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Neural Networks in an Assessment of Investment Projects Efficiency

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Abstract
The efficiency assessment of investment projects contains one of important tasks is forecasting of the estimated price of design production, the discount rate and the life cycle period of the estimated investment project. It is offered to use models of neural networks for the solution of this task in article. Three options of neural model in the form of the scheme are presented. The need to develop software and create a fact data base on the realized projects is the next task.

Keywords: forecasting, price, discount rate, period of the project life cycle, neural models

Introduction

The problem of efficiency assessment consists in the solution of a number of the interconnected tasks one of which is the task of predicting the values of the estimated *price of design products, the discount rate* and the estimated *period of the life cycle* of the investment project. These indicators are key and efficiency or an inefficiency of this or that investment project depends on their correctness of a choice. The existing official methodology of efficiency assessment of investment projects [Kossov, 2000] is subjective and locally oriented (oriented on receiving economic effect of investors, not considering global restrictions and restrictions on noneconomic externality). The presence in the modern conditions of force majeure, deviations and business environment (political and economic instability, the imperfection of a legal framework, development of shadow economy, etc.) becomes undesirable norm of everyday activities of economic entities. The nonlinear, inadequate, difficult predicted behavior of activity subjects, unfortunately, aggravates a problem of forecasting and an assessment of activity, and especially activity on the prospect connected with long-term capital investments and innovations. In such conditions of activity the majority of earlier developed formalized methods of forecasting can't be as valid and reliable. The main reason for it is use of abstract linear models and restrictions on them, application the censored sample, an exception of any single deviations (fluctuations) of possibility of consideration, use of the principle "with other things being equal", etc. It is clear that in such conditions it is necessary to be based on the principle of "permanence" or "continuous approach" in any activity, i.e. the mechanism of actions

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on a chain "activity control – the analysis of deviations – the correcting action activity " has to become the main and constant.

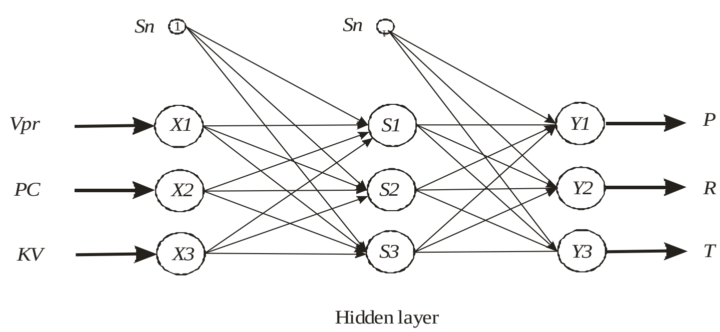
Method

The nonlinear forecasting concept in modern conditions of activity is a concept based on the use of *neural network theory* or *the theory of neural network modeling* [Kallan, 2003; Kruglov, 2002]. Neural networks have a wide range of the application. The theory of neural network modeling has been widely applied in many domains of science, but only slightly in economics and management of socioeconomic systems. In this article possible options of application of the theory of neural network modeling in solving the problem of forecasting are formulated. One of the applications is development of neural network model, which will be capable after undergoing the process of training and testing to generalize the output required data, i.e. at the same time to give out values of the estimated price of design production, the discount rate and the period of life cycle of the estimated investment project. In the course of research of this question the model as a full-coherent neural network with direct link and algorithm of the return distribution of errors was developed, proved and presented in works [Puryaev, 2007; Puryaev, 2011; Kharisova, 2014; Kharisova, 2013].

Results

Three options of neural models for in advance defined data of investment design are at the moment offered on consideration. In case of investment design the following three situations (option) are possible:

1. Absence of reliable factual information on criterion of *NPV* samples (kept secret, deliberately distorted). Samples are the realized investment projects submitted on training. It is known only that to *NPV>0* on these projects. In this case the neural network model can be presented in other option, without the input indicator of *NPV* which acted as criterion of efficiency of the realized investment projects (fig.1).

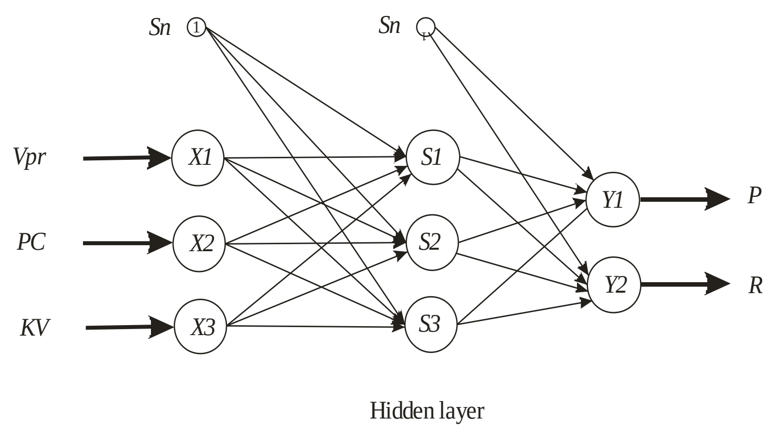


$$W_{XS} = \begin{bmatrix} 0.3 & 0.3 & 0.3 \\ -0.2 & -0.2 & -0.2 \\ 0.2 & 0.2 & 0.2 \\ -0.1 & -0.1 & -0.1 \end{bmatrix} W_{SY} = \begin{bmatrix} -0.3 & -0.3 & -0.3 \\ 0.2 & 0.2 & 0.2 \\ -0.2 & -0.2 & -0.2 \\ 0.1 & 0.1 & 0.1 \end{bmatrix}$$

Fig.1.– Neural network model for option 1 assessment of investment projects

a) *X1,X2,X3* – values of the specified input elements (scaled) of a network according to V_{pr} (production output), *PC* (production costs), *KV* (capital investment);
b) *S1,S2,S3* –calculated values of the hidden layer of a network;
c) *Y1,Y2,Y3* –the calculated scaled values of output elements of a network respectively *P* (price), *R* (discount rate), *T* (the period of project life cycle);
d) *Sn* – shift network activity equal to 1;
e) W_{XS}, W_{SY} –matrixes of weighting factor of the first and second layers of communication respectively with values at the start of training.

2. The actual information on criterion of *NPV* samples kept secret or deliberately distorted. *NPV>0* condition is satisfied. The assessment of investment projects is carried out for in advance strictly certain period of life (for example, for the operation term of the invested technological complex established by passport characteristics for the set period of distribution of the moratorium at the solution of various social and economic problems). Under such circumstances, there is no need to forecast the lifetime of the investment project (fig. 2).



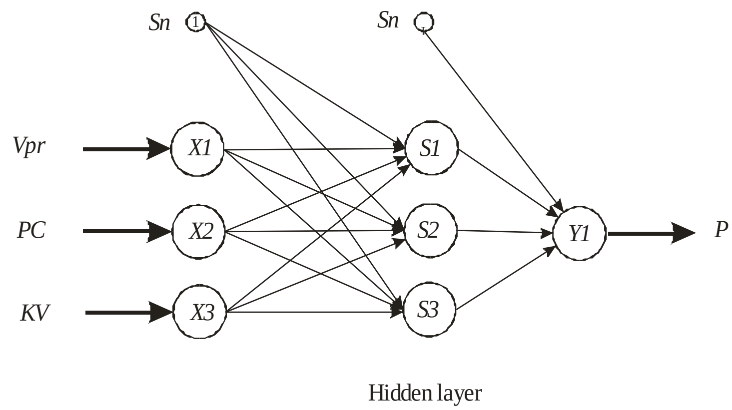
$$W_{XS} = \begin{bmatrix} 0.3 & 0.3 & 0.3 \\ -0.2 & -0.2 & -0.2 \\ 0.2 & 0.2 & 0.2 \\ -0.1 & -0.1 & -0.1 \end{bmatrix} W_{SY} = \begin{bmatrix} -0.3 & -0.3 \\ 0.2 & 0.2 \\ -0.2 & -0.2 \\ 0.1 & 0.1 \end{bmatrix}$$

Fig. 2 – Neural network model for option 2 assessment of investment projects

a) *X1,X2,X3* – values of the specified input elements (scaled) of a network according to V_{pr} (production output), *PC* (production costs), *KV* (capital investment);
b) *S1,S2,S3* – calculated values of the hidden layer of a network;
c) *Y1,Y2* – the calculated scaled values of output elements of a network respectively *P* (price), *R* (discount rate);
d) *Sn* – shift network activity equal to 1;
e) W_{XS}, W_{SY} –matrixes of weighting factor of the first and second layers of communication respectively with values at the start of training.

3. The same conditions, as in the second option (the *NPV* values distorted, but it is precisely known that *NPV>0* samples effective; the life cycle of the project is in advance established). There is no need to take

account of the time factor (discounting procedure) in the calculations (it is possible when projects simple, not capital intensive and incontinuous). In this case there is no need to predict the discount rate. There is only one output element – the price of design production (fig.3).



$$W_{XS} = \begin{bmatrix} 0.3 & 0.3 & 0.3 \\ -0.2 & -0.2 & -0.2 \\ 0.2 & 0.2 & 0.2 \\ -0.1 & -0.1 & -0.1 \end{bmatrix} \quad W_{SY} = \begin{bmatrix} -0.3 \\ 0.2 \\ -0.3 \\ 0.1 \end{bmatrix}$$

Fig.3 – Neural network model for option 3 assessment of investment projects

a) *X1*,*X2*,*X3* – values of the specified input elements (scaled) of a network according to V_{pr} (production output), *PC* (production costs), *KV* (capital investment);
b) *S1*,*S2*,*S3* – calculated values of the hidden layer of a network;
c) *Y1* – the calculated scaled value of an output element of a network *P* (price);
d) *Sn* – shift network activity equal to 1;
e) W_{XS}, W_{SY} – matrixes of weighting factor of the first and second layers of communication respectively with values at the start of training.

The offered models of neural networks are at the moment theoretical and tentative. Change in their structure, topology, the number of weighting factor is possible, but the change in the number and content of the input and output elements is unlikely. Necessary condition of neural network modeling is existence of enough educational samples (investment experience in similar projects). Models have the following characteristics: a) the network model - the model fully connected feedforward and backpropagation of error algorithm; b) the number of input elements - the three; c) output elements – from the three to the one (depending on option); d) the activity function – the sigmoidal function $f(net) = \frac{1}{1+\exp(-net)}$;

e) the rule of training – the operated rule of training; f) the rule of error correction – the delta learning rule (*Widrow-Hoff rule*: minimizing the sum of squared errors); g) weighting factor is random set of interval -0.3 to +0.3; h) data scaling (indication) is in the range from 0 to 1 with the formula (1) to the range of 0.1-0.9. It is required to avoid a condition of "idling" network at achievement of extreme limits of area of its working capacity [1]:

$$y = \frac{0.9 - 0.1}{x_{\max} - x_{\min}} \cdot x + \left(0.9 - \frac{0.9 - 0.1}{x_{\max} - x_{\min}} \cdot x_{\max} \right) \quad (1)$$

y – new value of ab indication; x – initial value of ab indication; x_{min}, x_{max} – the minimum and maximum value of ab indication from set of educational samples.

Conclusion

The received models of neural networks will allow to increase probability of exact forecasting of key indicators of an efficiency assessment of investment projects when using the software and a sufficient datafiles: the price, the discount rate, and the life cycle of the investment project. The following tasks are a development with use of these software models and formation of actual database on the realized projects. The first task demands special knowledge, but is solvable. The last task is labor-consuming and long on time. In general the efficiency assessment needs it.

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