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MODELLING A COMPANY'S FINANCIAL SECURITY ALLOWING FOR FUNDS RESERVATION

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Abstract. The paper analyses the factors of the company's financial security, which, in turn, formed the basis for justifying the need to study the level of financial security. To research the dynamics of financial security of the company, the article considers the system-dynamic model and modelling of distributed financial flows of an industrial enterprise under the influence of random factors that reflect the threats affecting the financial security of the enterprise. Information about the firms' financial statements is often confidential, which leads to the need to develop a simulation model of the firm's operation and conduct experimental research based on the size of the reserve fund of the enterprise, which ensures its financial security. Three scenarios (pessimistic scenario, optimistic scenario and most probable scenario) were considered in the simulation experiments for an industrial enterprise, and it was found that in at least half of the cases the enterprise needs to form a reserve fund to maintain autonomy and ensure the necessary level of financial security.

Keywords: financial security, financial stability, current assets, cash flow, simulation model

JEL Classification: C02, C60, G10, L00, M00, O00

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1. Introduction

Ensuring sustainable growth of the enterprise's activity, stability of its performance, achievement of goals that meet the interests of owners and society as a whole, is achieved by forming the enterprise's strategy, which in the global economy is determined by the availability of a reliable system of its financial and legal security (Rudensky, 2002; Starinets, 2018; Slizkaya, 2007).

Financial security is the object of research in the works of Ukrainian researchers (Baranovsky, 2004; Bilyiy, 2018; Solomin, 2018; Epiphanov, 2009). The need to ensure sustainable long-run development, especially under crisis, requires further study of approaches to estimating and analysing the level of financial security of an enterprise.

In the field of financial security of an enterprise there are problems associated not so much with the inefficiency of the company's financial activity, the impossibility of payments, the appearance of arrears, which reduces the level of financial security of the enterprise (Thompson, 2006; Bagrov, 2008), but with a systematic analysis of the dynamics of the company's financial condition, causing both administrative and criminal liability. This kind of problem requires research using a systems approach and dynamic analysis of the system.

The level of the enterprises' financial security will ensure that the government can perform its functions and provide economic development, make improvements to social standards. Thus, financial security of enterprises is one of major components of the national security of any country, because enterprises are taxpayers. Estimation of financial security will allow the company to minimize the threats of financial instability and increase the safety of its existence.

"Major victims of COVID-19 outbreak are the small and medium-sized enterprises (SME), because SMEs, in comparison to large enterprises, usually do not possess sufficient resources, especially financial and managerial, and are not prepared for such disruptions. Due to the lack of sufficient governmental support, most SMEs face financial decline and even go bankrupt. SMEs have limited capability and resources to recover from such crisis. Likewise, the situation of other industries is no different." (Shafi et al., 2020).

It is necessary to know the methods and indicators of evaluation, the factors that affect financial security and the levels of financial security of an enterprise to conduct financial security evaluation. Under conditions of economic, political and pandemic instability, variability of micro and macro environment factors influencing the financial security of an enterprise becomes a particularly relevant question. The main tasks of the enterprise's financial security are to protect its own financial interests from the influence of external and internal threats in order to ensure business efficiency.

The purpose of this paper is to assist practitioners in identifying strategies required to respond to the impact of external and internal factors on defined representative industrial enterprise

to help them in predicting risks in the early stage of business decision-making and planning finance security of enterprises using a simulation model.

2. Literature Review

Methodology for evaluating the ecological and economic security of public forestry enterprises comprises a sequence of stages that ensure the formation of an information base for the research, selection of indicators, their processing using component, index, normative methods, interpretation of the results of calculations (Cherchyk et al., 2019). Methodology for assessing the level of economic security makes use of two approaches: qualitative (mathematical model) and quantitative (simulation models) determination of the level of economic security. These approaches can help develop the strategies and allow identifying and implementing the strategy that will maximize the level of economic security of the enterprise (Yaremko et al., 2018).

The author (Kaczmarek, 2019) quantifies corporate value in relation to the level of the financial security of a company's functioning. Assessments concern the degree of balancing effects in the context of value creation and financial security sustainable management. The entities analysed comprise all the manufacturing enterprises in Poland recorded in public statistical data in 2007-2018. The paper examines both value drivers and financial security explanatory variables. The following result was obtained: there is a directly proportional relationship between the effects of the value creation process and ensuring financial security of manufacturing enterprises.

Various companies from the automotive, metal and chemical sectors implementing their strategies based on the concept of risk management allowing for the risk factors affecting relations with suppliers operating in the Polish. The surveyed firms indicated the following as the most critical sources of threats in relations with suppliers: the possibility of untimely deliveries, quality defects of products, suppliers' financial situation, communication problems, low level of supply flexibility, product assortment errors, limited production capacity. Risk management is still essential to avoid disruptions in supply chains (Urbaniak, 2019).

Financial security of a microeconomic systems means the achievement of such a level of financial stability that will contribute to maintaining financial equilibrium and ensuring targeted growth aligned with the development strategy simultaneously. Three main determinants of the financial security of railway enterprises were identified for Ukrzaliznytsia: a reduction in traffic volumes, an unstable capital structure and the impossibility of timely repayment of current liabilities (Britchenko et al., 2018). The effectiveness of financial security depends on building a high-quality financial architecture, which consists of capital structure, ownership structure and quality of corporate governance (Sosnovska & Zhytar, 2018).

Sensitivity of small and medium enterprises to shocks in the economy and new rivals generates risks of own resources shortage and derived demand on credits. In this case, business also faces a number of challenges, including high interest rates and significant requirements to loan

against a pledge. In this connection solving these problems is an important task to ensure the growth of small business development (Korkuna et al., 2016).

The study (Mutoko, 2015) aims at exploring the financing challenges faced by manufacturing small, micro-and medium enterprises (SMME). Results show that SMMEs use more of internal than external financing because they cannot easily access external financing due to a lack of collateral security, high default rate, poor credit-rating, poor banking history, lack of honest reporting and lack of up-to-date records. Commercial banks should offer mentors and guide SMMEs rather than only finance them. SMMEs need to benchmark with best companies in other countries. Commercial banks should develop financing packages that suit firms according to their growth rate.

Over 94% of enterprises have been affected in some form by the ongoing coronavirus outbreak or due to lockdown (Shafi et al., 2020). Particularly, 31% of SMME have shut down their business completely, while 19% have partially closed their businesses, whereas 18% of enterprises are planning to apply for a loan to ensure their financial security. During any economic crisis, most of businesses face a cash-flow shortage; therefore, they require new strategies to overcome it. About two-thirds of participating enterprises can be maintained under pandemic conditions up to 8 weeks (around 2 months). Over 27% of the participating enterprises indicated the need for the provision of a loan on the low-interest basis, over 23% aim to get subsidies on utility charges (Shafi et al., 2020).

During the process of ensuring economic security of an enterprise, special attention should be paid to the economic security of production, which includes KPI of operational activity, such as break-even point, financial safety margin and operating leverage. The analysis of these indicators and data analysis can help in determining the reserves for increasing production efficiency (Ianioglo, 2016; Kobets et al., 2018). Effective corporate governance structure is designed as an institute to ensure scientific decision-making at enterprises as a mechanism for financial management operation that helps companies guard against operational risks, reduce the company's financial risk (Long & Liu, 2016).

In turn, it should be noted that aspects of sustainability in the information economy, namely the processes of strategizing in the context of Industry 4.0, are fundamental in forming exponential growth in development (Kurzweil, 2005). The works by scientists (Aleksander et al., 2020; Arefieva et al., 2021; Boiko et al., 2019; Bogachov et al., 2020; Borychowski et al., 2020; Chygryn et al., 2020; Cyfert et al., 2020; 2021; Czakon et al., 2020; Czyżewski et al., 2019; 2020; Dalevska et al., 2019; Dementyev & Kwilinski, 2020; Dementyev et al. 2021; Drozdz, 2019, 2020; Dyduch, 2019a; 2019b; Dzwigol, 2019a; 2019b; 2020a; 2020b; 2020c; 2021a; 2021b; 2021c; Dzwigol & Wolniak, 2018; Dzwigol & Dźwigoł-Barosz, 2018; 2020a; 2020b; Dzwigol et al., 2019a; 2019b; 2019c; 2020a; 2020b; 2021a; 2021b; Furmaniak et al., 2018; 2019a; 2019b; Gorynia et al., 2019; Gorynia, 2019; Hrytsenko et al., 2021; Kaźmierczyk & Chinalska, 2018; Kharazishvili et al., 2020; 2021a; 2021b; Khrapkina et al. 2021; Klimas et al., 2020; Koibichuk et al., 2021; Kondratenko et al., 2020; Kuzior et al., 2019; 2021a; 2021b; Kwilinski, 2018a; 2018b; 2019; 2021; Kwilinski et al., 2019a; 2019b; 2019c; 2019d; 2019e;

2019f; 2020a; 2020b; 2020c; 2020d; 2020e; 2021; Kwilinski & Kuzior, 2020; Kyrylov et al., 2020; Lakhno et al., 2018; Lyulyov & Pimonenko, 2017a; Lyulyov & Shvindina, 2017b); Lyulyov et al., 2018; 2020a; 2020b; 2021a; 2021b; 2021c; Mlaabdal et al., 2020; Miskiewicz, 2017a; 2017b; 2018; 2019; 2020a; 2020b; 2021a; 2021b; Melnychenko, 2020; 2021; 2019; Miśkiewicz & Wolniak, 2020; Pająk et al., 2016; 2017; Pimonenko & Lyulyov, 2019; Polcyn, 2018; 2021; Ponomarenko et al., 2018a; 2018b; Prokopenko & Miskiewicz, 2020; Saługa et al., 2020; Savchenko et al., 2019; Shkodina et al., 2020; Tkachenko et al., 2019a; 2019b; 2019c; 2019d; 2019e; Trąpczyński et al., 2019; Vatamanyuk-Zelinska & Melnychenko, 2020; Zastempowski et al., 2020) present research that emphasizes the relevance of the above thesis.

Security means a state of enterprise's protection from all threats in present and in future when a company can survive and expand its growth despite threats that affect it. "Financial security is a financial position of enterprise that is characterized by the balance of financial interests and the ability to ensure their implementation; resistance to the negative impact of internal and external threats of company's environment; and ability to provide financial equilibrium and sustainable financial stability of the enterprise in the short and long run" (Nosovaa & Yafinovycha, 2015).

An enterprise’s financial security includes the following aspects:

1) regarding financial security as a component of a company’s economic security and stable financial position;

2) identifying problem areas to protect own financial interests and independence of the enterprise;

3) monitoring the internal and external factors of company’s risk, growth and stability;

4) combining quantitative and qualitative indicators that should have the appropriate threshold (normative values) to determine the level of security;

5) evaluating measures to ensure effectiveness of financial security.

The objects of impact to support these aspects are income; cash flows; equity; commitment; investment in assets; financial and economic risks. Effect of financial risks on an enterprise are the most dangerous.

The company’s financial interests cover the following:

- maximizing a welfare of enterprise owners;
- increasing profitability of equity;
- adequacy of financial resources at all stages of company development;
- financial stability of the company under conditions of its growth;
- a high level of investment activity;
- a high level of financial innovation activities.

An enterprise’s financial security is a protection of its own financial interests at all levels of financial relations. It should ensure its development and stability.

Financial security demonstrates an accuracy of the financial strategy chosen under dynamic market conditions. Fluctuations in the individual parameters of an enterprise's financial security requires decision making about reserve fund to ensure a necessary level of financial stability of an enterprise.

Financial security and bankruptcy are legally regulated by the Constitution of Ukraine and indirectly by Laws of Ukraine such as "On the Fundamentals of National Security of Ukraine", "On Protection Against Unfair Competition" and The Commercial Code of Ukraine, the European convention on certain international aspects of bankruptcy, which explains the international aspects of bankruptcy procedures.

The financial component of an enterprise's economic security is the organization of cash flows analysis and profit formation affecting most components of an enterprise. The mechanism of an enterprise's financial security has to assess and identify internal and external factors influencing financial security which can be determined not only on the basis of data from previous periods of business, but also using simulation methods in evaluating the current situation and giving predictions for the future considering the influence of micro and macro factors on the enterprise activity. To simulate the influence of internal and external environment factors on financial position indicators the scenario method can be applied. An optimal criterion for financial stability indicators means the bigger amount of equity than liabilities. If an enterprise has indicators lower than recommended, it can affect its solvency. If indicators are bigger than their normative value, it can be a sign of an ineffective use of financial resources available. Requirements for the values of the indicators are not mandatory, but advisory.

Devising a financial security assessment system will help develop tactics and strategy of enterprises' operation.

The financial mechanism that ensures the appropriate level of financial security, consists of financial methods, instruments, leverage, legal and information support.

Financial forecasting is used to determine the short-term and long-term indicators that characterize the company's financial state.

Financial indicators can provide several scenarios of actions. Plans are based on forecasts considering the company's financial capabilities and strategies and provide key indicators in the future.

The following reasons can spark off a financial crisis at the enterprise:

1) incorrect development strategy and key performance indicators;
2) mistakes in managing the enterprise (incorrectly defined capital structure, failures in planning of reserve fund, etc.).

Environment can affect an enterprise in two different ways:

- internal (endogenous, including own finance) factors under control of an enterprise;
- external (exogenous) factors, which are beyond the enterprise's control and which may affect its activity (changing economic conditions, adopted legislation acts). External environment consists of micro and macro factors, permanent (technical progress, exchange rate) and temporary ones (disasters, pandemic, seasonality).

The classification of financial security threats is demonstrated in *Table 1*.

Table 1. The Classification of Financial Security Threats

Characteristics of financial security threats	Interpretation of characteristics
The source of financial security	unfair competition; reservation price of buyers; supply chain contractors; strike-breakers; criminal deals; actions of State and local authorities
The object of attacks	informational; financial; human resources
The size of the expected loss	catastrophic (bankruptcy or deep finance crisis); critical size (long-run instability); - difficulties (short-run instability); minor impact (immediate instability).
Forms of revealing	quantitative threats (poor reserve fund); qualitative threats (financial crisis, bankruptcy, corporate conflicts etc.).

Source: developed by the author.

Financial risk management (stand-alone risk, risk of a specific project, stand-alone risk measured by assessing the volatility of cash flow and profitability of the enterprise, market risk) is a part of the enterprise's financial security system. It includes:

- qualitative analysis of risks that threaten the financial security of the company (revealing of risk factors, identification of diversified and undiversified risks);
- quantitative risk assessment (e.g., standard deviation of expected values of reserve fund), which involves determining the probability of occurrence and the size of potential losses to minimize risks of the company's financial instability.

Financial risk depends on the availability of debt sources in the enterprise's capital structure and is characterized by the indicator of financial leverage. The sources of financial risk comprise instability of demand and variability of financial conditions of credit. The more is the interest on borrowing, the more are the financial risks, which can lead to reducing financial security.

In order to assess financial sustainability of an enterprise, it is necessary to determine normative values of the indicators based on empirical or simulation data for determined industries of the economy. They can be considered as indicators characterizing the activity of the best enterprise or average data for the studied enterprises plus / minus standard deviation, where number of indicators may vary depending on the task of analysis (Nosovaa

& Yafinovycha, 2015). The effectiveness of the cash flow management is defined by synchronization of cash receipts and cash payments of the enterprise.
The use of key indicators to assess the enterprise's financial security reveals the weaknesses of its operation. In order to improve the company's financial security, it is necessary to develop an estimation algorithm of financial security:

1) Simulating probability function, which includes expected value and standard deviation of reserve fund and identification of threats to the enterprise's financial security;
2) Calculating the indicators to explain the financial security of the enterprise;
3) Summarising all quantitative performance (means-st.dev.) and qualitative indicators (optimistic, pessimistic and most probable scenarios);
4) Diagnosing financial security and decision-making regarding its maintenance and improvement;
5) Monitoring the level of financial security and enforcing the optimal performance level of the company's financial security.

By mining meaningful and important information, advanced statistical analysis can bring new insights to many areas, such as markets, industries, and microeconomic systems. This paper proposes to combine the methods of statistical analysis with practical applications.

"The simulation model can determine key characteristics based on an original system, transaction, or process for experimentation or training. The model is designed to simulate key features. Simulation is not a single technique, but a method to solve problems. It can use various models to represent practical difficulties and verify which measures are effective at solving them. Using a platform provided by computational economics, establish a simulation model of agents in artificial markets" (Song & Fisher, 2018).

The problem for the manufacturer is to determine the initial level of the reserve fund. The authors derive the mean and variance of the reserve level as a function of time and provide a robust heuristic approach to aid the manufacturer in its decision (Buczkowski & Kulkarni, 2006). A significant number of cooperatives in the world have a reserve fund. At the same time, successful cooperatives can exist without reserve funds. The existence of reserve funds decreases the quality of service to members for rural areas in Israel (Galor & Sofer, 2019). The paper by Hughes & Nagurney (1992) presents a network model and algorithm of financial flow of funds accounting which can be used to calculate reconciled values of all outstanding financial instruments, tangible assets, and net worth. A computer simulator is developed to run empirical experiments to assess different coupling structures and parameters of the economic and financial models (Onural et al., 2020).

Due to numerous uncertainties such as bad weather conditions, frequent changes in the vessels' schedules, breakdowns of equipment, port managers are aiming at providing adaptive and flexible strategic planning using AnyLogic simulation platform. An agent-based system dynamics simulation model developed can achieve the stable state of the main parameters of intermodal terminals (Muravev et al., 2020).

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3. A Simulation Model

To develop a simulation model of an enterprise, there was considered an indicator of the company's net cash flow (NCF), the increase of which is due to the following factors:

1) total revenue (TR);
2) borrowing CR^+ ;
3) repayment of receivables DZ^-.

The distribution of the cash flow leading to its decrease is determined by the following reasons:

1) ensuring the current production process, including the acquisition of various resources for production (M), wages (L), capital cost (K);

2) compensation and payments, including repayment and servicing of loans CR^-; repayment and maintenance of payables to suppliers KM^-; repayment of debts related to the wage fund KL^-; repayment and servicing of debts related to the maintenance of the functional state of fixed assets KK^-.

Thus, in the model, the value of a net cash flow at each time moment is determined as follows:

$$NCF = TR + DZ^- + Cr^+ - K - KK^- - L - KL^- - M - KM^- \quad (1)$$

Exploring the financial security of the company, there will be distinguished the state of autonomous and non-autonomous functioning and development.

The state of fully autonomous functioning and development of an enterprise is the best possible state of financial security of an enterprise, because its own financial resources generated from the enterprise's operation are sufficient to cover the current needs $(M + L)$ and development (K):

$$M + L + K \leq Vr \quad (2)$$

In practice, production and business activities and the financial flows serving it are influenced significantly by the random factors, which require some compensatory reserve.

To assess the value of the guaranteed reserve ensuring the state of fully autonomous functioning and development of the enterprise (u_1), it is necessary to meet the following condition at each time period:

$$\max(M) + \max(L) + \max(K) = \min(Vr) + R \tag{3}$$

where R is the reserve, i.e., a minimal value of the company's net cash flow, which guarantees the autonomous fulfilment of the company's current obligations in an unfavorable market environment.

To estimate the value of this reserve, the following simplifying assumptions are introduced:

1) for each financial flow, there are stable average standard deviations denoted as σ_M, σ_L. σ_K, σ_{Vr};

2) the boundary probabilistic values of financial flows should be determined taking into account the three-sigma rule, which gives the following values:

$$\begin{gathered} \max(M) = M + 3\sigma_M \\ \max(L) = L + 3\sigma_L \\ \max(K) = K + 3\sigma_K \\ \min(TR) = TR - 3\sigma_{TR} \end{gathered} \tag{4}$$

3) standard deviations of financial flows are directly proportional to their average values:

$$\begin{gathered} \sigma_M = \alpha_M M \\ \sigma_L = \alpha_L L \\ \sigma_K = \alpha_K K \\ \sigma_{TR} = \alpha_{TR} TR \end{gathered} \tag{5}$$

As follows from *(5),* α are proportionality coefficients between standard errors and expected values to simulate probability distribution for representative industrial enterprise. For a qualitative interpretation of its possible values, the following scale is used *(Table 2)*

Table 2. The Interpretation Scale of Variation Coefficients' Values

Meaning of variation coefficient	Interpretation of meaning
$\alpha \leq 0.1$	Financial flow is stable
$0.1 \leq \alpha \leq 0.2$	Financial flow is subject to insignificant fluctuations
$0.2 \leq \alpha \leq 0.33$	Financial flow is subject to significant fluctuations

$\alpha \geq 0.33$	Irregular cash flow

Source: developed by the author.

4) total revenue is determined by the total cost of production, taking into account the profitability index of sales as follows:

$$TR = (1 + r) \cdot TC \tag{6}$$

where r is a profitability index of sales; TC is the total cost of the final product.

5) total cost of production has a stable structure. In (29), the following structure of the cost for ferrous metallurgy in Ukraine is given: material costs - 86%; labour costs - 8%; expenses for social events - 3%; depreciation - 3%. Thus, given the structure of financial flows identified in the simulation model, the following relations can be defined:

$$\begin{gathered} M = 0.86 \cdot TC \\ L = (0.08 + 0.03) \cdot TC = M = 0.11 \cdot TC \\ K = 0.03 \cdot TC \end{gathered} \tag{7}$$

Then, taking into account expressions (4) and (5), the state of fully autonomous functioning and development of an enterprise is achieved under the following condition:

$$M \cdot (1 + 3\alpha_M) + L \cdot (1 + 3\alpha_L) + K \cdot (1 + 3\alpha_K) = TR \cdot (1 - 3\alpha_{TR}) + R \tag{8}$$

where R is a reserve fund which guarantees the fully autonomous functioning and development of the enterprise.

Using *equations (6), (7)* and also taking into account that the average profitability of Ukrainian metallurgical enterprises was r=6.61%, the *expression (8)* can be rewritten as follows:

$$\begin{gathered} TC \cdot (0.86(1 + 3\alpha_M) + 0.11(1 + 3\alpha_L) + 0.03(1 + 3\alpha_K)) \\ = TC \cdot 1.066(1 - 3\alpha_{TR}) + R \end{gathered} \tag{9}$$

from where

$$R = TC \cdot (0.86(1 + 3\alpha_M) + 0.11(1 + 3\alpha_L) + 0.03(1 + 3\alpha_K) - 1.066(1 - 3\alpha_{TR})) \tag{10}$$

As can be seen from *(10),* the value of the reserve fund is proportional to the value of the current assets of the enterprise, the value of which is TC. For further analysis, the share of the reserve fund in the structure of the current assets (R/TC) will be considered:

$$\frac{R}{TC} = 0.86(1 + 3\alpha_M) + 0.11(1 + 3\alpha_L) + 0.03(1 + 3\alpha_K) - 1.066(1 - 3\alpha_{TR}) \qquad (11)$$

Let us consider the main factors determining the dynamics of (R/TC). So, for the analysis, the system of partial derivatives should be determined:

$$\begin{cases} \frac{\partial(R/TC)}{\partial\alpha_M} = 3 \cdot 0.86\alpha_M = 2.58\alpha_M, \\ \frac{\partial(R/TC)}{\partial\alpha_L} = 3 \cdot 0.11\alpha_L = 0.33\alpha_L, \\ \frac{\partial(R/TC)}{\partial\alpha_K} = 3 \cdot 0.03\alpha_K = 0.09\alpha_K, \\ \frac{\partial(R/TC)}{\partial\alpha_{TR}} = 3 \cdot 1.066\alpha_{TR} = 3.198\alpha_{TR}, \end{cases} \qquad (12)$$

From *(12)* it follows that the key factors determining the dynamics of the reserve, guaranteeing the autonomy of the operation and development of the enterprise, comprise the variation of the financial flow, serving the formation of various resources for production (α_M), and the variation of the financial flow, forming revenue from sales of products (α_{Vr}). If the values of the variation coefficients are comparable, the variation of revenue determines about 52% $(\frac{3.198}{2.58+0.33+0.09+3.198} \cdot 100\%)$, and the variation of resources about 42% $(\frac{2.58}{2.58+0.33+0.09+3.198} \cdot 100\%)$ of the reserve fund variation.

Thus, exploring the mechanisms to reduce the variation in financial flows is associated with revenue generation and financing of inputs. It is possible to achieve a significant reduction in the reserve fund. To illustrate the scale of this fund, there will be determined its expected values for various combinations of the corresponding coefficients of variation. In this case, to calculate the value of the fund, *formula (11)* is used, and as the possible values of the coefficients of variation, there are taken the values presented *in Table 1*. The results of the relevant calculations are presented in *Table 3.*

Table 3. Dynamics of the Reserve Fund under Changing of Financial Flows Variation

№	Values of variation coefficients	α_{TR}		
		0.1	0.2	0.33
	α_M	$\alpha_K = \alpha_L = 0{,}1$		
1	0.1	0.5538	0.8736	1.28934
2	0.2	0.8118	1.1316	1.54734
3	0.33	1.1472	1.467	1.88274
	α_M	$\alpha_K = \alpha_L = 0{,}2$		
4	0.1	0.5958	0.9156	1.33134
5	0.2	0.8538	1.1736	1.58934
6	0.33	1.1892	1.509	1.92474
	α_M	$\alpha_K = \alpha_L = 0.33$		
7	0.1	0.6504	0.9702	1.38594
8	0.2	0.9084	1.2282	1.64394
9	0.33	1.2438	1.5636	1.97934

Source: developed by the author.

The results show that even with relatively stable financial flows with a variation of 10%, to ensure autonomous sustainable operation and development of ferrous metallurgy enterprises, the reserve fund should be more than half of their total cost ($\frac{R}{TC} = 55.38\%$). This in turn leads to the fact that in order to independently achieve a high level of financial security guarantees, enterprises have to sacrifice production efficiency, since the reserve fund is an immobilized enterprise's return capital. The arising losses for enterprises of the ferrous metallurgy from this will be equal (supposing that $R = 0.5538 \cdot TC$):

$$R \cdot (1 + 0.066) = 0.5538 \cdot TC \cdot 1.066 = 0.5538 \cdot TR \quad (13)$$

It is obvious that the independent formation of such a reserve is an unbearable burden for the enterprise. To distribute it, it is necessary to transfer a part of this burden to external counterparties. The state of non-autonomous (dependent) functioning and development of an enterprise is characterized by non-negative values of receivables and payables indicators, as well as a possible non-zero credit flow, which can be represented by the following system of equations:

$$\begin{aligned}
&Cr \in \left(0, \max\left(Cr\right)\right); Cr^{+} \geq 0; Cr^{-} \geq 0;\\
&KK \in \left(0, \max\left(KK\right)\right); KK^{+} \geq 0; KK^{-} \geq 0;\\
&KL \in \left(0, \max\left(KL\right)\right); KL^{+} \geq 0; KL^{-} \geq 0;\\
&KM \in \left(0, \max\left(KM\right)\right); KM^{+} \geq 0; KM^{-} \geq 0;\\
&DZ \in \left(0, \max\left(DZ\right)\right); DZ^{+} \geq 0; DZ^{-} \geq 0.
\end{aligned} \tag{14}$$

Thus, the level of financial security of an enterprise can be estimated through the degree of its financial autonomy. To study the dynamics of financial security of an enterprise, there are considered a system-dynamic model and simulation of allocated financial flows of an industrial enterprise in the context of random factors, which reflect threats affecting its financial security. Let us proceed to the definition of the integral indicator, which will give a full image about the financial security state of the enterprise as a whole. To determine the integral indicator of financial security, the following procedure is proposed:

1. There is formed a system of indicators and, for each indicator, there are defined a normative value and the direction of its optimization. In this case, to calculate the corresponding coefficients in the simulation model, the following indicators will be used *(Table 4)*:

Table 4. The System of Integral Indicators of Financial Security Assessment

№	Name of the indicator	Normative value	Direction of optimization
1	Current solvency ratio	2	Max
2	Autonomy ratio	0.6	Max
3	Return on assets	inflation index* (*i inf.*)	Max

* The NBU (National Bank of Ukraine) discount rate was adopted as an estimation of the standard value
Source: developed by the author.

Additionally, the system of indicators includes receivables and payables, but unlike indicators (1)-(3), these indicators will be compared not with normative values but with each other. To do this, the turnover ratio of receivables (K_{ODZ}) will be compared with the turnover ratio of accounts payable (K_{OKZ}).

2. There is calculated the level of deviation for a specific indicator of the enterprise from the normative value as follows:

$$x = \frac{k_{fact}}{k_{norm}} \tag{15}$$

where k_{fact} is a factual value of an indicator;
k_{norm} is a normative value of an indicator.

For the system of indicators introduced into the simulation model, deviations from the normative values and conditions corresponding to the minimum required level of financial security are defined as follows:

$$\begin{aligned} x_1 &= \frac{K_{TP}}{2} > 1; \\ x_2 &= \frac{K_A}{0,6} > 1; \\ x_3 &= \frac{R_A}{7\%} > 1. \end{aligned} \tag{16}$$

When comparing receivables and payables, the situation when the turnover ratio of receivables is greater than the turnover ratio of accounts payable is considered favourable. Thus, a favourable situation will be when the following inequality holds:

$$x_4 = \frac{K_{ODZ}}{K_{OKZ}} > 1 \tag{17}$$

3. There is determined an integral assessment of the financial security during each period of the enterprise's operations. To do this, there can be used any convolution procedures based on calculations of cumulative or average values, for example, arithmetic or geometric average. Since at this stage special studies grounded the importance of the selected coefficients are not supposed, a sum of estimators is taken as an integral assessment (H):

$$H = x_1 + x_2 + x_3 + x_4 \tag{18}$$

Taking into account the introduced conditions, the minimum required level will equal 4. The value of the integral index fluctuates within 2.9 – 4.15, which can be interpreted as an insufficient level of the enterprise's financial security. Thus, in three cases out of five, the values less than four, moreover, the dynamics of the integral index tends to decrease *(Figure 1).*

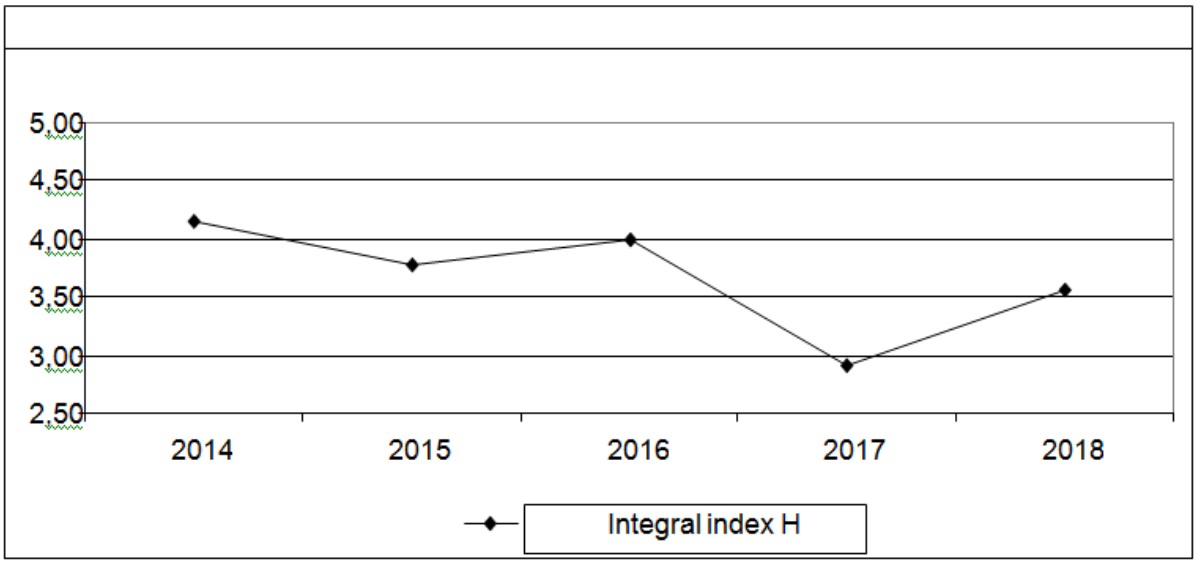

Figure 1. Dynamics of the Integral Indicator of Financial Security
Source: developed by the author.

4. Experiment

Information on the firms' financial statements is often confidential, which leads to the need to develop a simulation model of the firm's activities and to conduct experimental research based on the size of an enterprise's reserve fund which guarantees its financial autonomy.

For the experiment, 3 scenarios are considered:

1) *Pessimistic scenario*: the standard deviation of resource costs is determined by the ratios (resource costs above their average value): $\overline{\mathrm{M}} < \mathrm{M} < \overline{\mathrm{M}} + 3\sigma_{\mathrm{M}}$, $\overline{\mathrm{L}} < \mathrm{L} < \overline{\mathrm{L}} + 3\sigma_{\mathrm{L}}$, $\overline{\mathrm{K}} < \mathrm{K} < \overline{\mathrm{K}} + 3\sigma_{\mathrm{K}}$, and on total revenue (which is below average): $\overline{\mathrm{TR}} - 3\sigma_{\mathrm{TR}} < \mathrm{TR} < \overline{\mathrm{TR}}$;

2) *Optimistic scenario*: the standard deviation of resource costs is determined by the ratios (resource costs are less than its average value): $\overline{\mathrm{M}} - 3\sigma_{\mathrm{M}} < \mathrm{M} < \overline{\mathrm{M}}$, $\overline{\mathrm{L}} - 3\sigma_{\mathrm{L}} < \mathrm{M} < \overline{\mathrm{L}}$, $\overline{\mathrm{K}} - 3\sigma_{\mathrm{K}} < \mathrm{K} < \overline{\mathrm{K}}$, and on total revenue (which is above average): $\overline{\mathrm{TR}} < \mathrm{TR} < \overline{\mathrm{TR}} + 3\sigma_{\mathrm{TR}}$;

3) *Most probable scenario*: the standard deviation of resource costs is determined by bilateral inequalities (resource costs can be both higher and lower than their average values): $\overline{\mathrm{M}} - 3\sigma_{\mathrm{M}} < \mathrm{M} < \overline{\mathrm{M}} + 3\sigma_{\mathrm{M}}$, $\overline{\mathrm{L}} - 3\sigma_{\mathrm{L}} < \mathrm{M} < \overline{\mathrm{L}} + 3\sigma_{\mathrm{L}}$, $\overline{\mathrm{K}} - 3\sigma_{\mathrm{K}} < \mathrm{K} < \overline{\mathrm{K}} + 3\sigma_{\mathrm{K}}$, and on total revenue: $\overline{\mathrm{TR}} - 3\sigma_{\mathrm{TR}} < \mathrm{TR} < \overline{\mathrm{TR}} + 3\sigma_{\mathrm{TR}}$.

The following formula is used to determine the required number of experiments to reveal the structure of the links between R/TC and the explanatory variables (Lapach et al., 2001):

$$N = (1{,}5 \div 2) \cdot \left(1 + \sum_{i=1}^{m} L_i\right) \tag{19}$$

where m is the number of explanatory variables,
L_i is the degree of approximation by the factor i,
$L_i = F_i - 1$, where F_i is the number of variation levels of each independent variable.

Application of the *formula (19)* allows using experiments in 95% to obtain conclusions that are adequate to real life.

Using the formula *(19)* and four explanatory variables of the *formula (11),* there is obtained for a step of variation coefficient value with an accuracy of hundreds from 0 to 0.33 (absolute value): F_i=34, where i=1,2,3,4. After substitution of values F_i to *formula (19)* there is

$$\begin{aligned} minN &= 1{,}5 \cdot (1 + \textstyle\sum_{i=1}^{m} L_i) = 1{,}5 \cdot \big(1 + 4 \cdot (34 - 1)\big) \approx 200 \\ maxN &= 2 \cdot (1 + \textstyle\sum_{i=1}^{m} L_i) = 2 \cdot \big(1 + 4 \cdot (34 - 1)\big) = 266. \end{aligned} \tag{20}$$

From this, the average number of experiments required to obtain results adequate to real life should be $N = \frac{minN + maxM}{2} \approx 233$. Therefore, the number of observations should be at least 233. Let us consider 250 experimental observations for the pessimistic and optimistic scenarios respectively.

Scenario 1. It considers the pessimistic scenario of forming reserves by the enterprise for all coefficients, which vary in the range from 0.1 to 0.33 *(Table 3)*. Using the procedure for random numbers generating using existing restrictions for variables of the representative metallurgical firm *(7)*, there will be generated 100 indicators for the four coefficients defined by the corresponding intervals, and there is calculated for each of them the share of the reserve fund in the structure of current assets based on *formula (11).*

The average value of the R/TC ratio as a result of simulation experiments for the initial actual data was 128% with a standard deviation of 28%. With a 95% probability, the reserve for representative enterprise should be between 123% and 134% of its current assets.

Table 5. Distribution of the Share of the Reserve Fund R/TC in the Structure of Current Assets (Pessimistic Scenario)

Interval	Frequency	Cumulative frequency, %
0.6665	1	0.40%
0.7210	5	2.40%
0.7755	4	4.00%
0.8300	7	6.80%
0.8845	7	9.60%
0.9390	7	12.40%
0.9935	10	16.40%
1.0480	10	20.40%
1.1025	16	26.80%
1.1570	16	33.20%
1.2115	19	40.80%
1.2660	13	46.00%
1.3205	17	52.80%
1.3750	23	62.00%
1.4295	13	67.20%
1.4840	15	73.20%
1.5384	16	79.60%
1.5929	10	83.60%
1.6474	17	90.40%
1.7019	9	94.00%
1.7564	7	96.80%
1.8109	5	98.80%
More	3	100.00%

Source: developed by the author.

The histogram of the distribution obtained for the experimental data described in *Table 4* is shown in *Figure 2.*

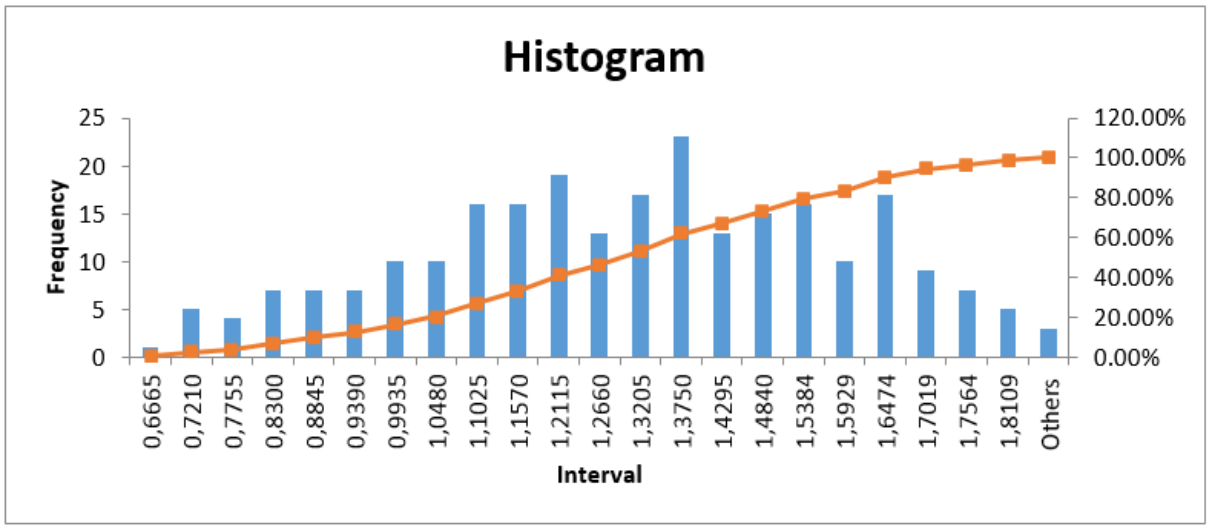

Figure 2. The Histogram of the Share of the Reserve Fund R/TC Distribution in the Structure of Current Assets (Pessimistic Scenario)
Source: developed by the author.

Scenario 2. Similarly, there is considered the optimistic scenario of reserves formation by the enterprise for all coefficients, which vary in the range from 0.1 to 0.33 *(Table 3)*.

With a confidence level of 95%, the excess of revenues over the enterprise's costs during the simulation experiment *(Figure 3)* will be established at the level of 136 to 147% of the current assets of the metallurgical firm *(Table 6).*

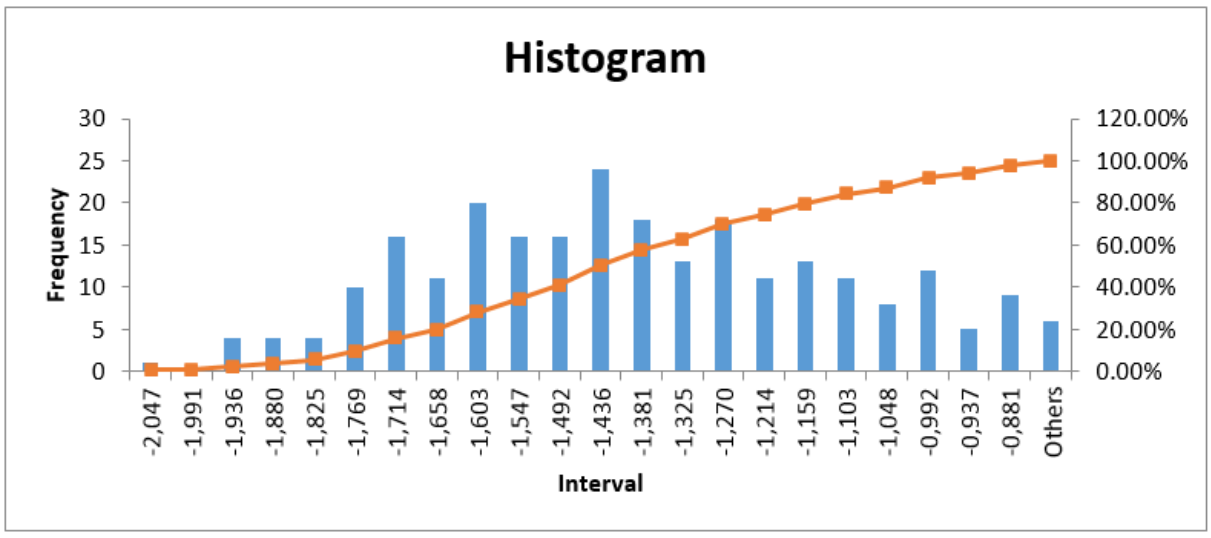

Figure 3. The Histogram of the Share of the Reserve Fund R/TC Distribution in the Structure of Current Assets (Optimistic Scenario)
Source: developed by the author.

Table 6. Distribution of the Share of the Reserve Fund R/TC in the Structure of Current Assets (Optimistic Scenario)

Interval	Frequency	Cumulative frequency, %
-2.047	1	0.40%
-1.991	0	0.40%
-1.936	4	2.00%
-1.880	4	3.60%
-1.825	4	5.20%
-1.769	10	9.20%
-1.714	16	15.60%
-1.658	11	20.00%
-1.603	20	28.00%
-1.547	16	34.40%
-1.492	16	40.80%
-1.436	24	50.40%
-1.381	18	57.60%
-1.325	13	62.80%
-1.270	18	70.00%
-1.214	11	74.40%
-1.159	13	79.60%
-1.103	11	84.00%
-1.048	8	87.20%
-0.992	12	92.00%
-0.937	5	94.00%
-0.881	9	97.60%
More	6	100.00%

Source: developed by the author.

Scenario 3. Next, there is considered the most likelihood scenario for forming reserves by the enterprise for all coefficients which vary in the range from -0.33 to 0.33 *(Table 3),* according to the procedure described above, when each of the four simulated indicators may deviate as above, then the average value, and within the interval, the values in which are lower than the average *(Table 6)*.

Using *formula (19)* and four explanatory variables of *formula (11),* there is obtained for a step the coefficient of variation with an accuracy of hundreds from -0.33 to 0.33: $\mathrm{F_i} = 67$, where $\mathrm{i} = 1,2,3,4$. After the substitution values of F_i to *formula (19)* there is

$$minN = 1{,}5 \cdot (1 + \sum_{i=1}^{m} L_i) = 1{,}5 \cdot \big(1 + 4 \cdot (67 - 1)\big) \approx 398$$
$$maxN = 2 \cdot (1 + \sum_{i=1}^{m} L_i) = 2 \cdot \big(1 + 4 \cdot (67 - 1)\big) = 530. \quad (21)$$

From this, the average number of experiments required to obtain results adequate to real life should be $\mathrm{N} = \frac{\mathrm{minN+maxM}}{2} \approx 464$. Therefore, the number of observations should be at least 464. Let us consider 500 experimental observations.

Table 7. Distribution of the Share of the Reserve Fund R/TC in the Structure of Current Assets (Most Probable Scenario)

Interval	Frequency	Cumulative frequency, %
-1.85471	1	0.20%
-1.69321	5	1.20%
-1.5317	4	2.00%
-1.3702	7	3.40%
-1.20869	14	6.20%
-1.04719	18	9.80%
-0.88568	26	15.00%
-0.72417	29	20.80%
-0.56267	28	26.40%
-0.40116	33	33.00%
-0.23966	44	41.80%
-0.07815	39	49.60%
0.083354	46	58.80%
0.244859	33	65.40%
0.406365	30	71.40%
0.567871	30	77.40%
0.729376	18	81.00%
0.890882	20	85.00%
1.052388	24	89.80%
1.213893	18	93.40%
1.375399	18	97.00%
1.536905	9	98.80%
More	6	100.00%

Source: developed by the author.

The results of the simulation experiment in table 5 demonstrate that in 49.6% of cases there is no need for metallurgical enterprises to form a reserve fund, while in 50.4% of cases it becomes necessary to form a reserve fund to maintain the autonomous operation of the enterprise *(Figure 4)*.

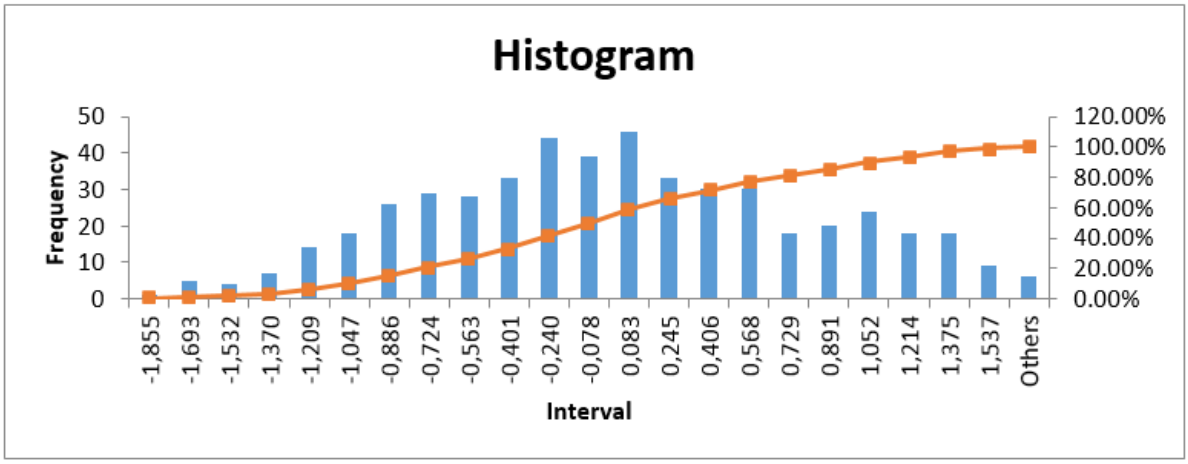

Figure 4. The Histogram of the Share of the Reserve Fund R/TC Distribution in the Structure of Current Assets (Most Probable Scenario)
Source: developed by the author.

The average value of the R/TC ratio as a result of simulation experiments for the initial actual data was -3.96% with a standard deviation of 77.4%. With a 95% probability, the reserve for a metallurgical company should be at least 11% of its return capital.

5. Conclusion

Thus, the use of the proposed simulation model made it possible to evaluate the complex effect of various factors on the financial security of an enterprise and its structure, investigate the dynamics of the integrated assessment of the financial security of an enterprise.

For statistically valid parameters for the operation of a metallurgical enterprise, three scenarios were considered for its operation, and during simulation modelling it was determined with a 95% probability that the reserve of a representative industrial enterprise should be up to 11% of its return capital. Moreover, in 50.4% of cases of production activities, representative enterprise will explore these reserves using either equity or debt capital to ensure own financial security. This simulation model can be implemented in any other industries for decision-making of practitioners about the size of a reserve fund for initial parameters of a representative industrial enterprise using different scenarios.

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