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MODELING THE FINANCIAL STRATEGY OF THE ENTERPRISE IN AN UNSTABLE ENVIRONMENT

Modern conditions of enterprise operation are characterized by a large number of negative factors. First of all, such factors include decrease in business activities of stock markets, low level of exchange fluctuations predictability etc. These factors generate additional financial risks and lead to significant losses and damages, and as a result they can cause the financial crisis situations. The novelty of scientific challenges contains the following tasks: to develop the complex of economic mathematical models which allows assessing the impact of uncontrollable external factors on financial activity; to create preventive financial strategies ensuring stable functioning and development of the enterprise under threats. The development of models is based on methods of multivariate analysis (principal component analysis, the method of the development level, the method of gravity center, hierarchical agglomerative methods and iterative cluster analysis, discriminant analysis, classification trees), econometric methods (pool data models, logit- and probit-models, vector autoregression technology, error correction models), simulation methods and system dynamics approach. The models implication in companies' activity has allowed developing financial strategy balanced on various directions while considering the potential financial risks.
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1. Introduction

One of the predominant tendencies in the development of modern economy is the escalation of globalization, formation of a unified trade and economic space. The globalization degree has totaled up over 60% worldwide and reaches 90% in Western

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European countries (Kononova, 2015). This has led to a significant boost of competition on local commodity markets, including but not limited markets of Eastern Europe and Ukraine, forcing national companies to look for new devices of attention-seeking and customer acquisition. As the conducted analysis shows, production of local manufacturers keeps up with their foreign counterparts in technology, price and ergonomics. In a similar vein, foreign companies pursue active crediting policies for their clients which makes the purchase of their products more attractive. In other words, one of the key factors of competitiveness of local companies is the factor of efficient financial activity management.

It stands to mention that national companies have shown negative tendencies of decreasing efficiency in financial activity. Thus, according to State Statistics Service of Ukraine, the ratio of unprofitable businesses was 44.9% as to the beginning of 2015; the amount of losses had almost doubled; the value of profit/loss on ordinary activities before taxation for enterprises and companies has decreased by a factor of 6. The established negative tendencies can be explained through objective and subjective reasons. Objective reasons stem from significant financial imbalances manifested in hardly foreseeable exchange rate volatility, inflation processes, tax burden growth, high credit rates, rapid bank crediting capacity decrease etc. Subjective reasons include low adaptation rate of strategic financial enterprise management system to negative influence of factors of unstable economic environment. That is what determines scholars and managers' interest towards anticipatory financial management and model base development that enables estimating consequences of influence of unstable economic environment factors on the financial activity of enterprise. Applying such model base to the financial activity management system of enterprise allows to predict effects of external environment uncontrollable by the enterprise, estimate financial strategy fulfillment risks, and settle on the financial strategy that ensures stable functioning and development of the enterprise in the context of rapidly changing economic environment.

Theoretical and methodological approaches to building financial strategy of the enterprise were studied in works by O. Azarova (2010), V. Barannikov (2008), S. Berneti (2011), R. Brumnik (2014), L. Guryanova, T. Klebanova (2006, 2010, 2014), R. Kaplan (2001), O. Kononov (2006), I. Lukianenko (2001, 2015), J. Minussi (2003), A. Oliskevych (2015), V. Plisa (2009), Y. Putyatin, O. Pushkar (1999), A. Semenov, O. Ieroputova, T. Perekrest (2008), A. Trided (2009, 2014), Yelysyeyeva (2010) and others. The approaches presented by the authors are based on the concept of a balanced index system which realization involves developing strategy-oriented budgets; building related strategic maps of goals, indices of their achievement, responsibility centers projects and budgets; shifting the control focus by designated people from tactic budget indices to strategic ones; shifting the coherence between budgeting and strategy. Managing such technology in the enterprise involves solving tasks which include analyzing and diagnosing external and internal financial environment of the enterprise, choosing strategic goals of financial activity, strategic alternatives which form the constraint system for budgets of different levels.

Methods and models of analysis and diagnosis of external financial environment are considered in works by O. Azarova (2010), V. Plisa (2009), Y. Putyatin, O. Pushkar (1999), A. Trided (2009) and others. Considering the widespread and non-debatable advantages of diagnosis methods studied in economic literature which allow to distinguish the factors most influential with financial activity of the enterprise, it is worth noting that they are primarily aimed at building a concept factor model of strategic financial position of the enterprise which reflects the results of qualitative analysis of financial environment factors. These methods can be used in further development of financial environment complex estimation model; however, their application presents difficulty within strategic planning based on quantitative effectiveness estimation of financial strategy and plans in monitoring their implementation. Aside from this, the issues which remain open are organizing expert analysis, building qualitative analysis information base, ranging factors according to significance level, estimating prolonged influence. This justifies application of common qualitative analysis methods of external financial environment as well as formalized diagnosis methods as multivariative analysis (cluster, discriminant analysis, classification trees, logit-, probit- models), vector autoregression and vector error correction model, panel data (Klebanova, Guryanova and Kononov, 2006; Lukianenko, Oliskevych, 2015; Brumnik, Klebanova, Guryanova, Kavun, Trydid, 2014).

The goal of developing estimation and diagnosis model base of internal financial environment of the enterprise is considered in studies by O. Azarova (2010), S. Berneti (2011), A. Eliseeva (2010), T. Klebanova, L. Chahovets', O. Panasenko (2011), J. Minussi (2003) and others. The proposed models are based on multivariative analysis, theory of fuzzy multitudes and neural network technologies. One cannot argue the prospects of applying these approaches while building estimation models of enterprise's tendency to bankruptcy, estimating integral index of enterprise's financial security, building models of choosing predominant hazards and identifying enterprise's class of states, estimating financial environment with expanded multitude of factors of financial state and branch differentiation of economic entities. Particularly, neural network technologies enabling building self-tuning models considering characteristics of the enterprise and economic environment, allow increasing efficiency of financial security management. However, applying these methods in strategic financial analysis is restricted with the necessity of building a big data base, which to a greater extent corresponds with analysis of mass phenomena and developing scoring models. In this regard, it seems advisable to build models which allow getting reliable forecast estimation of state class of the enterprise's internal financial environment in condition of small selections.

When choosing strategic goals and alternatives of financial activity of the enterprise, V. Barannikov (2008), O. Kononov (2006), V. Plysa, I. Pryymak (2009), Y. Putyatin, O. Pushkar (1999), A. Trided (2009, 2014) and others apply methods of cognitive modeling, expert analysis and imitation modeling. It is worth noting than aside from unquestionable advantages of the suggested approaches which enable building local functional investment strategies and sanitation strategies, a range of restrictions can be drawn related to use of predominantly qualitative estimates, necessity of developing

action forecasts of all partners of the enterprise which presents difficulty in conditions of competitive market, absence of control loops for operational, investment and financial activity resulting in impossibility of balance and coherence estimate of a financial strategy in different directions and business-processes.

The issue of synthesis of concepts of balanced index system and anticipatory financial activity management focused on detecting hazards to stable functioning beforehand and preventive correction of strategic alternatives and goals has been considered by T. Klebanova, L. Chahovets', O. Panasenko (2011), T. Klebanova, L. Guryanova, O. Kononov (2006). Particularly, the following aspects have been studied: developing forecast models of financial state of the enterprise in conditions of acting hazards, developing an imitation model of managing circulating capital in conditions of acting hazards. Still, some issues remain poorly studied, and namely: developing a coherent set of economic and mathematic models that allow estimating internal and external financial environment of the enterprise, diagnosing possible adverse changes in strategic financial position of the enterprise, detecting potential hazards, estimating risks of realizing strategic financial alternatives, building a financial strategy balanced in different directions considering the most possible hazards.

2. The conceptual scheme

The scheme suggested in the paper presents the relationship of modules and procedures of building the financial strategy of the enterprise functioning in conditions of unstable external environment, which is shown in Figure 1. The first module of the suggested scheme (Figure 1) presents assessment and analysis of the factors of external and internal financial environment of the enterprise (FEE) in three areas: 1) external FEE of indirect influence; 2) external FEE of direct influence; 3) internal FEE. This module includes the following sets of models and procedures: procedures of forming informational space of features – M1; procedures of classification of states – M2; models of identification of the state class – M3; models of forecasting FEE performance – M4; model of assessing strategic financial position of the enterprise – M5.

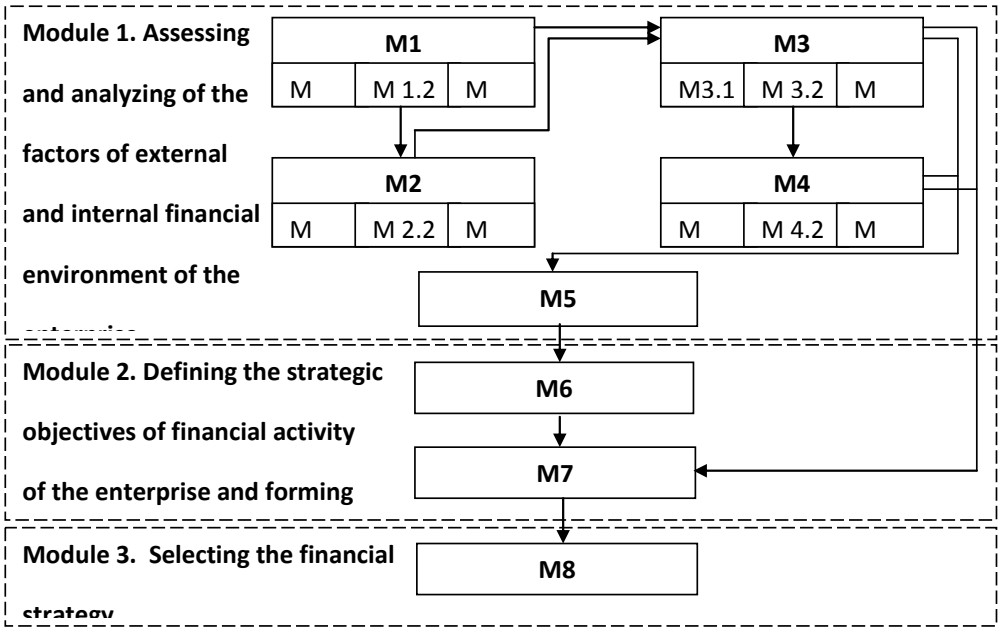
The second module defines the strategic objectives of financial activity of the enterprise and forms a set of strategic measures for their achievement. The model bases of the second module comprises: a model of selecting the type of financial strategy – M6; simulation model of financial activity of the enterprise – M7.

The third module selects the financial strategy. For the implementation of this module's tasks a procedure of building and choosing strategic alternatives of financial activity of the enterprise is suggested – M8. The content of each module is considered below.

Realization methods for modules of building financial strategy are considered in Table 1.

Figure 1

Scheme of interrelation between modules, models and procedures of building the financial strategy of the enterprise



Source: Developed by the authors.

Table 1

Realization methods for modules of building financial strategy of the enterprise

Designated sign of module	Designated sign of model or procedure set	Name of model or procedure set	Realization methods
1	2	3	4
Module 1.	M1	Procedures of forming informational space of features	Group representatives method, taxonomy and factor analysis, method of reducing informational space of indicators
Module 1.	M 1.1	Procedure of forming informational space of features of external environment of the enterprise (macro-level)	Group representatives method, taxonomy and factor analysis, method of reducing informational space of indicators

	M 1.2	Procedure of forming informational space of features of external environment of the enterprise (meso-level)	
	M 1.3	Procedure of forming informational space of features of external environment of the enterprise (micro-level)	
	M2	Classification of financial states of the enterprise	Hierarchical and iterative cluster analysis methods
	M 2.1	Classification procedure of external environment state of the enterprise (macro-level)	
	M 2.2	Classification procedure of external environment state of the enterprise (meso-level)	
	M 2.3	Classification procedure of internal environment state of the enterprise (micro-level)	
	M3	Identification models of state class of financial environment of the enterprise	Discriminant analysis method, Logit- / Probit- models, classification trees
	M 3.1	Identification models of state class of external financial environment of the enterprise (macro-level)	
	M 3.2	Identification models of state class of external financial environment of the enterprise (meso-level)	
	M 3.3	Identification models of state class of external financial environment of the enterprise (micro-level)	
	M4	Models of forecasting financial environment of the enterprise	Vector autoregression models (VAR), error check models (ECM), panel data model
	M 4.1	Models of forecasting indices of external financial environment of the enterprise (macro-level)	

	M 4.2	Models of forecasting indices of external financial environment of the enterprise (meso -level)	
	M 4.3	Models of forecasting indices of internal financial environment of the enterprise (micro-level)	
	M5	Model of assessing the strategic financial position of the enterprise	Matrix models
Module 2.	M6	Model of choosing type of financial strategy of the enterprise	Expert methods, matrix models
	M7	Imitation model of financial activity of the enterprise	Imitation modeling, system dynamics method
Module 3.	M8	Procedure of building and choosing strategic financial alternatives of the enterprise	Expert methods, imitation modeling, system dynamics method

Source: Developed by the authors.

Content of each module is considered below.

3. Assessment and analysis models of external environment factors of the enterprise

The purpose of the first block (M1) (Figure 1) is forming the informational space of features. The basic system of parameters $\{X_i\}$ which includes 76 indicators of external financial environment of indirect (X_{macro}) and direct influence (X_{mezo}) as well as the internal financial environment of the enterprise (X_{micro}) is formed based on procedures of expert analysis. Since the original number of indicators characterizing FEE is large enough, the use of the whole original scorecard $\{X_i\}$ leads to information overload of decision-making processes. In this regard, the problem arises of finding a set of the most informative parameters (diagnostic space indicators (DSI)) $\{X_i *\} \in \{X_i\}$ so that, on the one hand, the number of indicators was small, and on the other hand, no loss of information significant for making decisions would emerge. To solve this problem, methods of multivariate analysis were applied: choice of group representatives method, taxonomy and factor analysis. The choice of the method of reducing informational space of indicators was made based on the analysis of the DSI quality criteria.

Comparison of informative value criteria of alternative scorecards derived through the selected methods of reducing informational space of indicators (Table 2), has allowed to prioritize the use of principal components of forming the final DSI of the financial environment of the enterprise. The dimension of such DSI stands at 35 indicators, while the informative value ratio ranges from 75 to 95%, which is sufficient to display all the significant correlations. The information base of the study is the statistic data of the State Statistics Committee of Ukraine, the NBU and the PFTS for 2005-2014, financial reporting data of 25 machine-building enterprises in Kharkiv region for 2005-2014. Statistica softwate was used for data mining.

Table 2

Results of DSI informative value comparison (excerpt)

Indicator set / Method of reducing informational space of indicators	Percentage of declared dispersion		
	The "center of gravity" method	Taxonomic indicator	Factor analysis
Indicators of external financial environment of indirect X_{macro}			
Indicators of foreign exchange situation	100.00	100.00	100.00
Indicators of money market condition	60.69	57.88	81.00
Indicators of loan market condition	77.43	73.27	84.00
Indicators of stock market condition	81.54	82.66	84.00

Source: Developed by the authors.

The second block (M2) enables classification of financial states of the enterprise environment based on previously distinguished FEE diagnostic indicators.

To construct classifications, hierarchical and iterative cluster analysis methods are used that allow to identify the internal relationship between units of observed population as well as form science-based classifications on a set of indicators. This involves a dynamic analysis of characteristics and composition of the designated groups. The study was carried out on the set of states of FEE $\Omega = \{\omega_1, \omega_2, \omega_3\}$, where ω_1 is a set of states of the financial environment of indirect influence; ω_2 – a set of FEE states of direct influence; ω_3 – a set of states of internal FEE.

Features of each given class of states of the enterprise financial environment is presented in Table 3.

The task of assigning the FEE state to one of the classes is solved with the model block M3 (Figure 1), which uses discriminant analysis method, multiple choice models, classification trees. Model selection was based on a comparison of classification quality criteria (Table 4). As is seen from Table 3, the highest recognition quality is provided by multiple choice models.

Table 3

Features of state classes of the enterprise financial environment

Feature	State class name (designation)		
	Positive (1)	Neutral (0)	Negative (-1)
1	2	3	4
External FEE of indirect influence (SFE^{out}_{macro})	Low level of inflation, high values of stock market development indicators, stable exchange rate of hryvnia against the US dollar, high volumes of issued bank loans at a low interest rate	Average values of all indicators of the financial market development in Ukraine	High rate of inflation, high values of stock market development indicators, low values of the volume of loans issued by the bank at a high interest rate
Exterlan FEE of direct influence ($SFE^{out}_{meso}(t_i)$)	Low level of overdue receivables and payables in its total amount, high level of investment activity and economic potential of the region	Average values of all indicators of financial development in the region	High level of overdue receivables and payables in its total amount, low level of investment activity and economic potential of the region
Internal FEE (static, dynamic section) ($(SFE^{in}_{sec}(t_i); SFE^{in}_{dyn}(t_i))$	Stable (1)	Satisfactory (0)	Unsatisfactory (-1)
	High level of financial solvency, normal resistance, high rate of financial resources turnover as well as high values of profitability	Average level of financial solvency, minor financial imbalance, average turnover rate of financial resources as well as average values of profitability	Low level of financial solvency, significant financial imbalance, low rate of financial resources turnover as well as low values of profitability

Source: Developed by the authors.

Table 4

Assessment of FEE state classification quality (excerpt)

Recognition method	Percentage og correctly recognized objects			
	Class (1)	Class (0)	Class (-1)	Total
	External financial environment of indirect influence			
Discriminant analysis	100.0	100.0	96.15	97.50
Classification trees	100.0	100.0	96.15	97.50
Logit- / Probit- models	100.0	100.0	100.0	100.0
	Internal financial environment (dynamic section)			
Discriminant analysis	86.3	69.4	90. 8	82.7
Classification trees	76.3	55.8	81.4	78.4
Logit- / Probit- models	88.1	82.3	96.4	93.8

Source: Developed by the authors.

A model set of identifying state class of external FEE of indirect influence can be presented as follows:

$$\begin{cases} p(Y(1)) = \frac{e^{-45,5892+151,9269X_{1,3}+259,5876X_{1,4}-153,554X_{1,7}-1793,05X_{1,8}}}{1+e^{-45,5892+151,9269X_{1,3}+259,5876X_{1,4}-153,554X_{1,7}-1793,05X_{1,8}}} \geq 0,5 \rightarrow SFE_{macro}^{out} = (1); \\ p(Y(1)) = \frac{e^{-45,5892-151,9269X_{1,3}+259,5876X_{1,4}-153,554X_{1,7}-1793,05X_{1,8}}}{1+e^{-45,5892+151,9269X_{1,3}+259,5876X_{1,4}-153,554X_{1,7}-1793,05X_{1,8}}} < 0,5 \rightarrow \\ \rightarrow p(Y(2)) = \frac{e^{201,5201-210,095X_{1,3}-89,7985X_{1,4}-64,0008X_{1,8}}}{1+e^{201,5201-210,095X_{1,3}-89,7985X_{1,4}-64,0008X_{1,8}}} \geq 0,5 \rightarrow SFE_{macro}^{out} = (0); \\ p(Y(2)) = \frac{e^{201,5201-210,095X_{1,3}-89,7985X_{1,4}-64,0008X_{1,8}}}{1+e^{201,5201-210,095X_{1,3}-89,7985X_{1,4}-64,0008X_{1,8}}} < 0,5 \rightarrow SFE_{macro}^{out} = (-1); \end{cases} \quad (1)$$

Similarly, models of identifying external FEE of direct influence and internal FEE state class were received.

Model block of forecasting indicators of financial environment of the enterprise (M4) (Figure 1) is designed for strategic financial analysis and assessment of long-term financial status of the enterprise environment as a result of possible changes in certain factors and conditions. For the indicators presented in the dynamic section, the construction of forecasting models was based on vector autoregression and vector error correction model. The choice of these models is underpinned by the fact that they can simultaneously simulate multiple time series with a system of dynamic equations of ARIMA-processes, include and examine the relationship between the indicators and their lagged values and do not require deviding variables in endogenous and exogenous ones.

The choice of the method of forecasting the indicators of financial environment of the enterprise, as well as the specification of models is carried out through implementation of the next research stage: assessing the presence of causal relationships between the series and determining the number of lags included in each model; checking for cointegration vectors.

The presence of causal relationships between the series of X_i ($i = \overline{1,n}$) to identify groups of FEE related indicators is assessed with the Granger test. The results of the test implementation in EViews 6.0 software environment for one of the groups of analyzed indicators are shown in Table 5.

Table 5

Results of the Granger test (excerpt), developed by the authors

Null hypothesis (H_0)	Estimated F- statistics value	Confidence level p
Indicators of external financial environment indirect influence X_{macro} (lag: 4)		
X1,4 is not the cause of X1,3	1.62965	0.19562
X1,3 is not the cause of X1,4	4.77288	0.00483
X1,7 is not the cause of X1,3	7.25158	0.00042
X1,3 is not the cause of X1,7	1.50717	0.22802
X1,8 is not the cause of X1,3	5.85697	0.00158
X1,3 is not the cause of X1,8	2.40686	0.07411
X1,7 is not the cause of X1,4	2.81123	0.04518
X1,4 is not the cause of X1,7	1.39618	0.26185
X1,8 is not the cause of X1,4	1.48599	0.23413
X1,4 is not the cause of X1,8	5.30520	0.00276
X1,8 is not the cause of X1,7	1.64014	0.19306
X1,7 is not the cause of X1,8	4.39940	0.00723

Legend: $X_{1,8}$ - interest rates on loans granted in the accounting period up to 1 year, $X_{1,3}$ - the consumer price index; $X_{1,4}$ - the price index of industrial products; $X_{1,7}$ - growth rate of loans issued to non-financial corporations in the accounting period up to 1 year

As can be seen from Table 5, all indicators of FEE of indirect foreign influence are interrelated. Therefore, upon further study, they were considered one group of indicators. Similar results were received with the indicators of the internal FEE.

The number of lags included in each model is based on the Akaike information criterion (AIC - test). At the first stage, the maximum possible VAR-model - p * order is selected (10% of the total number of levels in the series). Next, a certain set of VAR-models with different number of lags p = 1,2, ..., p * is estimated with the least squares method. A model of order p_{max} ($0 \leq p_{max} \leq p$ *) with the lowest AIC criterion value is selected from the estimated models. The results of this criterion assessment test are shown in Table. 6.

Table 6

Value of the Akaike information criterion

Lag (p)	Value of the Akaike information criterion		
	X_{macro}	X_{micro} (1) (dynamic section)	X_{micro} (2) (dynamic section)
1	-19.783	2.67	-3.282
2	-20.276	2.58	-3.52
3	-21.54	2.41	-3.76
4	-22.784	2.48	-4.11

Source: Developed by the authors.

To check the time series cointegration the Johansen test is used. The test results implemented in Eviews 6.0 software environment for a group of internal FEE indicators are given in Table 7. These results confirm the existence of three cointegrating vectors – CE (3), i.e. to predict the studied group of indicators it is reasonavle to use ECM-model. In the study of indicators of external financial environment of the enterprise it was concluded that their dynamics can be represented as a vector autoregression process.

Table 7

The results of the Johansen test for cointegration of the vectors (excerpt)

Characteristic roots (λ_i) of matrix π	Verisimilitude value	Critical value (5%)	Critical value (1%)	CE cointegration vectors number hypothesis (s)
The first group of indicators of the internal financial environment of the enterprise X_{micro} (1) (dynamic section)				
0.970661	238.6822	94.15	103.18	No**
0.778917	115.1732	68.52	76.07	At least 1 **
0.657908	62.35055	47.21	54.46	At least 2 **
0.370775	**24.80694**	**29.68**	**35.65**	**At least 3**
0.208342	8.592619	15.41	20.04	At least 4
0.011808	0.415728	3.76	6.65	At least 5

** The divergent hypotheses are marked
Source: Developed by the authors.

After selecting the prediction method, the assessment of model parameters is carried out. A set of FEE indicator models X_{macro} can be presented as follows:

$$\begin{cases} DX_{1,8|t} = a_{1,8} + \sum_{j=1}^{q} b_{1,8} DX_{1,8|t-j} + \sum_{j=1}^{q} b_{1,3} X_{1,3|t-j} + \sum_{j=1}^{q} b_{1,4} X_{1,4|t-j} + + \sum_{j=1}^{q} b_{1,7} X_{1,7|t-j} + \varepsilon_{1,8|t}; \\ X_{1,3|t} = a_{1,3} + \sum_{j=1}^{q} c_{1,8} DX_{1,8|t-j} + \sum_{j=1}^{q} c_{1,3} X_{1,3|t-j} + \sum_{j=1}^{q} c_{1,4} X_{1,4|t-j} + \sum_{j=1}^{q} c_{1,7} X_{1,7|t-j} + \varepsilon_{1,3|t}; \\ X_{1,4|t} = a_{1,4} + \sum_{j=1}^{q} d_{1,8} DX_{1,8|t-j} + \sum_{j=1}^{q} d_{1,3} X_{1,3|t-j} + \sum_{j=1}^{q} d_{1,4} X_{1,4|t-j} + \sum_{j=1}^{q} d_{1,7} X_{1,7|t-j} + \varepsilon_{1,4|t}; \\ X_{1,7|t} = a_{1,7} + \sum_{j=1}^{q} f_{1,8} DX_{1,8|t-j} + \sum_{j=1}^{q} f_{1,3} X_{1,3|t-j} + \sum_{j=1}^{q} f_{1,4} X_{1,4|t-j} + \sum_{j=1}^{q} f_{1,7} X_{1,7|t-j} + \varepsilon_{1,7|t}, \end{cases} \quad (2)$$

where $a_{1,k}$, $b_{1,k}$, $c_{1,k}$, $d_{1,k}$, $f_{1,k}$ are parameters of the model.

The results of modeling lead to the conclusion that such criteria as determination coefficient ($R^2(X_{1,8})$=0,929; $R^2(X_{1,3})$=0,901; $R^2(X_{1,4})$=0,849; $R^2(X_{1,7})$=0,871); Fisher's exact test ($F(X_{1,8})$=13,808; $F(X_{1,3})$=9,653; $F(X_{1,4})$=8,967; $F(X_{1,7})$=9,167); Akaike criterion (AIC=-22,785); Schwarz criterion (SC=-20,299), the absolute percentage error of approximation (m.a.p.e.($X_{1,8}$)=6,15%, m.a.p.e.($X_{1,3}$)=7,42%, m.a.p.e.($X_{1,4}$)=7,89%, m.a.p.e.($X_{1,7}$)=7,53%) confirm the high accuracy of the forecast. Similar results were obtained for indicators of the internal financial environment of the enterprise (dynamic section).

To predict the indicators describing the state of the external FEE of direct influence and the internal FEE (static cut), dynamic models of panel data (the AR) are applied, which allow to simultaneously take into account the dynamic changes and spatial aspects of change in the studied parameters. The use of regression models on panel data has the advantage over models on variation or time series, because it gives an opportunity to analyze the changes at the individual level. An algorithm for constructing dynamic models of panel data to predict financial performance presented in a spatially dynamic section comprises the following steps: specification of the regression model on panel data using the Hausman test (selecting models with fixed or random effects); determination of the lags (p) number of the dynamic model on panel data by Student's test.

To select the model specification for panel data the Hausman test is used, the null hypothesis of which is the assumption concerning the lack of correlation between the individual effects and the explanatory variables of the model, that means that if this hypothesis is confirmed, the model with random effects is favoured. The calculated Hausman statistics for the studied groups of indicators are presented in Table 8.

Table 8

Calculated values of Hausman statistics

Group of indicators	Calculated value χ^2_H	Critical value χ^2_H
Indicators of the external FEE of diract value X_{meso}	6.13	5.26
Indicators of the internal FEE X_{micro} (static section)	67.84	16.92

Source: Developed by the authors.

Table 8 shows that the null hypothesis is rejected for both groups of indicators, therefore, a model with fixed effects is the preferred choice.

To determine the number of lags included in each AR-model, parameters of the regression model are assessed with the maximum possible number of lags at a full set of exogenous

symptoms. The AR-model parameter assessment on panel data is carried out in Eviews 6.0 software environment. Further analysis excludes the signs by which the model parameters are not statistically significant by Student's test (t-criterion). The model set of forecasting indicators of internal FEE (static section) is as follows (3).

Modeling results led to the conclusion that the criteria such as coefficient of determination ($R^2(X_{3,2})$=0,998; $R^2(X_{3,5})$=0,998; $R^2(X_{3,12})$=0,998; $R^2(X_{3,19})$=0,998; $R^2(X_{3,30})$=0,987; $R^2(X_{3,39})$=0,996; $R^2(X_{3,45})$=0,993); Fisher's criterion ($F(X_{3,2})$=71696,9; $F(X_{3,5})$=72528,5; $F(X_{3,12})$=36141,6; $F(X_{3,19})$=174959; F ($X_{3,30}$)=7984,9; $F(X_{3,39})$= 22285; $F(X_{3,45})$=17225,5), absolute percentage error of approximation (m.a.p.e.($X_{3,2}$)=4,38%; m.a.p.e.($X_{3,5}$)=5,19%; m.a.p.e.($X_{3,12}$)=8,34%; m.a.p.e.($X_{3,19}$)=4,66%; m.a.p.e.($X_{3,30}$)=6,13%; m.a.p.e.($X_{3,39}$)=7,47%; m.a.p.e.($X_{3,45}$)=6,53%), indicate a high prediction accuracy. Similarly, models for analysis and forecasting indicators of the external FEE of direct influence were developed.

$$
\begin{cases}
X_{3,2|it} = FE_i(X_{3,2}) + \sum_{j=1}^{4} b_{3,2} X_{3,2|t(t-j)} + \sum_{j=1}^{4} b_{3,5} X_{3,5|t(t-j)} + \varepsilon_{3,2|it}; \\
X_{3,5|it} = FE_i(X_{3,5}) + \sum_{j=1}^{4} c_{3,2} X_{3,2|t(t-j)} + \sum_{j=1}^{3} c_{3,5} X_{3,5|t(t-j)} + \varepsilon_{3,5|it}; \\
X_{3,12|it} = FE_i(X_{3,12}) + \sum_{j=1}^{4} d_{3,5} X_{3,5|t(t-j)} + \sum_{j=1}^{4} d_{3,12} X_{3,12|t(t-j)} + \\
\quad + \sum_{j=1}^{3} d_{3,45} X_{3,45|t(t-j)} + \varepsilon_{3,12|it}; \\
X_{3,19|it} = FE_i(X_{3,19}) + \sum_{j=1}^{4} f_{3,19} X_{3,19|t(t-j)} + \varepsilon_{3,19|it}; \\
X_{3,30|it} = FE_i(X_{3,30}) + \sum_{j=1}^{4} g_{3,30} X_{3,30|t(t-j)} + g_{3,39} X_{3,39|t(t-1)} + \\
\quad + \sum_{j=1}^{4} g_{3,45} X_{3,45|t(t-j)} + \varepsilon_{3,30|it}; \\
X_{3,45|it} = FE_i(X_{3,45}) + h_{3,30} X_{3,30|t(t-2)} + \sum_{j=1}^{3} h_{3,39} X_{3,39|t(t-j)} + \\
\quad + \sum_{j=1}^{4} h_{3,45} X_{3,45|t(t-j)} + \varepsilon_{3,45|it},
\end{cases}
\tag{3}
$$

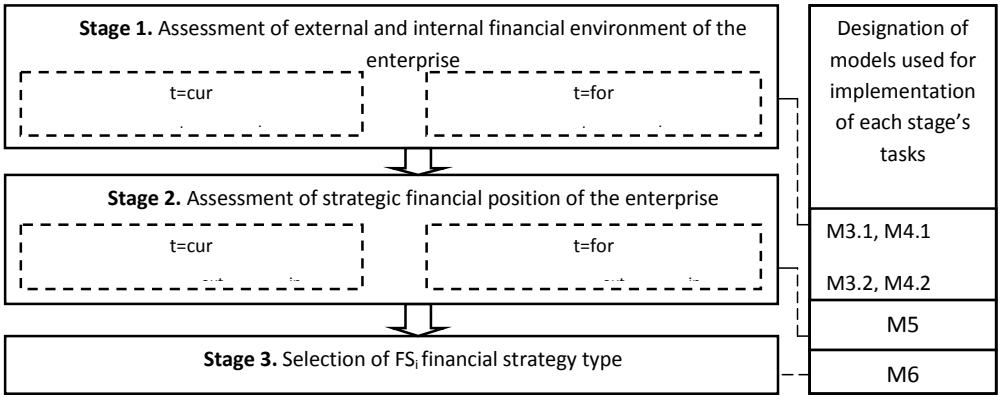
where $X_{3,2}$ is quick ratio; $X_{3,5}$ – liquidity ratio of funds in calculations; $X_{3,12}$ – funding rate; $X_{3,45}$ – return on assets ratio of fixed assets and other non-current assets; $X_{3,19}$ – long-term fund-raising factor; $X_{3,30}$ – factor of profitability of fixed assets; $X_{3,39}$ – capital turnover (transformation) ratio; $FE_i(X_j)$ – fixed effect for the i-enterprise; $b_{3,k}$, $c_{3,k}$, $d_{3,k}$, $f_{3,k}$, $g_{3,k}$, $h_{3,k}$ – model parameters.

The developed models (2-3) enable creating search and normative forecasts of the enterprise financial environment indicators, studying changes in the financial situation in the industry, the financial potential of the direct influence environment and thus improve reasonability and quality of management decisions in the estimation of strategic financial position of the enterprise.

The final in the first module (Figure 1) is a model of assessing the strategic financial position of the enterprise (M5). The construction of this model is based on defining certain areas that share similar integral characteristics of the state of the enterprise financial environment, which allows to form differentiated financial strategies. The position of the model in the procedure of selecting a financial strategy is shown in Figure 2.

Figure 2

The stages of procedures of financial strategy type selection based on the assessment of the strategic financial position of the enterprise



Source: Developed by the authors.

4. Models of building and choosing strategic alternatives of financial activity of the enterprise

The M6 model allows to determine the most appropriate for the current situation type of financial strategy based on the assessment of the current SFP(t_{cur}) and predictive SFP (t_{for}) strategic financial position of the enterprise. The proposed model consists of 16 squares, where with the help of methods of expert analysis the recommended type of financial strategy is defined (FS_1 – strategy of financial support of accelerated growth, FS_2– the financial strategy of sustainable growth, FS_3 – anti-crisis financial strategy).

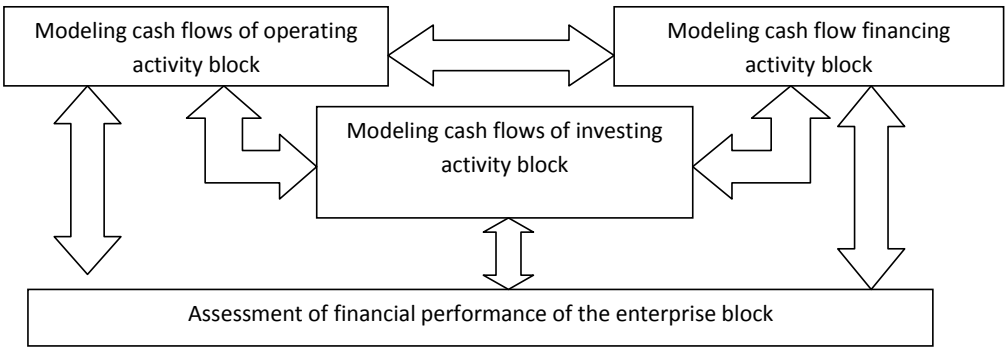
The M7 (Fig. 1) model is a simulation model of the financial activity of the enterprise that allows to estimate the consequences of implementing different strategic alternatives of financial activity of the enterprise, taking into account the negative impact of environmental factors uncontrolled by the enterprise which are specific to the selected classes of FEE states: positive financial environment, neutral financial environment and negative financial environment. The relationship of basic blocks of the simulation model is shown in the diagram in Fig. 3.

The diagram of model causality, developed in Vensim PLE environment, is shown in Figure 4.

Under the strategic financial alternatives (SFA_n^i) refers to a set of strategic activities (Pr_k^i), that allow you to achieve its strategic goal of financial activity (G_i). To compose a set of strategic financial alternatives a portfolio of priority strategic financial activities within the selected of financial strategies was made by using expert analysis methods (Table 9).

Figure 3

Diagram showing the relationship of blocks of the enterprise financial activity simulation model



Source: Developed by the authors.

Table 9

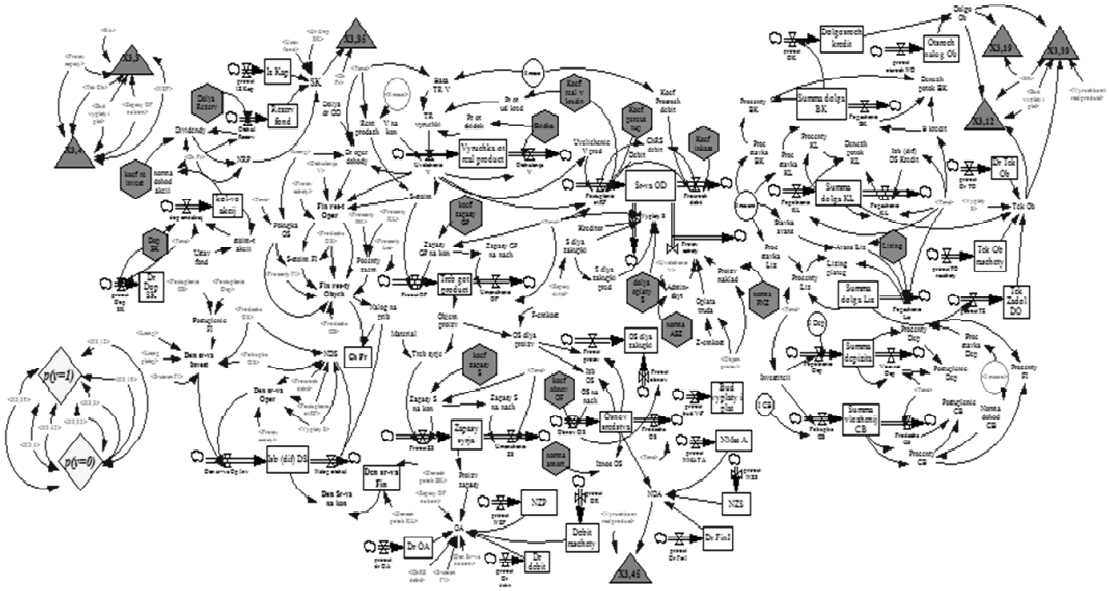
List of controlled variables of the simulation model in accordance with the strategic activities (excerpt)

Code	Name of strategic activity	Controlled variable
Pr_{11}	Reduction of insurance reserves of inventory	Index of tendency towards forming stocks of finished products (Pr_{11_1}); Index of tendency towards forming stores (Pr_{11_2})
Pr_{20}	Change of terms of commodity (commercial) credit with supplies distributer	Share of payment for raw stores and supplies of the current period
Pr_{19}	Sale of unused types of fixed and intangible assets	Index of fixed assets mortality
Pr_3	Accelerate collection of overdue debts receivable and product buyers' payment documents	Index of overdue debts receivable collection
Pr_5	Increase in insurance reserves	Share of contributions to the reserve fund
Pr_4	Reducing the amount of fixed costs	Standard of administrative and distribution costs per 1 unit of sales volume

Source: Developed by the authors.

Figure 4

The causality diagram of simulation model of the enterprise financial activity



Source: Developed by the authors.

The procedure of building and choosing strategic financial alternatives (M8) can be formularized as follows:

$$G_i\left(SFA_n^i\right) = G_i\left(\wedge_{k-1}^{n} Pr_k^i\right), i = \overline{1,N},\ k = \overline{1,T}, \tag{4}$$

$$p\left(G_i\left(SFA_n^i\right)\right) \geq \alpha \tag{5}$$

$$R\left(Pr_k^i\right) > R\left(Pr_{k+1}^i\right) \tag{6}$$

$$n \rightarrow \min \tag{7}$$

where SFA_n^i is the n-th strategic financial alternative for the i-type of financial strategy; Pr_k^i is the k-priority strategic financial activity that refers to the i-type of financial strategy; N is the total number of types of financial strategies; T – the total number of strategic financial activities; $p\left(G_i\left(SFA_n^i\right)\right)$ is the probability of achieving the goal of i-type financial strategy by the implementation of the n-th strategic financial alternative, α is the threshold value of achieving the financial strategy goal; R is the priority of the strategic financial activity implementation.

The proposed model set was implemented in the activities of a number of machine-building enterprises in the Kharkiv region. Applying analysis models of financial environment factors, strategic assessment of the financial position for one of the studied companies – OOO "PP Kharkov Electrical Equipment Plant" – allowed to selected the FS_3 anti-crisis financial strategy as the recommended one which targets financial stability. Under basic values of controlled variables and predicted adverse conditions of the external FEE at the end of the forecast period, the studied strategic financial position of the enterprise is impaired – a sharp decline appears in the probability of the enterprise being ranged to a class with satisfactory financial state to 0.312.

Through the use of the simulation model, the effects of implementation of strategic measures in order of priority allocated to the anti-crisis financial strategy were estimated (Table 10).

Table 10

Results of the experiments conducted on the basis of a simulation model of financial activities

Terms and conditions of the experiment	Probability of ranging the enterprise to the class with an unsatisfactory financial state			
	forecast period			
	1	2	3	4
under basic values of controlled variables	0.95154	0.89999	0.67338	0.31290
under implementation of $SFA_1 = (Pr_{11\_1})$	0.98967	0.89999	0.68845	0.33059
under implementation of $SFA_2 = (Pr_{11\_1} \wedge Pr_{11\_2})$	0.98967	0.89999	0.68845	0.35991
under implementation of $SFA_3 = (Pr_{11\_1} \wedge Pr_{11\_2} \wedge Pr_{20})$	0.98967	0.89999	0.68845	0.39475
under implementation of $SFA_4 = (Pr_{11\_1} \wedge Pr_{11\_2} \wedge Pr_{20} \wedge Pr_{19})$	0.98967	0.90444	0.71227	0.40343
under implementation of $SFA_5 = (Pr_{11\_1} \wedge Pr_{11\_2} \wedge Pr_{20} \wedge Pr_{19} \wedge Pr_3)$	0.98988	0.91233	0.73334	0.48698
under implementation of $SFA_6 = (Pr_{11\_1} \wedge Pr_{11\_2} \wedge Pr_{20} \wedge Pr_{19} \wedge Pr_3 \wedge Pr_5)$	0.98999	0.94554	0.75569	0.50365
under implementation of $SFA_7 = (Pr_{11\_1} \wedge Pr_{11\_2} \wedge Pr_{20} \wedge Pr_{19} \wedge Pr_3 \wedge Pr_5 \wedge Pr_4)$	0.98999	0.94554	0.78456	0.61456

Source: Developed by the authors.

As can be seen from Table 10, the strategic financial alternative $SFA = (Pr_{11\_1} \wedge Pr_{11\_2} \wedge Pr_{20} \wedge Pr_{19} \wedge Pr_3 \wedge Pr_5 \wedge Pr_4)$ is an effective and sufficient to achieve the strategic goal of the financial activity of OOO "PP Kharkov Electrical Equipment Plant", the implementation of which will maintain the current strategic financial position in the forecast period and prevent the transition of the enterprise to the class with critical threat level.

5. Summary and Concluding Remarks

The use of the proposed set of economic and mathematical models of building a financial strategy enables a comprehensive analysis of factors of external and internal financial environment of the enterprise, detecting possible adverse effects of strategic financial position of the enterprise, selecting the financial strategy of the enterprise most adequate to the current situation, forming a system of strategic standards of financial activity of the enterprise coherent in different directions, taking into account the negative effects of uncontrolled environmental factors.

It is worth saying that developing of the suggested model set involves multivariate calculations and is impossible without proper software. Statistica, EViews and Vensim software was used in development of the abovementioned model set. Based on the model set, Ukrainian-German company **KODA Ltd** developed program complex "Zevs" which enables forecasting financial indices of enterprise's activity under given control parameters (coefficient of credit sales, reinvestment coefficient, share of provisions for reserve fund etc.) and the most probable hazard levels (overdue accounts receivable tempo, exchange rate change tempo etc.); optimizing parameters of financial activity of the enterprise. Estimating opportunities for integration of the suggested model set into platforms used by the enterprise presents a good outlook, as well as developing a unite platform aimed at maintaining processes of enterprise financial activity script modeling under given parameters (hazard levels).

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