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Economic and Predictive Modeling of Company's Development as Major Strategic Planning Prerequisites

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Abstract: This study highlights the need to develop economic simulation analysis for strategic planning of an organization. Researchers focus on developing the methodology for analysis of organizational practices which effectively rests on time series smoothing technique (or leveling method), correlation and regression analysis and neural simulation. Results from the analysis, made in STATISTICA software package show that this methodology enables to define projected figures of production volumes and gross profit as well as pinpoint relevant factors that affect these values, thus predict company development options.

Key words: Economic simulation, strategic planning, predictive modeling, neural networks, autoregression, exponential smoothing

INTRODUCTION

The rationale of this topic is driven by the need to improve strategic planning methods and organizational analysis that enable to select competitive strategy of business development, enhance competence and target key factors which affect successful achievement of strategic goals of the company and also becomes a platform for policy decision-making (Rakhmankulova, 2010). The term "prediction" means making a forecast; strictly speaking, this means a specific study of realistic prospects of improving a process or developing a company. Prediction plays a vital role in planning and management (Korableva and Kalimullina, 2014). It allows to get prepared for market changes by either cutting down costs/losses or making additional profit. Currently prediction is extensively used in economic studies and in production sphere. Mathematical tools or techniques are also widely used in modern economy: dependency graphs are analyzed, mathematical formula are devised, statistical analysis of the results is made, computer-aided simulation of economic processes is made (Naylor, 1983). All these techniques facilitate long term strategic planning. Economic simulation models may be used to study various aspects of business practices or performance of divisions/units/ departments of an organization. Economic simulation models used to study economic processes and issues fall into classes:

- Operations models, both for entire organization and for its sub-systems
- Sets of models covering production, consumption, income generation and revenue distribution, labour resources, pricing, financial links, etc.

Therefore, economic simulation is an essential tool for making economic projection for any major organization, particularly manufacturing company (Rakhmankulova, 2009).

MATERIALS AND METHODS

Our concept pays special attention to predicting development of a commercial organization, in fact, to strategic analysis of economic parameters specific to its development.

There are different prediction techniques: ARIMA (Autoregression Integrated Moving Average), exponential smoothing; prediction based on neural networks. Autoregression and Integrated Moving Average Model (ARIMA) was introduced by American scholars Box and Jenkins in 1976 as one of the methods to evaluate unknown parameters and predict time series. Autoregression integrated moving average model is used to simulate nonstationary time series. A nonstationary time series is characterized by variable mathematical expectation, dispersion, auto-covariance and

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autocorrelation. Most time series include elements that sequentially depend on each other. This relation could be expressed by following Eq. 1:

$$x_t = \varphi + \Phi_1 \times x_{t-1} + \Phi_2 \times x_{t-2} + \Phi_3 \times x_{t-2} + \cdots + \varepsilon \quad (1)$$

Where:

φ = Constant (constant term)

ϕ_1, ϕ_2, ϕ_3 = Autoregression parameters

It follows that each experimental observation is sum of random component (random influence, ε) and linear combination of preceding inquiries.

Next technique that could be used for strategic analysis is exponential smoothing which can be applied to short-term prediction of future trends one period forward and automatically corrects any forecast in case there is difference between actual result and the predicted one (Savitskaya, 2006). That explains why this method is of great significance for economic simulation analysis. This technique was named so because it results in exponentially weighted moving average values throughout time/temporal series.

Key advantages of this method include: possibility to take into account input data weights, simplicity of computation, flexibility in describing dynamics of various process. This approach allows to obtain assessment of parameters and the general trend prevailing at the time of observation.

The last method considered in this paper is neural simulation technique. Compared to linear statistical methods (linear regression, autoregression, linear discriminant), neural networks allow to effectively plot curvilinear relationships describing data sets with greater accuracy (Thompson and Strickland, 2007). Neural networks are instrumental in data analysis, data recognition and data classification, prediction, management, etc. Simulation is made using Statistica and Excel software packages.

RESULTS AND DISCUSSION

The company needs to provide data of their reports and annual returns that would be used for economic simulation and predictive modeling of company's sustainable development. Based on the findings of economic and financial analysis and additional calculations, key performance indicators are determined and used in further analysis (Table 1) that are descriptors of company's sustainable development. Y1, Y2 and Y3 indices were taken as resultant indicators whereas variables (X1-X16) represent factors describing company's production and non-core operations. Figure 1 shows prediction results obtained by ARIMA method.

Table 1: List and refer to the financial and economic indicators

Points of indicators	Pramaters
Capital coefficient	X1
Coefficient of consolidation = 1/TURNOVER RATIO	X2
Profitability of sold products (profit per 1 ruble. of sold products) (%)	X3
Profitability of production (%)	X4
Product profitability (%)	X5
Return on sales (%)	X6
Return on assets (%)	X7
Assets turnover	X8
Return on equity (%)	X9
Absolute liquidity ratio	X10
Interim liquidity ratio	X11
Coverage ratio	X12
Financial independence ratio	X13
The coefficient of financial stability	X14
Investment ratio	X15
ROI (%)	X16
Production of type 1 of product, ths. pieces	Y1
Production of type 2 of product, ths. pieces	Y2
Gross profit, ths. Rub.	Y3

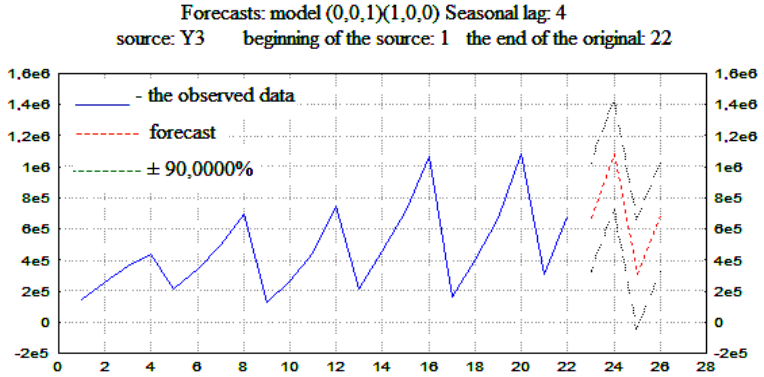

Fig. 1: Simulation results

Table 2: Observed and projected gross margins

Period	The predicted value (Y3)	The observed value (Y3)	Difference	SE
1 qr. 2012	100133,7	125750,0	-25616,3	0.027
2 qr. 2012	251133,3	269730,0	-18596,7	0.020
3 qr. 2012	459990,0	444656,0	15334	0.016
4 qr. 2012	864235,4	747833,0	116402,4	0.124
1 qr. 2013	217955,7	212033,0	5922,7	0.006
2 qr. 2013	480809,1	457753,0	23056,1	0.024
3 qr..2013	770556,6	720039,0	50517,6	0.054
4 qr. 2013	1059409,	1067491,	-8082	0.009
1 qr. 2014	173116,1	158101,0	15015,1	0.016
2 qr. 2014	351491,4	400030,0	-48538,6	0.052
3 qr. 2014	531298,4	666654,0	-135355,6	0.144
4 qr. 2014	900716,2	1078974,	-178257,8	0.189
1 qr. 2015	301797,3	305902,0	-4104,7	0.004
2 qr. 2015	640178,7	682661,0	-42482,3	0.045
3 qr. 2015	301797,3	305902,0	-4104,7	0.004
4 qr. 2015	640178,7	682661,0	-42482,3	0.045

Table 3: Consolidated table quality of predicted indicators gained by different methods

Prediction method	MSE	SSE	MAPE (%)
ARIMA	0.000039	0.00047	0.74
Exponential smoothing	0.0000035	0.000432	0.20
Neural networks	0.000007	0.0000841	0.34

That is, three company development options are represented here: the biggest (top line in Fig. 1), the least (bottom line Fig. 1) and middle option (the line between the top and bottom range) of development. The intermediate value is most probable whereas the other two options may only be realized in case some unexpected favorable or adverse factors affect the development that is why all three development options need to be taken into consideration and three strategic plans shall be devised (Rakhmankulova, 2010). In Table 2, forecast may be made using exponential smoothing technique.

For the purpose of predicting a company's economic performance a net is selected to analyze time series, whereas input and output variables are selected for a range of quarterly figures. For initial setting of neural network parameters value in view window is set at 4 which correlates to four quarters a year and also 150 neural networks are set for training, this would allow to achieve optimal net in the shortest time possible. As soon as 150 taught-in nets are available, we select the net with minimal test performance should be selected. Thus we defined the optimal model-neural network with MLP Model. This net is shown in Fig. 2.

Analysis of prediction outcome is shown in the Table 3. According to this table best prediction results were achieved using prediction techniques based on neural networks.

A range of features characterizing a particular technique considered in this paper shall be taken into account when selecting a relevant prediction technique (Popov, 2013).

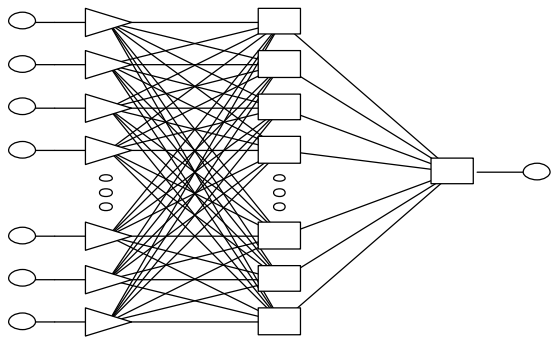

Fig. 2: Optimal neural network pattern (input X1-X13, output Y1-Y3)

Complexity of forecast generation shall also be kept in mind (Korableva and Kalimullina, 2016). For example, when making long-range projection it is possible to rely on exponential smoothing or ARIMA only, rather than build a neural network (this should only be expedient for developing high precision predictions). Neural networks techniques showed the best results. However building a neural network is reasonably expensive (Tung, 1986), so if there are no specific requirements to accuracy of forecast, there is no need to use this method. It should be also noted that ARIMA method and exponential smoothing technique are best suitable for tranquil markets with distinct cyclicality and trend, as is shown in our case. Prediction methods based on neural networks allow to achieve high results at markets with frequent trend reversals.

CONCLUSION

Methodology of company performance analysis devised by the authors which rests on economic simulation techniques-time series smoothing, correlation and regression analysis and neural networks simulation makes it possible to identify projected production levels and gross profit values, how they are affected by key factors depending on condition of indices characterizing company's financial and economic performance in the future. In the case of strategic planning, these techniques should facilitate the implementation of strategic objectives which may be adjusted depending on the needs of the organization.

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