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MATHEMATICAL MODELING OF THE DEVELOPMENT OF THE POTENTIAL OF INTEGRATED BUSINESS STRUCTURES

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The article presents the results of research in the field of modeling the development of the potential of integrated integrated business structures. It is substantiated that in the conditions of transformation of the economic system of Ukraine, economic systems, being by their nature complex, dynamic and probabilistic, are characterized by uncertainty of structure, condition and development. Market transformations of the economy of Ukraine, which are characterized by changes in property relations, the creation of capital of business structures, generate an increase in the probability of merging business entities to form integrated business structures. All this raises new priorities for finding new management methods and principles, modeling to develop the potential of integrated integrated business structures.

The hypothesis of the scientific research is to study the mathematical modeling of the process of developing the potential of joint business entities for the formation of integrated business structures in the transformation of the economic system of Ukraine.

The aim of the research is to substantiate at the theoretical level the use of mathematical modeling for the formation of integrated business structures and their combined potentials.

The methodology of scientific research is the following used research methods: within the existing integrated business structures, general scientific methods, such as the method of scientific abstraction, method of analysis and synthesis, the method of unity of historical and logical, positive and normative methods, as well as specific research methods mathematical modeling, which served as the basis for the study.

Conclusions. The process of potential development of integrated business structures is substantiated and mathematically modeled. It is determined that both in the world economy as a whole and in the economies of the leading countries of the world the main role is played not by individual business entities but by integrated integrated business structures. Currently, the so-called "era of integrated business structures" prevails, which combines the potential of different forms, and due to their integrative combination, a competitive economic system is formed.

Keywords: integrated business structures; integration potential; mathematical modeling; economic systems; transformational changes; management methods.

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11	1	0

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МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ РОЗВИТКУ ПОТЕНЦІАЛУ ІНТЕГРОВАНИХ БІЗНЕС-СТРУКТУР

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У статті викладено результати досліджень у сфері моделювання розвитком потенціалу об'єднаних інтегрованих структур бізнесу. Обгрунтовано, що в умовах трансформації економічної системи України, економічні системи, будучи за своєю природою складними, динамічними і імовірнісними, характеризуються невизначеністю структури, стану і розвитку. Ринкові трансформації економіки України, які характеризуються змінами у відносинах власності, створенням капіталу підприємницьких структур, генерують зростання імовірності об'єднання суб'єктів господарювання для утворення інтегрованих структур бізнесу. Все це ставить нові пріоритетні завдання відносно пошуку нових методів і принципів управління, моделювання для розвитку потенціалу об'єднаних інтегрованих структур бізнесу

Гіпотеза наукового дослідження полягає у дослідженні математичного моделювання процесу розвитку потенціалу об'єднаних суб'єктів господарювання для формування інтегрованих структур бізнесу в умовах трансформації економічної системи України.

Метою дослідження є обгрунтування на теоретичному рівні використання математичного моделювання для формування інтегрованих структур бізнесу і їх об'єднаних потенціалів.

Методологією наукового дослідження є наступні використані методи дослідження: в межах сформованих інтегрованих структур бізнесу, загальнонаукові методи, такі як метод наукової абстракції, метод аналізу і синтезу, метод єдності історичної і логічної, позитивний і нормативний методи, а так само специфічні методи дослідження, зокрема метод математичного моделювання, який слугував базою для проведеного дослідження.

Висновки. Обгрунтовано та математично змодельовано процес розвитку потенціалів інтегрованих структур бізнесу. Визначено, що як у світовій економіці у цілому, так і економіках провідних країн світу головну роль грають не окремі суб'єкти господарювання а об'єднанні інтегровані структури бізнесу. Наразі панує так звана «ера інтегрованих структур бізнесу», яка поєднує потенціали різних форм, і за рахунок інтегративного їх поєднання, формується конкурентна економічна система.

Ключові слова: інтегровані структури бізнесу; інтеграційний потенціал; математичне моделювання; економічні системи; трансформаційні зміни; методи управління.

Statement of the problem. A large number of studies are devoted to the qualitative assessment of the performance of economic systems of varying complexity. The authors use different approaches that allow both a narrow assessment – on the basis of productivity (Kosachev, 2004), and generalized – on the basis of identifying the competitive status of the manufacturer (Yermoshenko and Hanushchak-Iefimenko, 2010). The object of study is the economic relations of relatively simple components of a single economic system. The main prerequisite for building regression models is the absence of structural changes in the modeled system. It is obvious that to build forecasts of the dynamics of the potential of integrated integrated business structures in the transformation processes in the economy of Ukraine should use models that take into account the possibility of changing both the parameters of the economic system over time and its structure (Yermoshenko and Hanushchak-Iefimenko, 2010).

Analysis of recent publications on the problem For this type of research, it seems possible to use different numbers of indicators. Therefore, in scientific sources (Yermoshenko and Hanushchak-Iefimenko, 2010; Tsyhylyk et al., 2004; Kosachev, 2004; Kofman, 1982) there are recommendations regarding the number of indicators in each group of a balanced scorecard (Kofman, 1982).

The purpose of the study is study of the process of modeling the development of the potential of integrated integrated business structures in the conditions of transformation processes in the economy of Ukraine.

The main results and their justification. After analyzing different models (Kosachev, 2004) for universality, taking into account the economic situation in the country to develop the potential of integrated integrated business structures in our opinion, the most justified use of multifactor linear models, as the simplest in calculations and at the same time the most adaptive, describing economic situation.

Therefore, the author proposes the use of the following method of building an economic-mathematical model and forecasting financial and economic indicators of the development of the potential of integrated integrated business structures, which is as follows:

1. For samples find the sample means, sample variances and sample standard deviations, where y is the studied indicator, and x_1 and x_2 – the factors affect it.

2. Find the sample correlation coefficients r_{y1}, r_{y2}, r_{12}.

Given that r, write the correlation matrix:

$$R = \begin{pmatrix} 1 & r_{y1} & r_{y2} \\ r_{1y} & 1 & r_{12} \\ r_{2y} & r_{21} & 1 \end{pmatrix}. \quad (1)$$

3. Using the Student's *t* test, check the significance of the coefficients *t*, comparing the observed value with the critical $T_{кр.}$

4. To determine the closeness of the connection r and one of the parameters y and x excluding the influence of the other find the coefficients of the private correlation. The significance of the coefficients is checked according to the Student's criterion. Draw conclusions about the significance of the coefficients.

5. Using the found correlation coefficients, we obtain the linear regression. The required equations have the form:

$$y = b_{01} + b_{11}x_1, \quad y = b_{02} + b_{12}x_2 . \tag{2}$$

As a measure of how well the model (regression equation) describes this system of observations, find the coefficients of determination, check their significance.

6. Find the multiple regression equations. To do this, first compile and solve a system of equations:

$$\begin{cases} \beta_1 + r_{12}\beta_2 = r_{1y} \\ r_{12}\beta_1 + \beta_2 = r_{2y} \end{cases}. \tag{3}$$

Then find the coefficients b by the formulas:

$$b_1 = \beta_1 \frac{\sigma_y}{\sigma_1}, \quad b_2 = \beta_2 \frac{\sigma_y}{\sigma_2}, \quad b_0 = \overline{y} - b_1\overline{x_1} - b_2\overline{x_2} . \tag{4}$$

and write the regression equation

$$y = b_0 + b_1x_1 + b_2x_2 . \tag{5}$$

7. For each find the theoretical values.

Determine the coefficient of multiple determination. Using Fisher's test, the observed value of F is calculated and compared with the critical value. If the hypothesis of simultaneous equality of zero coefficients should be ignored. This means that at least one of the coefficients is significantly different from zero. In other words, the regression equation is significant and can be used for analysis in this economic system (Kosachev, 2004).

The value of using this technique as a tool for developing the potential of integrated integrated business structures is the analysis of any economic indicator with different factors, taking into account the influence of factors on each other, in a randomly selected period of time. Therefore, it is not necessary to rely only on the financial statements associated with a particular frequency, and use to consider the impact of production factors on economic or financial.

But such an analysis of economic systems of the relationship of financial and economic factors with production activities involves the following

forecasting as an effective tool for strategic management, as well as making informed current decisions.

Examining the literature on the use of forecasting methods (Yermoshenko and Hanushchak-Iefimenko, 2010; Tsyhylyk et al., 2004; Kosachev, 2004; Kofman, 1982), it was found that the most accurate forecast was obtained using Box-Jenkins models. For example, Kendell (Kofman, 1982) provides a comparative table for predicting time series using different models. In most cases, the predictions obtained using the Box-Jenkins models, ie the predictions made using one of the autoregressive models, which integrated the moving average, turned out better.

In practice, models with a finite number of non-zero coefficients are usually used, ie different variants of the ARKS model (p, q). This is due to the following reasons:

- the desire to build the simplest possible model;
- finite number of observations.

The development of the scientific apparatus of forecasting provides increasingly stringent requirements for the peculiarities of the use of a particular mathematical apparatus. However, the importance of accounting for expert assessments is a very important component that determines the description of the problem using a systematic approach, accounting for qualitative characteristics, the use of forecasts and their practical significance. According to modern methodology, the following methods of economic forecasting are considered and widely used: naive model, naive model taking into account the trend, naive model of the rate of change of the time series, naive model taking into account the seasonal component, simple averages, moving averages, double moving averages, exponential (Holt's method), exponential smoothing taking into account trend and seasonal variations (Winters' method), simple regression (linear, inverse, indicative, static), multidimensional regression analysis, Boxer-Jenkins autoregressive models (Kosachev, 2004; Kofman, 1982).

The Box-Jenkins model has a general appearance:

$$y_t = \varphi_0 + \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + ... + \varphi_p Y_{t-p} + \varepsilon_t - \omega_1 \varepsilon_{t-1} - \omega_2 \varepsilon_{t-2} - ... - \omega_q \varepsilon_{t-q}, \quad (6)$$

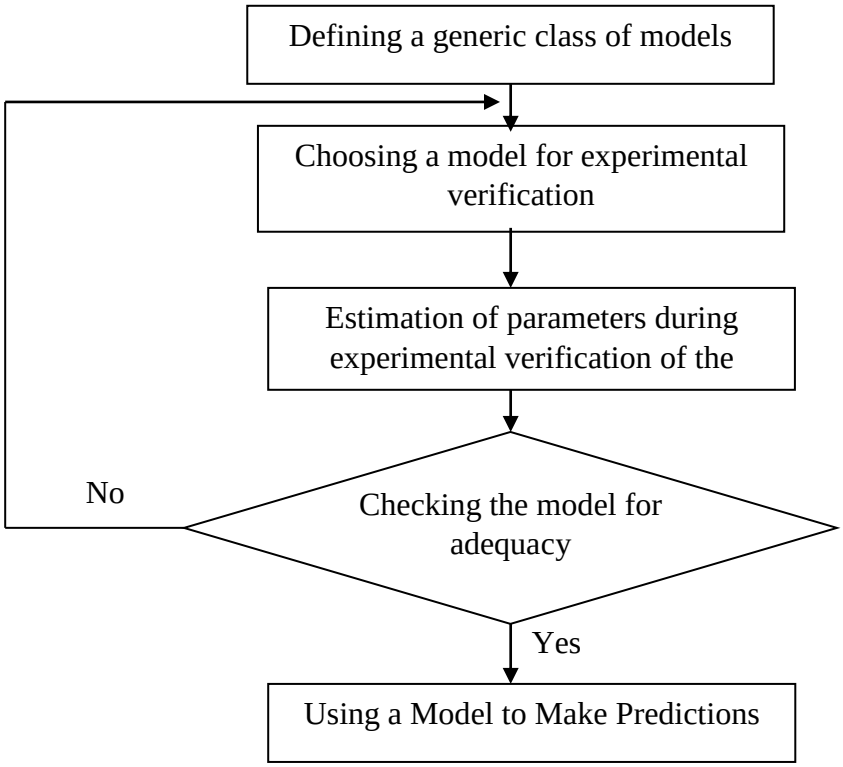
where Y_t – dependent variable at a time t;

Y_{t-1}, Y_{t-2}, …, Y_{t-p} – dependent variable at values of time intervals *t–1, t–2, ..., t–p* in accordance;

φ_0, φ_1, φ_2, ., φ_p і ε_t, ε_{t-1}, ε_{t-2}, …, ε_{t-q} – estimated coefficients.

The effectiveness of different forecasting methods depends on the remoteness of the forecast in time and type (annual, quarterly, monthly) of the analyzed data. Some methods provide greater accuracy for a short period of time, while others are more suitable for long-term predictions. Some methods

work well with annual data, while others are more effective for quarterly and monthly data. For further selection of the best technique, it is advisable to conduct a comparative analysis. For these techniques, special attention was paid to errors, which is an integral part of forecasting. In (Kosachev, 2004) such a comparative analysis was performed and found that the most adequate is the autoregressive method of Box-Jenkins, in which the errors of the method for the study period are up to 10%, which is several times less than when using other methods. Thus, the method makes it possible to predict financial and economic factors in the future. The Box-Jenkins prediction methodology differs from most methods in that it does not provide for any special structure in the data of the time series for which the prediction is made. It uses an interactive approach to determining a valid model among a general class of models (Kosachev, 2004; Kofman, 1982). The selected model is then compared with historical data to verify that it accurately describes the series. The model is considered acceptable if the residues are mostly small, distributed randomly and in general, do not contain useful information. If the given model is not satisfactory, the process is repeated, but with the use of a new, improved model. This integrated procedure is repeated until a satisfactory model is found. From this point on, the model can be used for forecasting purposes (Figure 1).



Source: (Kosachev, 2004; Kofman, 1982).

Fig. 1. **Block diagram of the model selection strategy by method Boxing-Jenkins**

The Boxing-Jenkins methodology is a very powerful tool for accurate short-term forecasting. It should be borne in mind that the creation of a satisfactory model according to the method of Box-Jenkins requires a fairly large amount of historical data and significant time spent by the analyst. This methodology is based on a number of procedures for identifying, adjusting and verifying models to analyze these time series. The forecast follows directly from the selected model. The principle of economy states that if there is a choice, a simple model is always more acceptable than a more complex one. The Box-Jenkins approach to time series analysis is a very powerful tool for constructing accurate, short-range predictions. The models are quite flexible and can describe a wide range of characteristics of time series that occur in practice. The formal procedure for checking the model for adequacy is simple and accessible. In addition, predictions and intervals of prophecy follow directly from the selected model (Kosachev, 2004; Kofman, 1982).

Conclusions. Modern requirements for speed, reliability, accuracy of management of financial and economic systems and information load on the analyst are so high that the set of tasks can be solved optimally only by automating management processes. Therefore, it is important to create such a software product that ensures compliance with all the above requirements with the possibility of in-depth mathematical analysis and as a consequence of an accurate economic forecast to enhance the development of the potential of integrated integrated business structures.

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