Kravchenko Tetiana,
«Kyiv National Economic University named after Vadym Hetman»,
State Institution of Higher Education,
Assistant to the Chair of Economic and Mathematic Modeling,
the Faculty of Information Systems and Technologies

For The General Coefficients Of Dynamic Models Of Economic Development Region On The Basis Of Neuro Fuzzy Expert Systems

Abstract The paper studies and classifies the most important factors that are the main factors of generalized dynamic model of economic development of an economic agent as an example of the region, and proposes neural expert system with machine representation and use of knowledge by the methods of fuzzy sets theory of to offset the factors of different nature in the generalized model coefficients.

Keywords: economic agent, dynamic model, generalized factor fuzzy modeling.

The main task of an economic agent (EA) management is forecasting (strategic and tactical) that provides the most efficient use of EA resources. This can be realized through implementation of balanced social and economic policies taking into consideration, if possible, all the main development factors of the particular EA.

Management of socio-economic development of the region as EA – is a complex creative process: the more reasonable and effective is a decision-making process as regards its development, the greater the cumulative gain of EA is, the higher is the elasticity of his actions in course of the economic crisis.

Difficulty of making decisions on development of the region as EA in the current market conditions lies primarily in the fact that decisions under uncertainty, conflict and the resulting risks. In addition, the person who makes the decision maker (DM) must take into account various information (both quantitative and qualitative), use most advanced methods and areas of research in modeling complex systems.

To solve the problems of decision making under fuzzy terms mathematical tools of probability theory are used, identifying the ambiguity of an accident. This mathematical apparatus is reflected in the fuzzy modeling. Fuzzy modeling becomes

relevant during the most difficult economic description of present uncertainty or the decision in circumstances where the objectives, constraints and consequences of possible actions are not clearly defined (not clearly known), so the use of precise quantitative methods and approaches is complicated or even eliminated.

Models that use fuzzy sets are analyzed in [1, 2, 4, etc.]. Using fuzzy sets (fuzzy modeling) can formally define imprecise and ambiguous concepts like “high efficiency”, “average income of the population”, “large enterprise” and so on.

In order to make the best decisions regarding the management of socio-economic development of EA it is necessary to define a set of conditions, factors that form the basis for its successful development. Determination of such aggregate depends on the respective EA and specific task the researcher, and may include, without taking into account environmental factors such groups [3]: group of factors that determine the visual appeal of EA (α); group factors determining the employment potential of EA (β); group factors determining employee turnover (γ); group of factors that affect the efficiency of capital (investment) (μ);group of factors that affect the amount of equity (domestic investment) (δ); group of factors that reflect the credit attractiveness EA (foreign investment) or access to borrowing (λ).

When using classical dynamic model [3]:

$$\begin{cases} \dfrac{dY_1}{dt} = \alpha Y_2 Y_3 - \gamma Y_1; \\ \dfrac{dY_2}{dt} = \mu(Y_2 + Y_3) - \beta Y_1 Y_3; \\ \dfrac{dY_3}{dt} = \delta Y_2 - \lambda Y_3. \end{cases} \qquad (1)$$

where Y_1 – labor resource, Y_2 – the amount of equity capital, Y_3 – the amount of borrowed capital, researcher or ATS faces the challenge of managing or identifying specific factors that are included into relevant groups of generalized coefficients α, β, γ, μ, δ, λ. Note that one and the same factor may enter into several groups and can have both numeric and linguistic values.

Use of a dynamic model, unlike other allows investigation of the EA trajectory generalized under conditions of varying coefficients and variables depending on its condition and development prospects.

Some factors which are formed on the basis of generalized coefficient of dynamic prediction model of EA are shown in Table 1, the possible values of variables and their linguistic equivalent are given in Table 2.

Table 1 Factors affecting the development of EA

Factors	**Denomination**
Group the factors that determine the visual appeal of EA	α
The tax burden (taxes)	x_1^{α}
Share entity (EA) in the market	x_2^{α}
Inflation rate	x_3^{α}
Solvency ratio (investment climate)	x_4^{α}
. . . .	. . .
The level of development of market infrastructure in the region	x_{19}^{α}
. . . . .	. . .
Group the factors that determine the employment potential of EA	β
Household income (total)	x_1^{β}
Payroll (Income from wages)	x_2^{β}
Social benefits. Expenditure on social security (insurance)	x_3^{β}
Personal expenditures (total)	x_4^{β}
. . . . .	. . .
Level of morbidity	x_{12}^{β}
. . . . .	. . .
Group the factors that determine employee turnover	γ
Coefficient U.Bivera	x_1^{γ}
Direct material losses related to low skilled workforce	x_2^{γ}

Factors	**Denomination**
. . . . .	. . .
Profitability of labor	x_6^{γ}
. . . . .	. . .
Group of factors that affect the efficiency of capital investments (investment)	μ
The expected rate of net profit	x_1^{μ}
Percent rate loan	x_2^{μ}
. . . . .	. . .
Capital investments lag	x_5^{μ}
. . . . .	. . .
Group of factors that affect the amount of equity (domestic investment)	δ
Equity capital mobility coefficient	x_1^{δ}
Permanent asset index	x_2^{δ}
. . . . .	. . .
Equity capital capacity coefficient	x_5^{δ}
. . . . .	. . .
Group of factors that reflect the credit attractiveness EA (foreign investment) or EA available for borrowing	λ
Absolute liquidity coefficient	x_1^{λ}
Interim coverage ratio	x_2^{λ}
. . . . .	. . .
Coefficient profitable products	x_5^{λ}
. . . . .	. . .

For EA development strategy, which means, among other things, the problem management specific factors that are relevant coefficients α, β, γ, μ, δ, λ or groups of generalized their definition, the proposed algorithm consists of three stages (Fig. 1).

Table 2 Terms for logical evaluation of selected factors and ranges of their change

Variable name	**Variable marking**	**The range of the variable**	**Terms (level of influence factor on the resulting indicator)**
Group the factors that determine the visual appeal of EA	α	0-10	very low (VL) low (L) below average (BA) average (A) above average (AA) high (H) very high (VH)
. . . . .	. . .	. . .	. . . . .
Group of factors that reflect the credit attractiveness EA (foreign investment) or EA available for borrowing	λ	0-10	low (L) below average (BA) average (A) above average (AA) high (H)
The tax burden (taxes)	x_1^{α}		low (L) average (A) high (H)
Share entity (EA) in the market	x_2^{α}		low (L) average (A) high (H)
. . . . .	. . .	. . .	. . . . .

Variable name	Variable marking	The range of the variable	Terms (level of influence factor on the resulting indicator)
Payroll (Income from wages)	x_1^{β}		low (L) average (A) high (H)
Social benefits. Expenditure on social security (insurance)	x_2^{β}		low (L) average (A) high (H)
. . . . .	. . .	. . .	. . . . .
Coefficient U.Bivera	x_1^{γ}		low (L) average (A) high (H)
Direct material losses related to low skilled workforce	x_2^{γ}		low (L) average (A) high (H)
. . . . .	. . .	. . .	. . . . .
The expected rate of net profit	x_1^{μ}		low (L) average (A) high (H)
Percent rate loan	x_2^{μ}		low (L) average (A) high (H)
. . . . .	. . .	. . .	. . . . .
Equity capital mobility coefficient	x_1^{δ}		low (L) average (A) high (H)

Variable name	Variable marking	The range of the variable	Terms (level of influence factor on the resulting indicator)
Permanent asset index	x_2^{δ}		low (L) average (A) high (H)
. . . . .	. . .	. . .	. . . . .
Absolute liquidity coefficient	x_1^{λ}		low (L) average (A) high (H)
Interim coverage ratio	x_2^{λ}		low (L) average (A) high (H)
. . . . .	. . .	. . .	. . . . .

On the **first stage** generalized coefficients are formed, namely the process of "collapse" of several factors in a general coefficient. For this, given fuzzy or linguistic nature of many factors, the following steps are performed:

Step 1 (selection of indicators and phasing). According to the standard algorithm modeling using fuzzy sets theory, object block diagrams are build that describe the dependence of the resulting parameters - simulated subset factors (**R**{ α, γ, μ, β, δ, λ}) of input parameters $\{x_i^j\}$, which are given in Tables 1, 2 fragments. This input belonging to each of coefficients α, γ, μ, β, δ, λ:

$$Y = f_y(x_1, x_2, ..., x_n)$$

where $(x_1, x_2, ..., x_n)$– input variables (in this task – set of factors by which an expert forms corresponding generalized dynamic model coefficient); Y – the initial value, the value of the generalized dynamic factor model; f_y – approximating function.

Step 2 (activation or formation of linguistic variables). Building procedures for knowledge in the polls with further processing of the data with use of the algorithm

presented in [5]. According to this algorithm, the process experts' interviews includes procedure of ten-point scale shading on the basis of a thermometer principle. In such a way information related to the factor is received.

Step 3 construction of a knowledge base (base synthesis rules). To build a system for the formation of general coefficients of EA dynamic prediction model a technique is used, according to which for a fixed vector of input variables $X^* = \langle x_1^*, x_2^*, ..., x_n^* \rangle$, $x_i^* \in U_i$ is clearly assigned a solution $y^* \in Y$. To solve this problem a formal prerequisite is the availability of membership function:

$$y = f(x_1, x_2, ..., x_n)$$

where $x_1, x_2, ..., x_n$ – a set of values of input variables; y – the corresponding value of the resulting variable.

The calculation of the effective rate in fuzzy logic theory of is carried out by the values of input variables on the basis of the parameters of membership function and a given set of rules.

Step 4. Defuzzification, namely the transition from membership function of the output linguistic variable to precise it (numerical) value.

Based on the results of numerical simulations [3] it is possible to determine correspondence of linguistic variable value to its numerical equivalent.

On the **second stage** calculations are done using a dynamic model (1). Simulation results are specific generalized coefficients values (or range of values), for which any path is obtained that satisfies the ATS. This result is passed to the next stage.

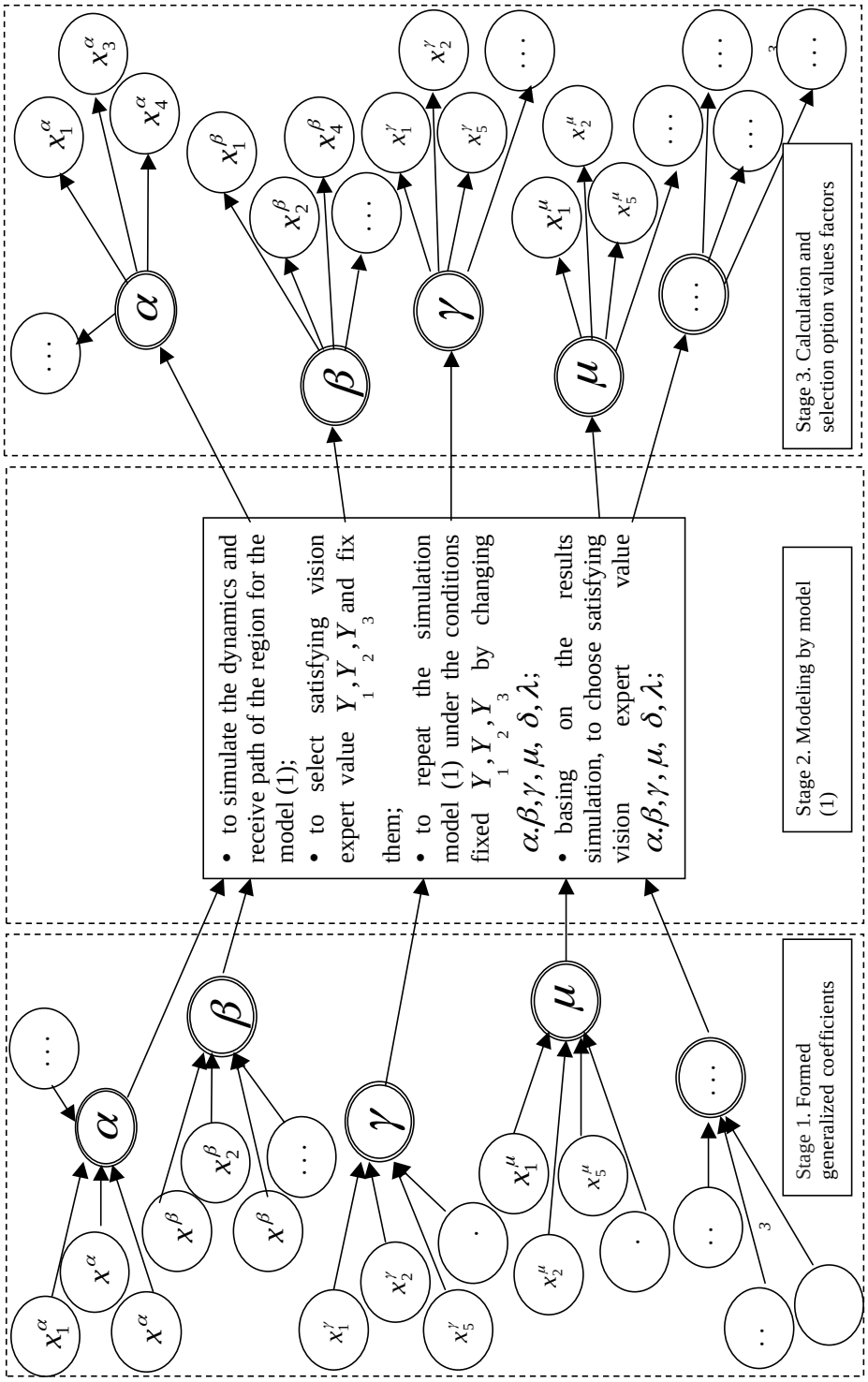

Fig. 1. Algorithm for determining factors

The **third stage** handles actions, opposing to the first phase, that is, having values of generalized coefficients it is necessary to choose a combination of values of factors that are relevant factor that satisfies the decision maker. To solve this problem using the knowledge base formed in step 3 of the first stage.

Conclusions. The paper presents a model of economic development that is neural network with integrated dynamic model. Its input, intermediate and derived parameters are considered as linguistic variables set to their universal set and evaluated using fuzzy terms. Setting the model can be done with use of genetic and other algorithms. Use of expert system with machine representation and use of knowledge by the methods of the theory of fuzzy sets is flexible and adaptive under the conditions occurring in a market economy in which EA particular region remain steady and growing normally.

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