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MODELLING AND FORECASTING OF INNOVATIVE DEVELOPMENT OF ENTREPRENEURIAL STRUCTURES UNDER THE GLOBAL COMPETITION

The article studies the possibilities and prospects for improvement of modelling and forecasting of innovative development of entrepreneurial structures under the global competition. The authors offer to use the fuzzy logic method to increase the effectiveness of this process, thus describing the essence of this method, its application by specific examples and substantiate its advantages as compared to other methods. Recommendations on its use in the process of modelling and forecasting of innovative development of entrepreneurial structures under the global competition are provided.

Keywords: innovative development; entrepreneurial structures; global competition.

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МОДЕЛЮВАННЯ І ПРОГНОЗУВАННЯ ІННОВАЦІЙНОГО РОЗВИТКУ ПІДПРИЄМНИЦЬКИХ СТРУКТУР В УМОВАХ ГЛОБАЛЬНОЇ КОНКУРЕНЦІЇ

У статті досліджено можливості та перспективи вдосконалення процесу моделювання і прогнозування інноваційного розвитку підприємницьких структур в умовах глобальної конкуренції. Запропоновано використовувати метод нечіткої логіки для підвищення ефективності зазначеного процесу, описано сутність даного методу, його використання на конкретних прикладах, доведено його переваги в порівнянні з іншими методами, а також надано рекомендації щодо його використання в моделюванні та прогнозуванні інноваційного розвитку підприємницьких структур в умовах глобальної конкуренції.

Ключові слова: інноваційний розвиток; підприємницькі структури; глобальна конкуренція. Форм. 4. Рис. 3. Табл. 1. Літ. 19.

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МОДЕЛИРОВАНИЕ И ПРОГНОЗИРОВАНИЕ ИННОВАЦИОННОГО РАЗВИТИЯ ПРЕДПРИНИМАТЕЛЬСКИХ СТРУКТУР В УСЛОВИЯХ ГЛОБАЛЬНОЙ КОНКУРЕНЦИИ

В статье исследованы возможности и перспективы совершенствования процесса моделирования и прогнозирования инновационного развития предпринимательских структур в условиях глобальной конкуренции. Предложено использовать метод нечеткой логики для повышения эффективности данного процесса, описана сущность данного метода, рассмотрено его применение на конкретных примерах, обоснованы его преимущества по сравнению с другими методами и составлены рекомендации по его применению в процессе моделирования и прогнозирования инновационного развития предпринимательских структур в условиях глобальной конкуренции.

Ключевые слова: инновационное развитие; предпринимательские структуры; глобальная конкуренция.

Introduction. Under the influence of globalization, national economic boundaries are erased, and global economic space is formed. Participation in international unions imposes certain limitations on further possibilities of state regulation of national economy, including the support for domestic production and protection of internal economic interests.

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Entrepreneurial structures should independently protect their interests with the use of accessible market tools. Flexibility and adaptability for changing market conditions, as well as capability for maximal satisfaction of needs of their clients are the most important conditions for sustainable development of entrepreneurial structures in the long term. Therefore, entrepreneurial structures should pay more attention to the issues related to corporate and strategic management.

Under the conditions of global competition, market environment is most dynamic, and entrepreneurial structures are subjects to ever increased risks. Without timely monitoring and analysis of situation at a market and corresponding corrections in the development strategy entrepreneurial structures cannot successfully adapt to new conditions and thus will lose their competitiveness.

The most effective means of preservation and increase of competitiveness for entrepreneurial structures under global competition is implementation of innovations. It should be noted that innovative activity is related to high risks. Thus, there emerges a necessity for reduction of uncertainty and risks in entrepreneurial activities under the global competition. That is why modelling and forecasting of innovative development of entrepreneurial structures become especially actual.

Latest research and publication analysis. Modelling and forecasting of entrepreneurial structures development assumes the determination of the most important factors which influence their functioning at present and in perspective (Solodilova et al., 2015) and the determination of possible directions for change in the character and direction of their influence in the future (Wach and Thorpe, 2015).

More detailed description of these factors is available in (Peris-Ortiz and Sahut, 2015) and the more precisely their role in the development of entrepreneurial structures is evaluated, the higher is the probability of practical realization of the forecasts (Khorev et al., 2015).

Innovative development of entrepreneurial structures means the implementation of new technologies in manufacturing of enterprise's products (Betz et al., 2014), the use of new technologies and methodologies of enterprise management (Souto, 2015), application of new approaches to marketing activities of an enterprise (Shic et al., 2015) etc.

There exists a wide observed regularity: the higher is the innovative activity of entrepreneurial structures, the higher is their competitiveness under the conditions of global competition (Li, 2011; Cantamessa and Montagna, 2015). Implementation of innovations in entrepreneurial activities stipulates the development not only at corporate but also regional, national, and global levels (Bezrukova et al., 2013; (Parahina et al., 2014).

Functioning of entrepreneurial structures within the global competition environment means their constant development (Zaharia et al., 2015), attention to the smallest changes in the market environment (Fudge, 2015), and the capability to adjust to new conditions of economic conduct (Fortin and Jolly, 2015).

Global competition opens the possibilities for entrepreneurial structures' entering global markets (Holste, 2015), and aggravates the competition at local and national markets (Smith and Rupp, 2015).

Analysis of publications on the research topic shows that there are a lot of works by contemporary authors concerning the peculiarities of modelling and forecasting of

entrepreneurial structures development, their innovative development, and functioning of entrepreneurial structures under the global competition.

Nevertheless, despite the high level of problematics elaboration, all these issues are viewed separately, and this does not allow forming an integral picture regarding modelling and forecasting of innovative development of entrepreneurial structures under global competition and this stipulates thus the necessity for further research in this sphere.

Research object. The object of this research is innovative development of entrepreneurial structures. The research topic is organizational, economic and managerial relations and ties which emerge in the process of innovative development of entrepreneurial structures under the conditions of global competition. The goal of this article is the development of recommendations on the improvement of the process of modelling and forecasting of innovative development of entrepreneurial structures under global competition. The paper is built on the deduction principle and is the verification of the hypothesis that the use of fuzzy logic method allows increasing the effectiveness of modelling and forecasting of innovative development of entrepreneurial structures under global competition.

Research methods. This study offers modelling and forecasting of innovative development of entrepreneurial structures under the conditions of the global competition with the help of fuzzy logic. Foundations for the use of fuzzy logic method in economics are set in the works of various authors (Radek, 2015; Roghanian et al., 2015).

Fuzzy logic methods allow conducting logical operations with economic systems under uncertainty and risk. The key parameter in the fuzzy logic method is μ , reflecting the level of belonging of x to multitude Y . Parameter μ can take values from 0 to 1, i.e. $[0, 1]$. The function of multitude Y could be graphically presented with the help of the fuzzy logic method in the following way (Figure 1).

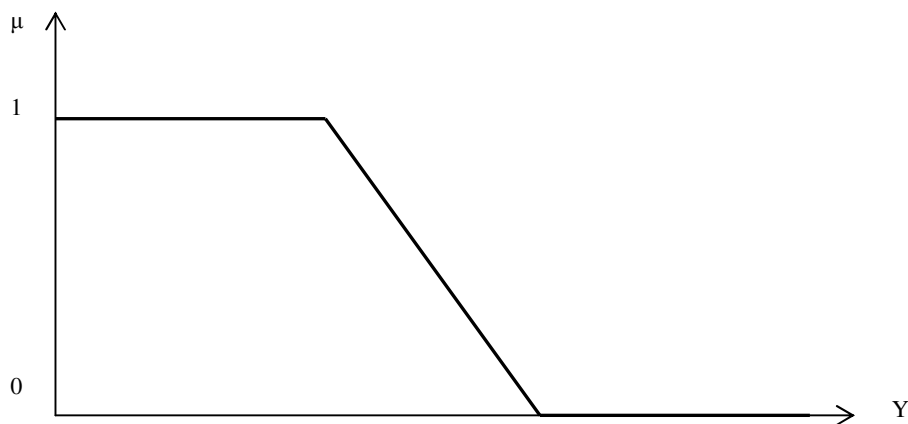


Figure 1. Graphical expression of the function of multitude Y with the help of fuzzy logic method, authors'

This study offers to use the fuzzy logic method for the analysis of experience entrepreneurial structures' realizing innovational projects under the conditions of

global competition. For that, it is necessary to state the initial parameters of an innovative project:

- the term of project realization, n , years;
- the volume of initial investments, C , RUB;
- the limits of fluctuation (min, max) of discount rate, D , %;
- the limits of fluctuation (min, max) of the planned net money flow, DP , RUB;
- the criterion of project effectiveness, Eff , RUB.

Then, it is necessary to calculate the limits of fluctuation (min, max) of net profit value (NPV) according to the following formulas:

$$NPV_{\min} = -C + \sum_{t=1}^n (DP_{\min} / (1 + D_{\max})), \quad (1)$$

where t is a year.

$$NPV_{\max} = -C + \sum_{t=1}^n (DP_{\max} / (1 + D_{\min})). \quad (2)$$

Then, the value of risk of an innovative project (Risk) of entrepreneurial structure is found by the following formula:

$$Risk = \begin{cases} 0 & \text{with } Eff < NPV_{\min}; \\ \beta \times (1 + (1 - \alpha) / \alpha \times \ln(1 - \alpha)) & \text{with } NPV_{\min} \leq Eff < NPV_{\text{mid}}; \\ 1 - (1 - \beta) \times (1 + (1 - \alpha) / \alpha \times \ln(1 - \alpha)) & \text{with } NPV_{\text{mid}} \leq Eff < NPV_{\max}; \\ 1 & \text{with } NPV_{\max} \leq Eff. \end{cases} \quad (3)$$

where NPV_{mid} – the average mean of NPV_{\max} and NPV_{\min} ; α – the point of intersection of function Y with axis μ on the graph; β – the estimated coefficient, calculated by the following formula:

$$\beta = \begin{cases} (Eff - NPV_{\min}) / (NPV_{\max} - NPV_{\min}) & \text{with } Eff < NPV_{\max}; \\ 1 & \text{with } NPV_{\max} \leq Eff. \end{cases} \quad (4)$$

At the final stage, the received value of risk of an innovative project is evaluated with the help of the scale developed at the enterprise.

Key research findings. Let us view the examples of the use of fuzzy logic method for modelling and forecasting of innovative development of entrepreneurial structures under the global competition. For example, an enterprise is to present innovative products at the market.

The project will be effective with the sales volume starting from 100 items, i.e., $Y = [100; \infty]$. Graphically, the function of effectiveness of this innovative project could be presented with the help of fuzzy logic method in the following way (Figure 2).

As seen in Figure 2, with the sales volume of 85 items of a new product, innovative project will be effective in half. Let us view another example. The enterprise realizes an innovative project with the following parameters:

- term of project realization – 5 years;
- volume of initial investments – 20 mln RUB;
- $D_{\min} = 6\%$, $D_{\max} = 8\%$;
- $DP_{\min} = 3$ mln RUB, $DP_{\max} = 12$ mln RUB;
- $Eff = 0$ RUB.

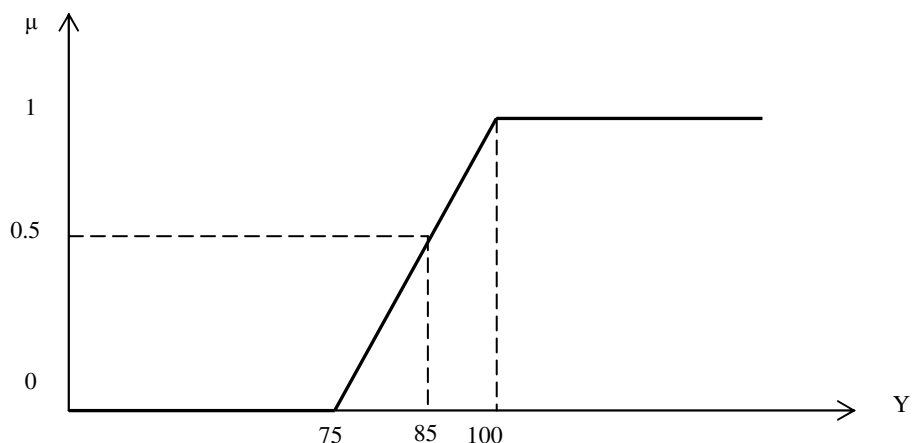


Figure 2. Graphical expression of the effectiveness function of an innovative project of entrepreneurial structure with the help of fuzzy logic method, authors'

Calculation of the limit of fluctuations of new profit volume takes the following form:

$$NPV_{\min} = -C + \sum_{t=1}^n (DP_{\min} / (1 + D_{\max})) = -20 + (3 / (1 + 0.08)^1) + (3 / (1 + 0.08)^2) + (3 / (1 + 0.08)^3) + (3 / (1 + 0.08)^4) + (3 / (1 + 0.08)^5) = -3.7 \text{ mln RUB.}$$

$$NPV_{\max} = -C + \sum_{t=1}^n (DP_{\max} / (1 + D_{\min})) = -20 + (12 / (1 + 0.06)^1) + (12 / (1 + 0.06)^2) + (12 / (1 + 0.06)^3) + (12 / (1 + 0.06)^4) + (12 / (1 + 0.06)^5) = 43.8 \text{ mln RUB.}$$

$$NPV_{\text{mid}} = (NPV_{\min} + NPV_{\max}) / 2 = (-3.7 + 43.8) / 2 = 20 \text{ mln RUB.}$$

Graphically, the function of net profit volume of this innovative project could be expressed with the help of fuzzy logic method in the following way (Figure 3).

As seen in Figure 3, the value of α is 0.1. As $Eff < NPV_{\max}$, calculation of the value of coefficient β takes the following form: $\beta = (0 + 3.7) / (43.8 + 3.7) = 0.08$.

As $NPV_{\min} < Eff < NPV_{\text{mid}}$ ($-3.7 < 0 < 20$), calculation of the value of risk from the innovative project (Risk) takes the following form: $Risk = 0.08 \times ((1 + (1 - 0.1) / 0.1) \times \ln(1 - 0.1)) = 0.16$. Risk of this innovative project could be evaluated by the following scale (Table 1).

The obtained value of risk level for the innovative project of entrepreneurial structure belongs to the last but one interval in Table 1. This shows that the risk here is very high, and entrepreneurial structure should reconsider this project in terms of risk reduction.

The considered examples of fuzzy logic method application modelling and forecasting of innovative development of entrepreneurial structures under global competition showed that this method allows not only evaluating the risk level of innovative projects of entrepreneurial structures but also determines the expediency of these projects implementation depending on the perception of risk and readiness for its acceptance.

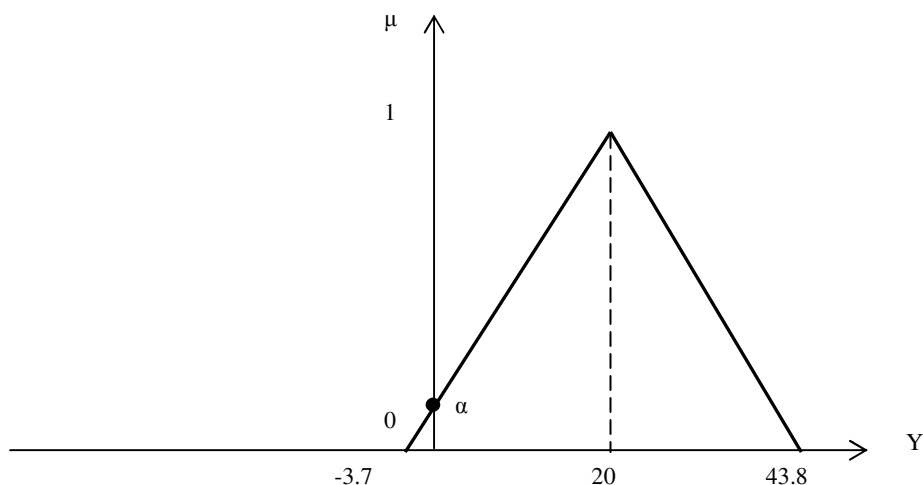


Figure 3. Graphical expression of the function of net profit volume of an innovative project of entrepreneurial structure with the help of fuzzy logic method, authors'

Table 1. Scale for evaluation of the risk level of an innovative project of entrepreneurial structure, authors'

Risk level (value of risk)	Risk level of innovative project	Decision on this innovative project
0–0.05	minimal	realization of the project
0.05–0.10	small	realization of the project under thorough control
0.10–0.15	acceptable	improvement of the project
0.15–0.20	high	reconsideration of the project
> 0.20	inadmissible	cancellation of the project

Besides, it is possible to distinguish the following advantages from the use of fuzzy logic in modelling and forecasting of innovative development of entrepreneurial structures under global competition:

- possibility for analysis under uncertainty and risk;
- getting information regarding various development scenarios of events at a market;
- general picture of situation at a market;
- interval presentation of data, which increases the precision of analysis results.

This work offers the following recommendations on the improvement of modelling and forecasting of innovative development of entrepreneurial structures under global competition with the help of fuzzy logic method:

- Expansion in the use of automation means in the process of modelling and forecasting of innovative development of entrepreneurial structures under global competition. Even generally accessible software (for example, Microsoft Excel) allows automatizing the process of analysis of innovative projects with the help of fuzzy logic. This will allow reducing the time required for evaluation and comparison of various innovative projects, as well as reducing the number of the staff engaged.

- Modelling and forecasting of innovative development of entrepreneurial structures under the global competition not only before the actual start of a project but also at various stages of realization. During the process of project realization, there may appear new information on the influence of various factors on an innovative project and on the future market situation, so the initial data for calculation could change, thus the causing necessity for repeated analysis of the project.

- Taking into account the external global factors of innovative development of entrepreneurial structures under the conditions of global competition. The role of external factors in enterprise development grows under the influence of globalization, so they should be paid more attention. Due to high level of aptitude of these factors to changes, it is necessary to repeat the procedure of analysis of innovative project by entrepreneurial structures, in order to reduce maximally the level of uncertainty and risks.

Conclusions. The offered hypothesis was proved: the use of the fuzzy logic method does allow increasing the effectiveness of modelling and forecasting of innovative development of entrepreneurial structures under the conditions of the global competition. This is possible due to higher precision of calculations, graphical presentation of the results, and significant decrease of subjectivity, along with sufficient simplicity and clarity of calculations.

Practical significance of this study consists in explaining the possibility of using the authors' conclusions and recommendations regarding modelling and forecasting of innovative development of entrepreneurial structures under the conditions of global competition.

It should be noted that fuzzy logic has its alternatives – the most popular of which is the games theory. However, a significant advantage of fuzzy logic method, as compared to this and other alternatives, is the objectivity of calculations and higher precision of the obtained results, while with the games theory, probability of various scenarios is determined by an expert – which makes the initial data and, accordingly, all further calculations an rather subjective.

However, it should be noted that even fuzzy logic does not allow evaluating innovative projects with 100% precision, due to the complexity and multi-factor nature of socioeconomic models and approximate future values of the initial data in these models. Development of tools for precise modelling of economic systems is a perspective direction for further research.

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Стаття надійшла до редакції 19.01.2016.