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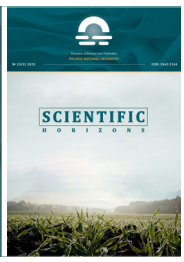

Price volatility in agricultural markets and financial security of enterprises: The role of forward contracts, insurance, and income diversification

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Abstract. The purpose of this study was to determine the impact of price risk management tools on ensuring the financial stability of Ukrainian agricultural enterprises in the context of military and macroeconomic instability. The study methodology combined theoretical and empirical approaches and was based on the methods of generalisation, dynamic and comparative analysis, structural-functional analysis, analysis of financial results and case analysis to assess the financial stability of agricultural enterprises in 2020-2025 based on statistical data on the price environment, financial results, and dynamics of the number of business entities. The results showed that price volatility in 2020-2025 affected the financial stability of agricultural enterprises. The index of sales prices of agricultural products decreased from 107.5% in 2021 to 100.4% in 2022, and in 2023-2025 it recovered only to the level of 101.2-103.0%, which indicated that the unstable price environment remained. Revenues of the agricultural sector increased from UAH 796 billion in 2022 to about UAH 2.4 trillion in 2024, and profits – from UAH 88.6 billion to about UAH 327 billion, but this recovery was mainly provided by large agricultural holdings. In particular, Myronivsky Hliboproduct and Kernel have growth indicators Earnings Before Interest, Taxes, Depreciation and Amortization in 2023-2024, it correlated with the active use of forward contracts and exchange-traded hedging instruments, while Astarta showed a stabilising effect of contracts due to the maintenance of cash flows in the sugar segment despite the fall in world prices. Thereby, from 2021 to 2025, 3,416 agricultural enterprises stopped operating, which reflected the high financial vulnerability of small and medium-sized farms. The practical importance of the study lies in the fact that these results can be used by agricultural enterprises, financial managers, and analysts to select effective tools for managing price risks

Keywords: hedging; liquidity; debt burden; cash flows; risks

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INTRODUCTION

Increasing instability of global commodity markets, increasing frequency of price shocks, and complicating logistics and financial conditions for the functioning of agricultural businesses vastly increase risks to the financial stability of enterprises. Fluctuations in prices for agricultural products directly affect the predictability of cash flows, the level of liquidity, the ability to service debt obligations and form investment resources, which in the context of military and global challenges becomes systemic. In the absence of effective price risk management mechanisms, enterprises become more vulnerable to loss of profitability and financial balance, even if production volumes are maintained.

The dominance of external shocks, financial risks, and unstable market conditions causes increased vulnerability of agricultural enterprises to loss of stability and deterioration of financial results, which stimulated scientific interest in economic security issues at the level of business entities. Yu. Mykhnovetsky (2024) made a major contribution to the research of this subject, which focused on the systemic nature of economic security of agricultural enterprises, identified key threats and justified the role of state regulation in creating favourable conditions for stable business functioning. In the results of the study, it was proved that the financial component of security is closely related to the risks of price fluctuations, military uncertainty, and limited opportunities for state support, and the effectiveness of protective mechanisms largely depends on management decisions at the enterprise level.

The growth of financial losses, logistics disruptions, and instability of export flows during the period of military transformations has increased the vulnerability of agricultural enterprises to the deterioration of their solvency and financial stability. These questions were investigated by A. Vasilyev and V. Galenko (2022), concentrating on assessing the financial security of enterprises under martial law and identifying key risk factors. The results showed the determining influence of inflationary pressures, currency fluctuations, rising costs and export restrictions on financial indicators, and the use of Strengths, Weaknesses, Opportunities, Threats (SWOT)- and Political, Economic, Social, Technological (PEST)-analysis allowed systematising the main threats and directions of stabilisation of enterprises' activities. O. Prokopyshyn and V. Dranus (2025) considered financial and credit collateral as an integrated system, combining credit mechanisms, accounting procedures, and analytical management tools. The authors proved that the scale of the enterprise determines the structure of available sources of financing: large companies work more efficiently with banks and international loans, while small and medium-sized farms focus on preferential programmes, agricultural receipts, and cooperative forms of attracting resources, and the integration of accounting with analytics reduces the debt burden and increases liquidity control.

The uncertainty of the external environment, the growth of financial risks and the complexity of choosing strategic decisions make it difficult to ensure the stability of agricultural enterprises. These aspects were investigated by L. Kostyrko *et al.* (2024), focusing on shaping a financial strategy in the face of uncertainty based on a comprehensive risk assessment. As a result, a system of risk indicators, a combination of SWOT-, PEST-, and scenario analysis, in addition to an approach to choosing strategic alternatives, accounting for the impact of risks on the profitability, liquidity, and market value of enterprises, was proposed. D. Pylypenko *et al.* (2025) identified economic threats and mechanisms for neutralising them through government support tools, credit programmes, business diversification, and the introduction of digital solutions. The authors proved that currency instability and rising borrowing costs directly affect the liquidity and investment capacity of enterprises, while concessional lending and international financial initiatives partially reduce this pressure.

In the context of a full-scale invasion, enterprises operate with increased macroeconomic instability, destruction of logistics chains, limited access to financial resources and the growth of multi-vector risks that directly affect their solvency and sustainability. These questions were investigated by N. Sytnyk and D. Polovko (2024), who viewed the financial security of the enterprise as a dynamic system capable of adapting to the turbulent environment of wartime, systematised key threats to financial stability and also proposed an integral methodological approach to its assessment, in view of liquidity, capital structure, efficiency, and quality of financial management.

High price volatility, asymmetry of market information, and limited opportunities to neutralise risks greatly complicate the financial decision-making of agricultural producers in conditions of uncertainty. These aspects were examined by M. Dyha and V. Dyha (2024), focusing on the use of hedging instruments to manage price risks, in particular, forward, futures contracts and options, proved their ability to stabilise cash flows, reduce the impact of volatility, and increase the predictability of financial results. In the results of the paper, it is proved that the development of the derivatives market and exchange infrastructure creates prerequisites for reducing price fluctuations and increasing the financial stability of business entities, while pointing out the low level of practical use of hedging in Ukraine due to institutional, information, and regulatory restrictions. The instability of income of agricultural enterprises in the context of climate change, military operations, and fluctuations in world prices determines the need to rethink approaches to the formation of financial results, which is reflected in the works of L. Kalachevska and

S. Lukash (2025), which systematised the factors influencing profitability, justified the role of diversification, digitalisation, and expansion of sales markets, and also proposed scenario modelling of income under various market and climatic conditions.

The relationship between price volatility, the use of hedging instruments, insurance, contractual, and credit mechanisms, and the financial stability of enterprises remains insufficiently disclosed in scientific research. The study aimed to substantiate the role of price risk management tools in strengthening the financial stability of agricultural enterprises. The study identified the following tasks to achieve this goal: analyse the impact of market price volatility on the financial stability and profitability of agricultural enterprises; investigate the role of contractual mechanisms for fixing prices and income diversification in reducing financial risks and stabilising cash flows of agricultural enterprises.

MATERIALS AND METHODS

This study has a complex theoretical and empirical nature and covered the time frame of 2020-2025, since this period includes the pre-crisis stage of functioning of the agricultural sector of Ukraine, the phase of sharp growth in price and macroeconomic instability in 2022, and the period of adaptation of enterprises to military, currency, and monetary shocks in 2023-2025, which allowed tracing the transformation of financial stability in various economic regimes. In the theoretical stage of the study, the theoretical foundations of financial stability of agricultural enterprises in a risky environment were determined, particularly financial stability as a dynamic economic category that can change under the influence of price volatility, seasonality of cash flows, capital structure, and management decisions. For this purpose, the method of theoretical generalisation and analysis of scientific approaches was applied, which enabled the formation of a conceptual basis for research based on the study by I.V. Dvornyk (2020). Further, key internal and external factors of the financial vulnerability of agricultural enterprises were identified. For this purpose, a structural and functional analysis was used, which enabled the distinction between internal factors (capital structure, liquidity, and cash flow management) and external factors (price volatility, currency fluctuations, monetary policy, and military risks). The application of this method aimed to explain the mechanisms of financial instability formation and its differentiated impact on enterprises of different scales (Pakhucha *et al.*, 2021; State Statistics Service of Ukraine, 2025).

The study also considered the role of risk-based management in ensuring the financial stability of enterprises. For this purpose, the analysis of financial results was applied, which allowed assessing the impact of management decisions on the ability of enterprises to adapt to financial shocks. In particular, the aggregated financial results of agricultural enterprises were analysed (Opendatabot, 2025), along with the role of digitalisation of financial management. Special attention is paid to the use of the Systems Applications and Products in Data Processing Suite Fourth generation High-Performance Analytic Appliance (SAP S/4HANA) system by Kernel (2024) and MHP (n.d.). At the empirical stage, an assessment of the financial stability of agricultural enterprises in conditions of price instability was conducted. For this purpose, the methods of dynamic and comparative analysis of sales price indices of agricultural products for 2020-2025 (MinFin, 2025a) were applied, enabling the assessment of changes in the price environment and its impact on the profitability of enterprises. Similar methods were used to analyse the average annual exchange rate of the National Bank of Ukraine (n.d.), changes in the number of operating entities (Dynamics of opening..., 2025) and key values of the discount rate of the National Bank of Ukraine in 2020-2025 (Minfin, 2025c) to assess the impact of currency and monetary factors on the financial vulnerability of the agricultural sector.

Within the framework of the study, tools for reducing financial risks of agricultural enterprises were identified based on a comparative case analysis of the activities of MHP, Kernel, and Astarta. For MHP, revenue and expenditure parts of operations, export orientation, margin indicators and Earnings Before Interest, Taxes, Depreciation and Amortisation (EBITDA) were analysed (MHP in 2024..., 2025). Chicago Mercantile Exchange and Chicago Board of Trade futures instruments, along with the dynamics of EBITDA were used for Kernel (2024). For Astarta (2025), the impact of falling prices and the stabilising effect of contract mechanisms on financial results was evaluated. Based on the comparative method, contractual price fixing mechanisms were generalised according to the criteria of the share of contractual operations, contract types, pricing basis, key effect, and role in financial security. The limitation of this study was that its results are interpreted within the period of 2020-2025 and specific conditions of military, currency, and price instability, which determine the contextual dependence of the conclusions obtained.

RESULTS

Theoretical foundations of the financial stability of agricultural enterprises in a risky environment. Financial stability of agricultural enterprises is one of the key prerequisites for their stable functioning and development in the conditions of increased uncertainty inherent in the modern economic environment. In contrast to the static approach, in which financial stability is considered as a fixed state of the balance of assets and liabilities, in scientific research, it is increasingly interpreted as a dynamic economic category. The variability of external and internal conditions of agricultural enterprises, cyclical production, seasonality of cash flows, price volatility for products and resources, in addition

to the influence of macroeconomic and military factors, can be considered due to this approach. The dynamic nature of financial stability is manifested in the ability of agricultural enterprises not only to maintain solvency and liquidity in the short term but also to adapt to structural shifts, crisis phenomena, and long-term shocks without losing production potential. Financial stability in this context is formed as a result of constant interaction between income, expenses, sources of financing, investment decisions, and risk management mechanisms. It is not a level that is achieved once and for all, but changes depending on market conditions, the availability of financial resources, the effectiveness of management decisions and the ability of the enterprise to respond to instability. The specifics of agricultural production determine the special dynamics of financial stability. The seasonality of revenues, the time lag between expenditures and revenues, and the dependence of operating results on natural and climatic conditions and world prices for agricultural products result in uneven cash flows. In such circumstances, financial stability becomes adaptive and requires the use of tools that ensure the equalisation of financial flows, reduce income volatility, and maintain an appropriate level of liquidity throughout the entire production cycle (Dvornyk, 2020).

As a dynamic economic category, financial stability is closely related to the risk tolerance of agricultural enterprises. It reflects their ability to counteract financial risks, in particular, price, credit, currency and production risks, and minimise the negative consequences of their implementation. Strengthening financial stability involves actively applying risk management tools, diversifying income sources, using insurance and contract mechanisms, and increasing financial flexibility, in addition to optimising the capital structure or reducing the debt burden. In the context of global transformations and military challenges, the financial stability of agricultural enterprises is becoming increasingly strategic. It serves as the basis for ensuring the continuity of reproduction processes, maintaining investment activity, and preserving competitiveness. Thus, the consideration of financial stability as a dynamic economic category provides for a comprehensive assessment of the state of agricultural enterprises, addressing the time aspect of financial processes, and making more reasonable management decisions aimed at strengthening their financial security in the long term. Financial vulnerability of agricultural enterprises is formed under the influence of a complex of internal and external factors that interact with each other and increase the risk of destabilisation of cash flows, liquidity, and solvency. The specifics of agricultural production determine the increased sensitivity of enterprises to fluctuations in the economic environment, which makes their financial stability largely dependent on the ability to adapt to multi-vector threats (Davydenko *et al*., 2024).

The key internal factors of financial vulnerability include the capital structure of agricultural enterprises. A high share of borrowed resources in financing activities, especially short-term loans, increases the debt burden and exacerbates the risks of loss of solvency in the face of rising interest rates or lower incomes. The low return on invested capital, which is typical for some agricultural enterprises, limits the possibility of self-financing and the formation of reserves necessary to compensate for financial shocks. An additional factor is an inefficient cost structure, particularly high energy and material consumption in production, which increases the cost of production and reduces the financial flexibility of enterprises. Cash flow management issues have a major impact on financial vulnerability. Uneven revenues throughout the production cycle, delays in payments to contractors, and poor payment discipline lead to a shortage of working capital during the off-season. A limited level of income diversification and a focus on a narrow list of crops or sales markets increase the dependence of financial results on market fluctuations. Thereby, fragmented digitalisation of financial processes and insufficient use of analytical tools reduce the quality of management decisions and complicate early diagnosis of financial risks (Pakhucha *et al*., 2021).

External factors of financial vulnerability of agricultural enterprises are systemic in nature and are often not subject to direct control by business entities. One of the determining factors is price instability in the agricultural and resource markets, which causes fluctuations in income and expenses and complicates financial planning. Inflationary processes, currency fluctuations, and changes in monetary policy directly affect the cost of credit resources, imported materials, and financial results of enterprises. A separate place among external factors is occupied by military risks and disruption of logistics chains, which limit export opportunities, increase transport costs, and reduce the predictability of cash flows. Climate change and the increasing frequency of extreme weather events worsen production risks and increase the likelihood of financial losses. Institutional factors, such as instability of state support, limited access to insurance mechanisms, and imperfect financial infrastructure, further increase the vulnerability of agricultural enterprises (Ahres *et al.*, 2025).

The aggravation of military and macroeconomic shocks has greatly increased the importance of risk-based management as a key tool for ensuring the financial stability of agricultural enterprises. After 2022, financial risks in agricultural production were transformed from episodic to systemic, which is confirmed by an increase in the share of unprofitable enterprises. In 2023, more than 50% of agricultural firms ended the year with losses, which was the result of military damage, logistics gaps, and a sharp increase in production costs. Despite this, among large and medium-sized enterprises in 2024-2025, the share of unprofitable ones

stabilised at the level of 22-26%, indicating a partial adaptation of the sector through management and financial decisions (State Statistics Service of Ukraine, 2025). The risk-based approach involves systematic identification of financial threats, monitoring their dynamics, and implementing mitigation tools. Liquidity and working capital indicators were especially vulnerable. In 2022, current liquidity decreased in 55% of medium-sized and large agricultural enterprises, while rapid liquidity – in 49%, which was due to an increase in short-term liabilities and a working capital deficit. However, the share of enterprises with sufficient current liquidity increased from 13% to 19%, highlighting the role of internal financial management and state support. The correlation between liquidity and profitability remained weak (0.15-0.42), which confirms the need for both financial injections and management changes (Dragan *et al.*, 2023).

The financial results of agricultural enterprises show an asymmetric adaptation to risks. In 2020-2021, the sector made a record net profit (UAH 238.8 billion in 2021), but in 2022-2023, profitability decreased by 50-60%. Therewith, in 2024, a recovery at the expense of large agricultural holdings took place: MHP (n.d.), Kernel (2024), LNZ Group provided a total profit of UAH 19.92 billion. This demonstrates the effectiveness of large-scale risk-based strategies, diversification, and access to financial instruments (Opendatabot, 2025). High price volatility remains a critical factor in financial instability. In 2022, fluctuations in wheat and corn prices reached 50-60% per annum, which drastically complicated income forecasting. Under such conditions, hedging and insurance instruments become of strategic importance, but their use remains limited: in 2025, only about 4% of acreage (968 thousand hectares) is insured, while in the countries of the EU this figure exceeds 60%. This demonstrates the incompleteness of risk-based infrastructure in agricultural production (MinFin, 2025b).

Digitalisation of financial processes is an important component of risk management. In Ukraine, Enterprise Resource Planning (ERP) systems and financial analytics are widely used mainly by large agricultural holdings. Thus, Kernel and MHP use SAP S/4HANA and integrated ERP solutions for budgeting, inventory management, liquidity control, and scenario risk analysis (MHP Holding implements..., 2021). The ERP implementation rate among large enterprises reaches 70-90%, while medium-sized farms show only 10-20% coverage, and small farms – less than 5%, limited to basic Excel tools. This creates a structural gap in the ability of enterprises to manage financial risks and explains the different rate of recovery of their financial stability. Consequently, risk-based management is a fundamental element of ensuring the financial stability of agricultural enterprises rather than an auxiliary one. Its effectiveness is determined by a combination of financial instruments, insurance protection, digital solutions, and management competencies, which is clearly manifested in conditions of military and price instability.

Assessment of the financial stability of agricultural enterprises in conditions of price instability. The financial results of Ukrainian agricultural enterprises in 2020-2025 were formed in the context of sharply increasing price volatility, which was combined with military, currency, and logistics shocks. Figure 1 displays the dynamics of sales price indices of agricultural products in Ukraine in 2020-2025 (data for March of each year), which allows assessing changes in the price environment of the agricultural market in the context of macroeconomic instability and military challenges.

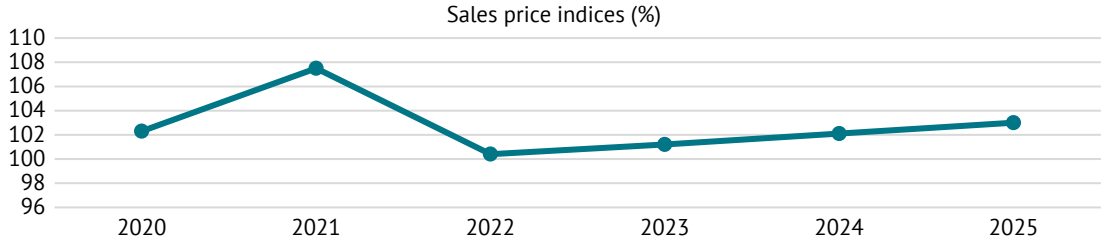

***Figure 1**. Agricultural sales price indices for 2020-2025*
***Source:** compiled by the authors based on MinFin (2025a)*

The highest level of the sales price index in March was recorded in 2021 (107.5%), which reflected a favourable price environment and high demand for agricultural products in the domestic and foreign markets. The lowest index value was observed in 2022 (100.4%), which was a consequence of the start of a full-scale invasion, the destruction of logistics chains, export restrictions, and growing market uncertainty. In 2023-2025, price indices showed a gradual recovery in the range of 101.2-103%, but did not reach the pre-crisis level of 2021, which indicates the persistence of increased price instability and its deterrent impact on the financial results of agricultural enterprises. The currency factor had a powerful impact on the formation of the hryvnia revenue of export-oriented agricultural enterprises. Figure 2 shows the dynamics of the average annual exchange rate of the hryvnia to the US dollar in 2020-2025, which characterises changes in the currency conditions of the agricultural sector.

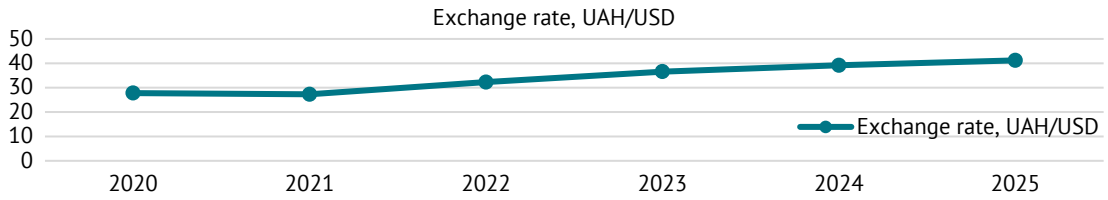

***Figure 2**. Average annual exchange rate of the hryvnia to the US dollar in 2020-2025*
***Source:** compiled by the authors based on Minfin (2025d)*

During the period under study, the exchange rate of the hryvnia to the US dollar was characterised by relative stability in 2020-2021, after which it acquired a stable upward trend. The lowest exchange rate value for the period was recorded in 2021 – UAH 27.3/USD, which corresponded to the pre-crisis state of macroeconomic equilibrium. The highest level of the exchange rate was observed in 2025 – 41.2 UAH/USD, which was a consequence of military risks, inflationary pressures, and deepening structural imbalances in the economy. In general, the growth of the hryvnia exchange rate against the US dollar by more than 50% in 2020-2025 partially offset the decline in dollar prices for exporters, also leading to an increase in the cost of imported resources and increased currency and financial risks for agricultural enterprises.

The financial results of Ukrainian agricultural enterprises in 2022-2024 were formed against the background of remarkable structural changes in the sector itself, manifested in the dynamics of income and profitability and the number of operating business entities. Between 2021 and 2025, 8,644 agricultural companies were registered in Ukraine, pointing to the relative adaptability of the sector to crisis conditions. The highest business activity was recorded in 2021, when 2,678 new enterprises were created, which corresponded to a favourable price environment and high profitability of agricultural production in the pre-war period. Since the start of the full-scale invasion in 2022, the number of new registrations has dropped to 1,558 businesses, reflecting growing financial uncertainty, loss of some production capacity, and deteriorating access to working capital. Already in 2023, the agricultural sector showed signs of partial recovery: 1,697 new agricultural enterprises were registered, and in 2025 – another 869, which indicates a gradual recovery of business activity even if military risks remain. In parallel with the processes of opening enterprises, the opposite trend was also observed – an increase in the number of business stoppages. During 2021-2025, 3,416 agricultural enterprises were closed in Ukraine, with the largest number of shutdowns occurring in 2021 (1,070 companies) and 2024 (685 companies). In 2025, another 536 agricultural enterprises stopped operating, which indicates the continued financial vulnerability of some entities, primarily small and medium-sized farms (Dynamics of opening..., 2025).

Such dynamics of entrepreneurial activity are closely related to the financial results of the sector. In 2022, the income of the agricultural business amounted to UAH 796 billion, and the profit – UAH 88.6 billion, in 2023, the income increased to UAH 920.9 billion, but the profit decreased to UAH 65.8 billion, which reflected an increase in costs and a decrease in marginality. In 2024 alone, against the background of a sharp increase in revenues to about UAH 2.4 trillion, the sector's profit recovered to about UAH 327 billion, which was mainly due to the results of large agricultural holdings. The combination of an increase in the number of closures of enterprises with record financial performance of individual companies signals an increase in the asymmetry of financial stability within the agricultural sector and confirms that price fluctuations and macroeconomic shocks have a differentiated impact depending on the scale and financial viability of enterprises (Ukraine's agricultural sector..., 2025). An important factor that reinforced these imbalances was the tight monetary conditions that determined the cost of credit resources and enterprises' access to financing. Figure 3 shows the dynamics of the National Bank of Ukraine discount rate in 2020-2025, which is a key monetary tool for influencing the cost of credit resources, inflation expectations and financial behaviour of enterprises, in particular, in the agricultural sector.

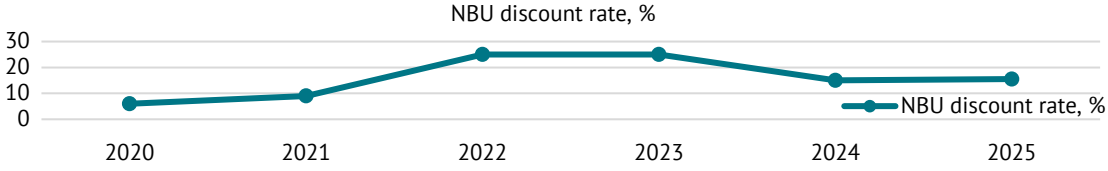

***Figure 3**. Key values of the National Bank of Ukraine discount rate for plotting (2020-2025)*
***Source:** compiled by the authors based on the MinFin (2025c)*

The lowest level of the National Bank of Ukraine discount rate for the analysed period was recorded in 2020 – 6%, which corresponded to a soft monetary policy in the pre-crisis period. In 2022-2023, the rate reached a maximum value of 25%, reflecting the National Bank of Ukraine 's response to a full-scale war, an inflationary surge and currency risks. In 2024-2025, there was a gradual easing of monetary policy with a rate cut to 15-15.5%, but its level remained drastically higher than before the war. This indicates the persistence of tight financial conditions that limited the access of agricultural enterprises to credit resources and increased their financial vulnerability, especially when combined with price and currency instability. The results show that price volatility in agricultural markets in 2020-2025 seriously affected the financial security of enterprises, but its effect was realised in cooperation with currency, monetary, and military shocks. Price fluctuations combined with the devaluation of the hryvnia and tight credit conditions increased liquidity risks and uneven financial results between large agricultural holdings and small and medium-sized farms. In turn, enterprises that had access to income diversification tools, export channels, and financial reserves demonstrated a higher ability to adapt to unstable price conditions.

Tools for reducing financial risks of agricultural enterprises. In 2022-2025, Ukrainian agricultural enterprises operated in an environment where price volatility was combined with military export restrictions, logistics reformatting, and currency fluctuations, which increased the risk of cash flow gaps and margin losses. Under such conditions, contractual price fixing mechanisms (forwards, long-term export transactions, flexible pricing formulas with deferred fixing and basic allowances) acquired the role of "market neutralisation" of risks: they transferred some of the uncertainty from the spot market to a managed contract space, where the enterprise can plan volumes, supply schedule, cost structure, and working capital requirements. Comparative analysis of three large companies (MHP, Kernel, Astarta) demonstrates different contractual hedging configurations due to differences in business models. For MHP, simultaneous control of revenue and expenditure parts is critical: the company generated 59% of export revenue in 2022 (EU, UK, Middle East), which means that it depends on external demand conditions and contract discipline of international markets (Tarasovsky, 2022). MHP reduces sensitivity to fluctuations in feed prices through vertical integration: up to 99.9% of feed needs in 2025 are covered by its own grain, while purchasing forward programmes (grain and oilseeds) and models of delayed price fixing ("advance now – price according to the formula/market later") allow smoothing the risk of peak purchase prices. For partners, such contracts combine an element of financing (prepayment) and flexibility of fixing, which reduces the likelihood of disruption of deliveries in seasonal "bottlenecks" (MHP is developing..., 2025). On the sales side, MHP does not disclose the exact share of sales at fixed prices compared to spot prices, but the revenue structure itself (export dominance) logically enhances the role of long-term export transactions as a tool for revenue stabilisation. The effect of this configuration was reflected in the recovery of operating results: EBITDA in 2023 was 4,445 million (margin ≈15%), and in 2024 – EB 566 million (margin ≈19%), which is consistent with the thesis that the combination of longer sales contracts and control of feed costs reduces the "price amplitude" of cash flows (MHP in 2024..., 2025).

For the Kernel, contract logic is more "market-financial": the company operates as a major grain exporter and processor, so the key is to manage price risk through forwards and exchange-traded instruments. Kernel sells about 50% of its grain through forward contracts; according to the company's position, this share supports the ability to consistently export approximately 4-8 million tonnes of grain annually. The forward programme is integrated into Open Agribusiness: counterparties are offered prepayment and pre-financing, which strengthens control over the resource base and logistics, in addition to "fixing" the price/formula. Forward pricing is based on free on Board (FOB) or Cost, Insurance and Freight, considering logistics and margins, and fixing is possible in flexible mode; in addition, Kernel (2024) uses hedging through Chicago Mercantile Exchange/Chicago Board of Trade futures and options, combining the stock exchange base with premiums (Black Sea FOB) as a specific "basis of origin". Such a scheme is important precisely in the war period, when basic costs (logistics/insurance/routes) become an independent source of volatility and can "eat away" at the gains from rising stock market prices. In financial terms, these instruments correlate with the stabilisation of results: EBITDA in 2023 was USD 381 million, and in 2024 it increased to USD 466 million (+22%). However, insurance coverage of crops in the company is estimated as limited (≈5-15% of the area), that is, contract hedging acts as the main "first barrier" against price shocks, supplemented by diversification of processing (oilseeds), but it is the contract component that sets the predictability of grain revenue and disciplines the export schedule.

Astarta represents the third model, where contract mechanisms are "tied" to the specifics of the product and the value chain. The company uses long-term contracts primarily in the sugar segment: annual export agreements for extra-high-quality sugar with key partners, which create more predictable sales even with fluctuations in world prices. In terms of crop production, Astarta (2024) maintains long-term relationships with grain producers and applies partner financing in UAH, and forward agreements for grain and sugar beet to manage risks for raw materials. In 2022-2023, the

company experienced pressure from military and logistics factors and falling prices (a decrease in the range of -11%.-38% for individual items), which was reflected in the dynamics of EBITDA (a decrease of approximately 23% in 2022 and 6% in 2023). In 2024, the stabilising effect of contracts was manifested due to an increase in sugar sales volumes (+40% to 396 thousand tonnes) and maintaining profitability even with a decrease in "market" prices: EBITDA per ton of sugar was about 60 euros (against >200 euros in 2023), which indicates a change in the margin profile and the importance of fixed/structured transactions for maintaining cash flow. Thus, for Astarta (2025), contracts perform not only the function of "price insurance" but also the function of stabilising the sales channel for products with higher added value and more predictable demand. Table 1 summarises the comparative characteristics of the use of contract price fixing mechanisms in the companies under study.

***Table 1**. Comparative characteristics of contract price fixing mechanisms in MHP, Kernel, and Astarta*

Criterion	MHP	Kernel	Astarta
Share of sales/purchases under contracts	≈59% of revenue (export)	≈50% grain	Mainly sugar and raw materials ≈50%
Main type of contracts	Long-term, index-linked, forwards	Forwards + Chicago Mercantile Exchange futures	Long-term + forwards
Pricing basis	EU/Middle East contracts	Chicago Mercantile Exchange + FOB Black Sea	Fixed export prices
Key effect	Margin stabilisation	Reducing income volatility	Easing price downturns
Role in financial security	Cost control	Hedging market risks	Cash flow support

***Source:** compiled by the authors based on Y. Tarasovsky (2022), Kernel (2024), Astarta (2025), MHP in 2024 increased net profit by 1.4%, EBITDA - by 27% with revenue growth of 0.8% (2025)*

It can be concluded that contractual price fixing mechanisms play a key role in stabilising the income of agricultural enterprises, but their effectiveness largely depends on the company's business model. For MHP, they are integrated into a vertically closed value chain and provide cost control, for Kernel, they are a central tool for hedging price and logistics risks, while for Astarta, they perform an auxiliary function in combination with product diversification. Together, this confirms that contractual mechanisms are not a universal solution, but if adapted to the business structure, they notably increase the financial security of enterprises in conditions of price volatility.

In 2022-2025, price volatility in agricultural markets became one of the critical risk factors for the financial security of enterprises, but its impact was greatly modified by the use of risk management tools. A comparative analysis of MHP, Kernel, and Astarta cases showed that contractual price fixing mechanisms allow transforming market uncertainty into a manageable financial parameter, reducing the amplitude of income fluctuations and ensuring the predictability of cash flows. Therewith, the effectiveness of such instruments is asymmetric and depends on the business model of the enterprise, the level of vertical integration and the combination of contract hedging with income diversification and risk insurance. In general, the results confirm that in military and post-crisis conditions, it is the integrated use of forwards, long-term contracts, and a diversified income structure that is a key prerequisite for maintaining the financial stability of agricultural enterprises in conditions of high price volatility.

DISCUSSION

Price volatility in the agricultural sector is one of the key factors of economic uncertainty affecting the stability of production, the financial stability of agricultural enterprises, and the functioning of food markets. Research focuses on various levels of price instability analysis – from global and national markets to individual segments of the agricultural economy and enterprises. Comparative analysis of this study and a paper of D. Hou and X. Wang (2024) showed the commonality of initial assumptions about the functioning environment of the agricultural sector, which was characterised by increased risk, price instability, and the impact of macroeconomic and climate shocks. In both approaches, insurance and contractual mechanisms were considered instrumental for reducing the financial vulnerability of agricultural producers. The logic of the analysis differed substantially: while the current study emphasised the financial stability of enterprises and an empirical assessment of the effectiveness of forward contracts, insurance and income diversification based on financial indicators, D. Hou and X. Wang concentrated primarily on the institutional and technological dimension of Agricultural Insurance development, highlighting the role of InsurTech in improving risk assessment, tariff formation, and loss settlement.

A similar complementarity was observed in comparison with the study by M. Bonato *et al.* (2024). Both studies were based on the recognition of price volatility as a key source of financial risks in the agricultural sector. While M. Bonato *et al.* considered volatility primarily as an object of quantitative forecasting, using

high-frequency data and Heterogeneous Autoregressive model of Realized Volatility (HAR-RV) models to assess its dynamics, this study interpreted an economic factor that directly affected cash flows, liquidity, and financial stability of enterprises. As a result, the focus shifted from the accuracy of the forecast to the practical effectiveness of risk management tools. The change in the scale of the analysis was even more pronounced compared to the study conducted by R.T. Djamar and D. Evelin (2025). The authors of this paper analysed the impact of global shocks after 2022 through the prism of Indonesia's national food security, focusing on production diversification and innovation as tools for reducing import dependence. However, in this study, the same shocks were interpreted from the standpoint of the micro level – as a source of financial instability of individual agricultural enterprises, which required the use of contract and insurance mechanisms to mitigate price risks.

A similar difference between the macro and micro levels was observed in comparison with the work of L. Hao and L. Ki-Seong (2024). In both publications, price volatility was recognised as a systemic risk exacerbated by external shocks. However, L. Hao and L. Ki-Seong viewed it as a result of economic policy uncertainty at the national level, applying econometric models to identify temporal variability of effects, while the present study focused on practical financial consequences for agricultural enterprises and the possibilities of stabilising their cash flows. Spatial measurement of volatility was central for the study by A. Theresia *et al.* (2025), which paid close attention to interregional spill over effects and transmission of price shocks in Indonesia. In contrast, spatial aspects were secondary in this study, giving way to an analysis of the internal financial stability of enterprises and the role of hedging and insurance instruments.

A similar shift in focus was observed when compared with the paper of M.R. Matondang *et al.* (2023), where food price volatility was viewed primarily through the prism of macroeconomic stability and inflationary risks using Autoregressive Conditional Heteroskedasticity/ Generalized Autoregressive Conditional Heteroskedasticity models. In this study, the same price fluctuations were analysed as a factor of financial vulnerability at the enterprise level, which led to a different set of management conclusions. Non-linearity and regime volatility, which were the focus of X. Zheng *et al.* (2025), also interpreted differently. X. Zheng *et al.* concentrated on identifying price dynamics modes and interregional spillover effects using Markov-Switching Vector Autoregression (MS-VAR)-models, while in the current study, these characteristics were considered primarily as a source of financial risks for agricultural enterprises that needed practical neutralisation mechanisms. A critical macro-financial perspective was inherent in the study authored by M. Venegas *et al.* (2024), where price volatility was interpreted as a consequence of the financialisation of agri-food markets and the activity of derivatives and index funds. Instead, the present study did not analyse these processes directly, but focused on how businesses can adapt to existing volatility through a combination of contract and insurance instruments. Compared to the findings of Y. Chen and J. Tang (2024) regarding the impact of financialisation and speculation on food security at the global level, this study offered a different logic of analysis – focused on microeconomic mechanisms for maintaining the financial stability of agricultural enterprises in an environment of high price volatility.

The significance of price volatility as a threat to food security was a common starting point for both this study and L.H. Lambert *et al.* (2025). Authors interpreted price volatility mainly through the prism of spatial and infrastructural organisation of markets, proving that the development and density of road networks can mitigate price fluctuations. In turn, in this study, the focus shifted from infrastructure factors to the financial behaviour of agricultural enterprises, where volatility was considered as a source of internal financial vulnerability, which required the use of contractual and insurance mechanisms to stabilise cash flows. A similar difference in the level of analysis was observed in comparison with the work of E.M. Kacperska *et al.* (2025). Both studies recognised that the full-scale invasion and associated trade uncertainty were a powerful trigger for increased volatility in grain markets. However, authors focused on the macro-level dynamics of European wheat and maize markets, analysing the stabilisation potential of the Black Sea grain initiative using econometric models. In this study, these same price shocks were interpreted because of their impact on the financial stability of agricultural enterprises, where the key role was played not by political agreements, but by the ability of businesses to adapt through contractual, insurance and diversification instruments.

The expansion of the analytical framework to financial markets was characteristic of the study by K. Yan and H. Yu (2024), which demonstrated how stock market volatility is transmitted to the agricultural credit sector through investor sentiment channels. This macro-financial approach underlined the systemic nature of risks and the complexity of forecasting cash flows at the industry level. This study focused on the consequences of the sources of financial shocks for individual agricultural enterprises, where stabilisation was achieved through the practical use of hedging, insurance, and income diversification tools. Another dimension of systematic price volatility was revealed in the paper of X. Zhuang *et al.* (2025), which reviewed the transmission of energy shocks to grain markets in China and the United States through logistics costs and biofuel demand. In this approach, volatility was formed as a result of inter-market interaction at the global level. Instead, in the present study, these inter-market processes were

not the central object of analysis. The main focus was on how agricultural enterprises can reduce the negative impact of already established price instability on their own financial stability through contract and insurance mechanisms. Summarising the results of the comparative analysis, it can be concluded that most studies agree on the recognition of price volatility as a systemic risk for the agricultural sector and food security, but substantially differ in explaining its sources and coping mechanisms. In contrast to macro-level, infrastructure or financial-market approaches, this study concentrates on the microeconomic dimension of the problem, proving that the financial stability of agricultural enterprises is largely determined by the effectiveness of using contract, insurance, and diversification instruments.

CONCLUSIONS

As a result of the study, it was established that price volatility in agricultural markets in 2020-2025 became one of the main factors of financial vulnerability of enterprises, especially in the context of a combination of military, currency, and monetary shocks. Analysis of agricultural sales price indices showed a sharp deterioration in the price environment in 2022 (100.4%) after the peak level of 2021 (107.5%), and further recovery in 2023-2025 (101.2-103.0%) remained unstable and did not reach pre-war values. This confirmed the continued high level of uncertainty and limited predictability of the income of agricultural enterprises. The financial results of the agricultural sector of Ukraine in 2022-2024 showed a major asymmetry in adaptation to price shocks. In 2022, the income of the agricultural business amounted to UAH 796 billion, and the profit – UAH 88.6 billion; in 2023, the income increased to UAH 920.9 billion, but the profit decreased to UAH 65.8 billion due to rising costs and falling margins. Only in 2024, there was a notable recovery in financial results: the sector's revenue increased to about UAH 2.4 trillion, and profit – to UAH 327 billion, which was primarily due to the activities of large agricultural holdings. The parallel growth in the number of closed enterprises (3,416 in 2021-2025) indicates the continued high financial vulnerability of small and medium-sized farms.

The study showed that risk management tools, primarily forward and long-term contracts, income diversification, and partly insurance, play a key role in reducing the negative impact of price volatility. Comparative analysis of MHP, Kernel, and Astarta cases demonstrated that the use of contractual mechanisms allows transforming market uncertainty into a manageable financial parameter, stabilising cash flows, and reducing the amplitude of fluctuations in financial results. In particular, the use of forward contracts for 59% of MHP and 50% of kernel sales volumes and the integration of exchange-traded hedging instruments correlated with EBITDA growth in 2023-2024, even in unfavourable market conditions. It was determined that the low level of development of insurance coverage (about 4% of acreage in 2025) and the limited implementation of digital financial solutions in small and medium-sized enterprises reduce the overall sustainability of the agricultural sector. Thus, the results of the study confirm that in military and post-crisis conditions, the financial security of agricultural enterprises depends not only on market conditions but above all on the ability to combine contractual, diversification, and management tools to neutralise price risks and ensure long-term financial stability. The prospects for further research are related to the analysis of the transformation of price risk management mechanisms in the post-war period and the assessment of the long-term impact of contract and diversification strategies on the financial stability of agricultural enterprises.

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Волатильність цін на сільськогосподарських ринках та фінансова безпека підприємств: роль форвардних контрактів, страхування та диверсифікації доходів

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Анотація. Метою цього дослідження було визначити вплив інструментів управління ціновими ризиками на забезпечення фінансової стабільності українських сільськогосподарських підприємств в умовах воєнної та макроекономічної нестабільності. Методологія дослідження поєднувала теоретичні та емпіричні підходи та базувалася на методах узагальнення, динамічного та порівняльного аналізу, структурно-функціонального аналізу, аналізу фінансових результатів та аналізу конкретних випадків для оцінки фінансової стійкості сільськогосподарських підприємств у 2020-2025 роках на основі статистичних даних про цінове середовище, фінансові результати та динаміку кількості суб'єктів господарювання. Результати показали, що волатильність цін у 2020-2025 роках вплинула на фінансову стійкість сільськогосподарських підприємств. Індекс цін реалізації сільськогосподарської продукції знизився зі 107,5 % у 2021 році до 100,4 % у 2022 році, а у 2023-2025 роках відновився лише до рівня 101,2-103 %, що свідчить про збереження нестабільного цінового середовища. Доходи аграрного сектору зросли з 796 млрд гривень у 2022 році до близько 2,4 трлн гривень у 2024 році, а прибутки – з 88,6 млрд гривень до близько 327 млрд гривень, але це відновлення було забезпечено переважно великими агрохолдингами. Зокрема, «Миронівський хлібопродукт» та «Кернел» мають показники зростання прибутку до вирахування відсотків, податків, амортизації та зносу у 2023-2024 роках, що корелює з активним використанням форвардних контрактів та біржових інструментів хеджування, тоді як «Астарта» продемонструвала стабілізуючий ефект контрактів завдяки збереженню грошових потоків у цукровому сегменті, незважаючи на падіння світових цін. Таким чином, з 2021 по 2025 рік припинили роботу 3416 сільськогосподарських підприємств, що відображало високу фінансову вразливість малих та середніх фермерських господарств. Практичне значення дослідження полягає в тому, що ці результати можуть бути використані сільськогосподарськими підприємствами, фінансовими менеджерами та аналітиками для вибору ефективних інструментів управління ціновими ризиками

Ключові слова: хеджування; ліквідність; боргове навантаження; грошові потоки; ризики