible assets of the enterprise.

This difference reflects the balance of value (usefulness), which cannot be attributed to any of the assets of the enterprise. At the same time, the use of systemic factors of financial security determines the definition of qualitative and basic parameters of the process of managing the value of financial flows, thus providing a comprehensive assessment and multifactor modeling of the stable financial condition of agricultural entities. Accordingly, the variability of financial transactions of economic entities should cover all possible changes in the structure of sources of financing. First, each financial transaction determines the cycle of financial flow, in the process of which there are changes in the composition of financial resources and sources of funding. Second, the total amount of financing changes when financial transactions provide a regrouping of the structure of property assets (Pelagidis and Tsahali, 2019; Mohammad Aliha et al., 2018; Hasyim et al., 2019; Koudoumakis et al., 2019). That is, this variability of operations is determined by the need to finance variable costs and costs associated with the replacement of machinery and equipment (Pantazis and Pelagidis, 2017). Third, the balance between financial resources and their sources must be maintained after any financial transaction. This equality arises with the redistribution of financial resources, i.e. with an increase or decrease in the amount of financial potential, which significantly affects the integrated level of financial security of agricultural enterprises (Trusova, 2016).

Thus, from the standpoint of a complete approach to modeling the systemic factors of financial security of agricultural enterprises, we propose to use a multiplicative function that identifies local indicators (systemic stimulants, the growth of which has a positive effect on the aggregate indicator) of development of economic entities, taking into account possible threats to the functionality of the economic process:

$$B_t = \prod_{i=1}^n u_{ti}, \quad t = \overline{1, T} \quad (16)$$

where,  $n$  – the total number of indicators that characterize the potential of financial security of the enterprise ( $n = 56$ );  $t$  – time period number;  $v_{ti}$  – the value of the  $i$ -th indicator that characterizes the activities of the enterprise at the time  $t$ ,

$$u_{ti} = \frac{v_{ti}}{\max_{t \in [1, T]} v_{ti}}, \quad (17)$$

$t = \overline{1, T}$ ,  $i = \overline{1, n}$  – the threshold criteria of each indicator that characterizes the financial security potential of the enterprise.

Values  $u_{ti}$  characterize the relative deviation of the value of each financial security indicator relative to its maximum level for the period  $[1, T]$ .

At the same time, the possibility of the potential of financial security, during which a certain amount of balances of financial resources may be in non-monetary form, should be aimed at making short-term financial investments. The generalized level of financial security should cover inflation losses from the depreciation of the national currency and provide investment income, in accordance with the target or actual level of profitability.

### 3. Results and Discussion

Agriculture, which is a rather specific sector of the economy and has a number of features, has a significant impact on sectoral aspects of agricultural enterprises. The study of the parameters of systemic factors of financial security of economic entities of the Steppe zone allowed identifying their relationship with macroeconomic processes that affect the efficiency of entities (Table 1).

**Table 1: Interdependence of profitability and indicators of financial condition of agricultural enterprises of the Steppe zone of Ukraine on average for 2016-2019**

Indicators	Groups of enterprises by the level of profitability of operating activities								
	1	2	3	4	5	6	7	8	9
The share of enterprises in the group, %	4.1	5.7	19.8	22.8	24.4	14.6	2.2	3.6	2.8
The level of profitability, %:									
- of operating activities	-19.3	0.0	2.9	15.6	24.9	36.6	47.0	57.1	63.8
- of capital use	-22.9	-13.1	2.3	9.3	15.6	22.1	20.9	30.4	27.8
The number of assets turnover per year	0.71	0.96	1.12	1.22	1.88	1.82	1.34	0.81	0.69
- of cash	0.88	1.18	1.29	1.63	2.46	1.24	1.01	0.78	0.41
Per capita per 1 hectare of agricultural land, USD:									
- income	4643	5963	5428	7350	9702	18455	13013	7937	6014
- net profit	-1120	-330	244	582	1520	3179	2799	3562	5277
- assets	3673	3999	5994	9576	10988	14360	18909	9141	8496
Financial independence ratio	-0.34	0.00	0.55	0.71	0.72	0.83	0.83	0.95	0.71
Coverage ratio	0.78	1.54	10.38	17.28	10.56	1.80	22.03	14.66	3.11
Rapid solvency ratio	0.34	1.54	2.95	4.97	2.48	1.53	19.62	8.85	2.85
Depreciation rate of fixed assets	0.75	0.67	0.59	0.51	0.49	0.51	0.42	0.41	0.42
The ratio of maneuverability of working capital	-1.54	-1.20	0.27	0.43	0.58	1.04	0.84	0.93	0.54

Thus, the insufficient level of efficient activity of agricultural enterprises of groups I and II is the cause of loss of equity, deterioration of the structure of sources of financing, insufficient provision of economic resources and other processes. At the same time, the destabilization of the financial condition of enterprises worsens the conditions of their operation and leads to insolvency, reduced investment attractiveness and creditworthiness and, consequently, makes it impossible to attract financial resources from external sources. Improving the concentration of capital in general has a positive effect on the financial condition and efficiency of agricultural enterprises (Table 2). At the same time, due to its excessive increase, the effectiveness of such influence is lost. This is explained by the fact that in some enterprises the attraction of additional capital is not supported by its rational investment in the acquisition of fixed and current assets, as well as ensuring their effective use in the economic process.

**Table 2: The impact of capital concentration on the financial condition of agricultural enterprises in the Steppe zone of Ukraine on average for 2016-2019**

Indicators	Groups of enterprises by level of capital concentration per 1 ha of agricultural land								
	1	2	3	4	5	6	7	8	9
Share of enterprises, %	3.2	1.6	11.5	18.2	7.8	24.5	4.7	18.7	9.8
Limits of fluctuations in capital concentration, thousand USD	≤ 1.50	1.51-3.00	3.01-4.50	4.51-6.00	6.01-7.50	7.51-9.00	9.01-10.50	10.51-12.00	> 12.00
Average cost of capital, USD	1112	2299	3677	5176	6972	7906	9150	11051	13623
Financial independence ratio	0.50	0.52	0.54	0.71	0.80	0.82	0.60	0.42	0.39
Financial stability ratio	0.58	0.62	0.63	0.83	0.77	0.83	0.81	0.67	0.41
Investment ratio	6.87	4.61	3.13	2.56	2.06	1.62	2.21	1.55	0.96
Current liabilities coverage ratio	3.33	7.62	8.31	12.24	7.74	6.84	6.29	7.28	2.13
Rapid solvency ratio	2.12	4.17	1.19	3.10	1.84	2.11	2.27	3.23	1.19
Absolute solvency ratio	0.30	2.21	1.09	2.27	0.28	0.53	0.12	0.50	0.06
Maneuverability ratio of current assets	0.36	0.61	0.25	0.53	0.65	0.53	0.42	0.60	-0.52
Suitability ratio of fixed assets	0.63	0.58	0.55	0.53	0.56	0.43	0.54	0.58	0.37
Assets turnover ratio	2.23	1.01	0.75	0.58	0.64	0.46	0.46	0.28	0.53

Indicators	Groups of enterprises by level of capital concentration per 1 ha of agricultural land								
	1	2	3	4	5	6	7	8	9
Per 1 ha of agricultural land, USD:	1743	2025	2369	2602	3769	3906	3657	2857	4164
- income									
- operating activities	98	355	427	599	805	740	1160	960	-113
The level of profitability of operating activities, %	6.51	19.26	21.52	25.74	21.08	28.45	20.88	20.95	-0.86

Thus, when the concentration of capital increases to 6-9 thousand USD per 1 hectare of agricultural land independence and resilience are strengthened, and then there is a reverse process. In addition, the growth of capitalization to the level of 9 thousand USD per 1 ha of agricultural land leads to improved performance and increased operating income, while with a further increase in concentration, the efficiency of its use is significantly reduced. A similar trend is observed for the profitability indicator of operating activities. At the same time, the straightforward relationship between sales revenue and capital concentration is stronger, as the correlation coefficient reaches 0.87. As the level of debt increases, the coefficient of financial stability decreases, which in 6-9 groups of agricultural enterprises becomes critical (Table 3) and is accompanied by deterioration in the level of investment and maneuverability.

**Table 3: Relationship of debt with indicators of financial stability of agricultural enterprises of the Steppe zone of Ukraine on average for 2016-2019**

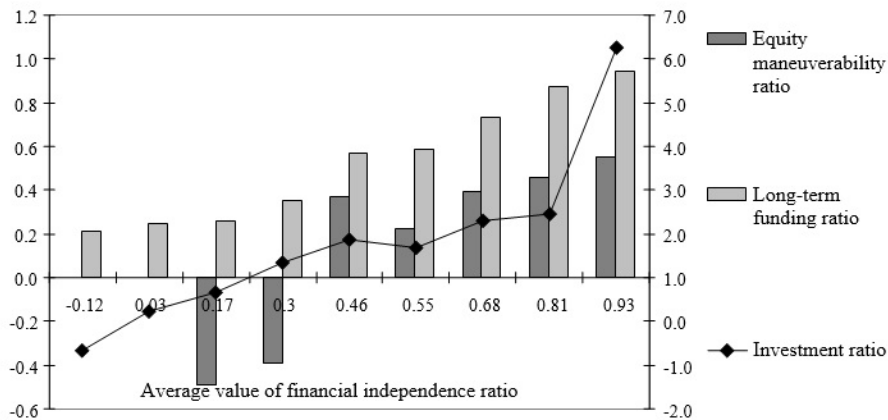
Indicators	Groups of enterprises by value of debt ratio								
	1	2	3	4	5	6	7	8	9
Share of enterprises, %	3.4	11.6	5.4	7.3	24.5	26.7	12.4	4.9	3.8
Limits of debt ratio	≤ 0.125	0.126-0.250	0.251-0.375	0.376-0.500	0.501-0.675	0.676-0.750	0.751-0.875	0.876-1.000	> 1.000
Debt ratio	0.07	0.19	0.32	0.45	0.54	0.70	0.83	0.97	1.12
Financial stability ratio	0.94	0.87	0.73	0.59	0.57	0.35	0.26	0.25	0.21
Short-term debt ratio in debt capital	0.88	0.64	0.82	0.92	0.80	0.93	0.89	0.77	0.71
Investment ratio	6.27	2.45	2.29	1.69	1.86	1.35	0.65	0.23	-0.68
Equity maneuverability ratio	0.55	0.46	0.39	0.22	0.37	-0.39	-0.49	-	-
Current assets maneuverability ratio	0.88	0.62	0.49	0.07	0.16	-0.87	-0.13	-0.07	-0.10
Fixed assets suitability ratio	0.58	0.59	0.46	0.47	0.55	0.61	0.60	0.45	0.55
Ratio of fixed assets security with current assets	4.83	1.70	1.95	1.91	2.73	3.11	2.78	6.14	6.05
Current share of retained earnings in equity	35.7	33.0	31.6	23.0	38.2	35.5	-14.4	-71.2	-

Thus, in 7-9 groups the investment ratio does not reach one, in 6-9 groups there is an unsatisfactory level of maneuverability of equity and current assets. Negative dynamics is observed in the enterprises of groups 4-9 due to irrational placement of borrowed funds in assets, because equity is not enough to finance non-current assets and inventories, which indicates a lack of financial stability. In farms of groups 7-9, the amount of financing does not provide financial stability, even when using a combination of long-term liabilities and short-term bank lending. A stronger relationship is observed between financial stability and the efficiency of agricultural enterprises (Figs. 2-3). However, the increase in the level of debt is accompanied by a decrease in the profitability of assets and operating activities, as well as the share of operating profit in income.

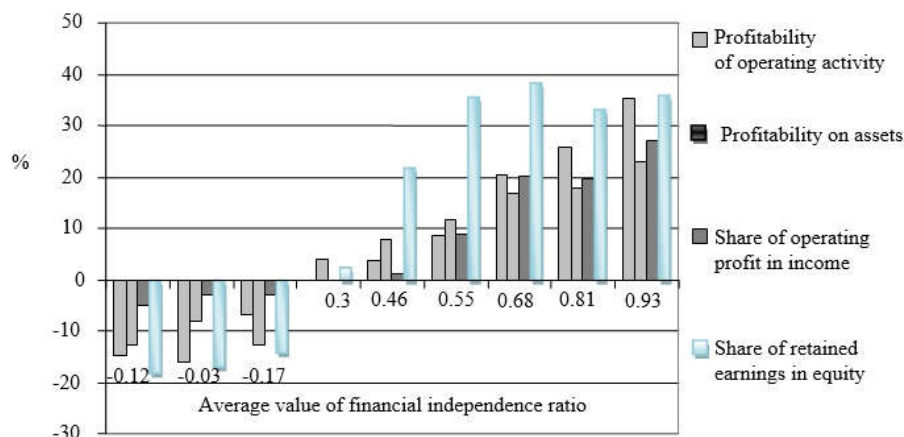
This connection is quite logical, because, on the one hand, borrowing requires interest, which reduces the efficiency of their operation, and on the other - the low level of profitability makes it difficult to form their own financial sources due to lack of capitalized income.



**Figure 2: Interdependence of financial stability and indicators of financial condition of agricultural enterprises of the Steppe zone of Ukraine on average for 2016-2019**

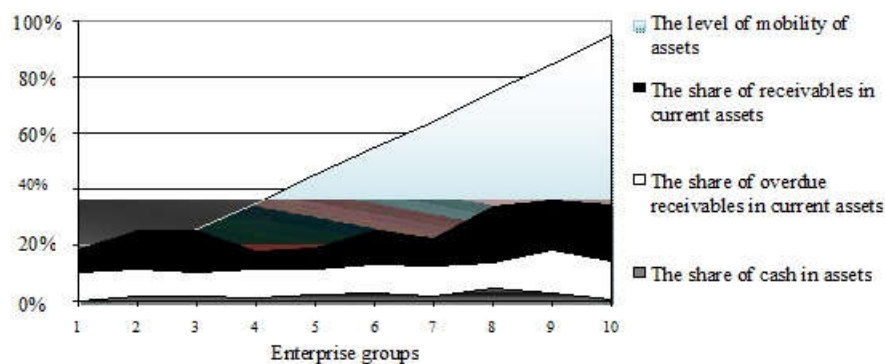


**Figure 3: Interdependence of financial stability and effective activity of the agricultural enterprise of the Steppe zone of Ukraine on the average for 2016-2019**



Important systemic factors-disincentives of financial security of economic entities of the Steppe zone of Ukraine are the lack of relationship between the level of mobility and the structure of current assets (Fig. 4). Thus, in general, the level of asset mobility for the period 2016-2019 ranged from 6.6 to 95.0%, in more than 50% enterprises it ranged from 34.9 to 54.9%.

**Figure 4: Interdependence between mobility and structure of current assets of agricultural enterprises of the Steppe zone on average for 2016-2019**



At the same time, the share of total and overdue receivables in current assets fluctuated in groups from 17.7 to 36.3% and from 10.1 to 18.7%; the share of cash in assets in these groups – from 0.4 to 4.9% and did not have a clear trend.

The stochastic nature of forecasting external and internal threats to identify the threshold interval of stable financial condition and stable development of agricultural enterprises allows identifying many factors that discourage financial security by reducing indicators such as: return on assets (deterioration occurs due to reduced efficiency and crisis in financial condition); debt ratio (deterioration of the structure of liabilities and the emergence of a crisis of funding sources); indicator of adequacy of financing of illiquid assets (indicator of threat to financial stability and asset formation); asset turnover ratio (slowdown indicates the emergence of a liquidity threat); the coefficient of maneuverability of current assets (signals the threat to liquidity and solvency).

The assessment of the level of financial security of agricultural enterprises of the Steppe zone of Ukraine was carried out by an integrated method with their division into clusters based on the Euclidean distance method. The financial security potential for a group of enterprises is the sum of standardized coefficients for each indicator parameter, which has a distance from 0.79 to 3.62 and is divided into five clusters (Table 4).

**Table 4: Clustering of agricultural enterprises of the Steppe zone of Ukraine according to the potential of financial security**

Clusters	Share of cluster enterprises in total, %	Average value of standardized indicators by clusters					Sum of standardized indicators (financial security potential)
		Profitability on assets	Debt ratio	Adequacy of financing of illiquid assets	Asset turnover	Maneuverability of current assets	
I	2.08	0.25	0.15	0.30	0.20	0.21	1.11
II	14.58	0.45	0.46	0.29	0.18	0.36	1.74
III	33.33	0.51	0.72	0.35	0.15	0.50	2.23
IV	42.82	0.58	0.86	0.40	0.21	0.67	2.72
V	7.18	0.72	0.92	0.55	0.32	0.73	3.24

According to the sum of squares of deviations of indicators for each cluster from the sample average, intra-cluster and aggregate variance (potential of financial security of agricultural enterprises) was determined, with the distribution of indicators of financial condition and stable development into three groups (Table 5). The first group is the threshold criteria that have slight deviations from the reference level of financial condition. The second group – relatively significant indicators, which include eight criteria, according to which the difference in the amount of intracluster variance is 30-40% less than the total variance. The third group – significant criteria, which include the ten most influential indicators of financial security.

**Table 5: Analysis of variance in clustering of agricultural enterprises of the Steppe zone of Ukraine by systemic factors of financial security**

Indicators	Dispersion of indicators		Deviation	
	by clusters	by aggregate	+,-	%
Financial stability ratio	14.0	33.2	19.1	57.6
Investment ratio	583.9	929.3	345.4	37.2
Coverage ratio	3409.6	5846.7	2437.3	41.7
Rapid solvency ratio	404.0	620.8	216.8	34.9
Inventory coverage ratio	2364.9	3676.5	1311.6	35.9
Ratio of provision of fixed assets with working capital	405.2	639.0	233.8	36.6
Share of retained earnings in liabilities, %	13.4	26.9	13.5	50.1
Share of short-term debt in liabilities	13.8	33.0	19.2	58.1
Share of operating income in income	12.4	18.6	6.2	33.4
Share of net profit in income	12.8	21.8	9.0	41.2
Profitability of operating activities, %	9.4	15.0	5.6	37.4
Profitability of economic activity, %	9.2	16.9	7.7	45.7
Profitability of fixed assets, %	80.0	134.8	54.8	40.6
Provision per 1 hectare of agricultural land, thousand USD:				
- borrowed capital	74.2	107.3	33.1	30.8
- short-term loans	43.9	65.7	21.8	33.2
- working capital	90.4	179.4	89.0	49.6
Per 1 ha of agricultural land, thousand USD:				
- operating profit	14.8	26.4	11.6	44.0
- net profit	13.4	27.0	13.6	50.4

The set of threshold criteria for the three groups (18 criteria) allowed to predict 7 important ones, which allow to stabilize the level of financial security and functionality of the economic process of agricultural enterprises (Table 6). To predict the integrated level of financial security of agricultural enterprises of the Steppe zone, a multiplicative function (23) was used, its value is a number from the interval [0, 1). The higher the value  $B_t$ , the more stable the financial condition of enterprises (characterized by a higher level of financial security).

**Table 6: Forecast normalized values of indicators that characterize the level of financial security of agricultural enterprises of the Steppe zone of Ukraine**

Indicator number (t)	$u_{t1}$	$u_{t2}$	$u_{t3}$	$u_{t4}$	$u_{t5}$	$u_{t6}$	$u_{t7}$	Forecast of the integrated level of financial security, $B_t$
1	0.8611	0.8750	0.8521	1.0000	1.0000	0.3860	0.4394	0.1089
2	0.6944	1.0000	0.8170	1.0000	0.9780	0.5545	0.4451	0.1369
3	0.8889	0.8125	0.7043	0.9908	0.9780	0.3496	0.6818	0.1175
4	1.0000	0.8438	0.7477	0.9908	0.9780	0.5842	0.7519	0.2685
5	0.8056	0.8750	0.6057	0.9908	0.9610	0.7945	0.9905	0.3199
6	0.7500	0.9844	0.7878	0.9908	0.9780	1.0000	0.8371	0.4718
7	0.8611	0.8438	0.9236	0.9259	0.8776	0.4396	0.7595	0.1820
8	0.8333	0.7500	0.8246	0.9259	0.8888	0.7041	0.8201	0.2449
9	0.7778	0.8125	0.8739	0.9259	0.8849	0.5964	0.9867	0.2663
10	0.7222	0.9063	0.7962	0.9259	0.8961	0.6320	0.9034	0.2468
11	0.8056	0.8281	0.8037	0.8980	0.8698	0.5019	1.0000	0.2102
12	0.7500	0.8438	0.6583	0.8980	0.8810	0.6597	0.7803	0.1697
13	0.8056	0.7969	0.8647	0.8980	0.8839	0.4825	0.8883	0.1888
14	0.8056	0.8906	0.8956	0.8980	0.8976	0.6588	0.6951	0.2372
15	0.8611	0.7969	0.9683	0.8697	0.8683	0.5614	0.5398	0.1520
16	0.7778	0.7500	0.9474	0.8697	0.8898	0.5670	0.5303	0.1286
17	0.7222	0.9219	1.0000	0.8697	0.9039	0.5617	0.5644	0.1659
18	0.8333	0.9531	0.8246	0.8697	0.9127	0.7813	0.6231	0.2531
$\max_{t \in [1, T]} v_{ti}$	0.8035	0.9697	0.7519	0.8476	0.9167	0.9068	0.6620	0.2733

The choice of the “best” predicted model of systemic factors of financial security is made based on the values of the coefficient of determination. The best polynomial models look like:

$$\begin{aligned} \tilde{u}_{t1} &= 0.671002 + 0.072959t - 0.010537t^2 + 0.000564t^3 - 0.000010t^4; \\ \tilde{u}_{t2} &= 0.827996 + 0.031224t - 0.004522t^2 + 0.000160t^3; \\ \tilde{u}_{t3} &= 0.619719 + 0.030863t + 0.006400t^2 - 0.001896t^3 + 0.000145t^4 - 0.000003t^5; \\ \tilde{u}_{t4} &= 1.026147 - 0.008501t; \\ \tilde{u}_{t5} &= 0.968386 + 0.027777t - 0.007036t^2 + 0.000448t^3 - 0.000009t^4; \\ \tilde{u}_{t6} &= 0.314741 + 0.040979t + 0.007288t^2 - 0.001151t^3 + 0.000037t^4; \\ \tilde{u}_{t7} &= 0.392985 - 0.040300t + 0.029750t^2 - 0.002693t^3 + 0.000067t^4. \end{aligned}$$

Forecast normalized values of indicators that characterize the level of financial security of enterprises have the following values:

$$\begin{aligned} \tilde{u}_{18(1)} &= 0.671002 + 0.072959 \times 18 - 0.010537 \times 18^2 + 0.000564 \times 18^3 - 0.000010 \times 18^4 = 0.8035; \\ \tilde{u}_{18(2)} &= 0.827996 + 0.031224 \times 18 - 0.004522 \times 18^2 + 0.000160 \times 18^3 = 0.9697; \\ \tilde{u}_{18(3)} &= 0.619719 + 0.030863 \times 18 + 0.006400 \times 18^2 - 0.001896 \times 18^3 + 0.000145 \times 18^4 - 0.000003 \times 18^5 = 0.7519; \\ \tilde{u}_{18(4)} &= 1.026147 - 0.008501 \times 18 = 0.8476; \end{aligned}$$

$$\tilde{u}_{18(5)} = 0.968386 + 0.027777 \times 18 - 0.007036 \times 18^2 + 0.000448 \times 18^3 - 0.000009 \times 18^4 = 0.9167$$

$$\tilde{u}_{18(6)} = 0.314741 + 0.040979 \times 18 + 0.007288 \times 18^2 - 0.001151 \times 18^3 + 0.000037 \times 18^4 = 0.9068$$

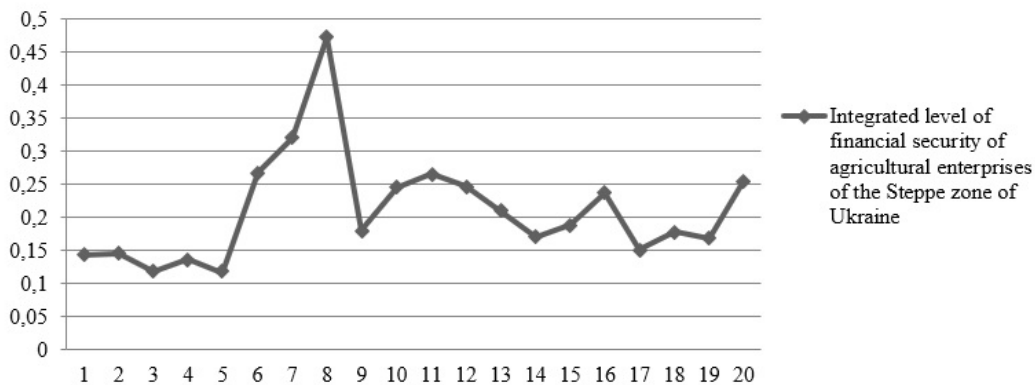
$$\tilde{u}_{18(7)} = 0.392985 - 0.040300 \times 18 + 0.029750 \times 18^2 - 0.002693 \times 18^3 + 0.000067 \times 18^4 = 0.6620$$

The forecast value of the integrated level of financial security of agricultural enterprises in the short term will be equal to:

$$B_{18} = 0.8035 \times 0.9697 \times 0.7519 \times 0.8476 \times 0.9167 \times 0.9068 \times 0.6620 = 0.2733$$

We should note that the forecast value of the integrated indicator is higher than several previous ones, which indicates a tendency to increase the level of financial security of enterprises in the Steppe zone of Ukraine. This is facilitated by the accelerated growth of accounts payable, equity and profits. Tendencies to reduce the value of fixed assets and income will have a negative impact on the potential of financial security. Graphic interpretation of the forecast change in the integrated level of financial security of agricultural enterprises for 2020-2024 is shown in Fig. 5.

**Figure 5: Graphic interpretation of the dynamics of the level of financial security of agricultural enterprises of the Steppe zone of Ukraine**



Thus, the process of ensuring the financial security of agricultural entities faces the need to radically reconsider the key interests of agricultural enterprises on the formation of the necessary and reproducible level of financial support, which should justify the implementation of functional elements of financial condition and protection of effective activities from internal and external threats.

#### 4. Conclusions

Stable functioning of agricultural enterprises is impossible without forecasting trends in their economic development, because factors such as changes in the international market, declining production, inflation, and the dynamics of non-payment are increasingly becoming decisive. Therefore, ensuring financial security and stable development of economic entities in agriculture of Ukraine should be based on adequate financial policy, the availability of the necessary financial and credit institutions, the use of means, methods and techniques to ensure it. This should take into account the irreversible, directed and natural change in agricultural development, which results in a new qualitative state of the economic process and a viable cycle of financial security potential of agricultural enterprises.

Systematization of stimulating factors of financial security should be formed on the platform of agrarian policy mechanisms of the state support of the industry in favor of the development of competitive entrepreneurship, support for greening and environmental protection measures; ensuring the scale of regional policy of advanced innovative development of financial, credit, social and engineering infrastructure; formation of

regulatory measures for the formation and operation of enterprises; risk leveling, implementation of protection measures against external and internal threats; improving the efficiency of financial resources of producers, the formation of trends in their profits, maintaining financial balance, through the optimization of financial flows of financial security entities in the context of ensuring their dynamic and stable development.

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