STOCK MARKET DECISION MAKING MACHINE

Abstract: *The article deals with the build up of the stock market decision making machine that can improve prediction accuracy. It uses fundamental, psychological and technical analyses together with simulation and other methods. The technical analyses are represented by the regression and chaos analyses, prediction by means of dynamic models, fuzzy logic, neural networks, genetic algorithms and hybrid models. It uses chaos analyses for the test of randomness of time series. The designed methodology is used for the processing of the data to obtain the information of buy and sale signals of the share prices, currency ratio and commodities on the world markets. The case study is mentioned where the evaluation of inputs is presented.*

Keywords: *stock market, decision making, fundamental analyses, psychological analyses, technical analyses, model, PC program*

1. INTRODUCTION

The article deals with one of the most complicated predictions represented by stock market. The aim is simple, to predict the right moment of buy, sell or hold of the index, share, commodity or currency to obtain the profit. The main part of this task is connected with the prediction of time series. The behaviour of stock market is influenced by economic, political, psychological, social and other phenomena. Stock market has its back feedback, too. This is the fact why the predictions on the stock markets are so difficult. The trade on the markets must be successful more than 50 per cent to create the profit. The more per cent you are successful the better. The article describes the build up of a model using combined prediction for the brokerage house.

2. THEORY

The aim is to fix best the future development of prices of shares, currency ratios and commodities during the operation in the world market. The results from fundamental, psychological, technical analyses and other methods can be applied for these purposes. The application of soft computing is spread together with the development of knowledge in the branch of mathematical analyses. The soft computing includes the findings from the theory of fuzzy logic, neural network and genetic algorithms. These methods enable better description of non linear processes that are present in business economy and finance. One of the possible methodologies of time series analyses and prediction is described in this article. The combined prediction includes fundamental analyses, psychological analyses, regression analyses, chaos analyses, dynamic models, fuzzy logic models, neural networks models, genetic algorithms models, hybrid systems, simulation and other methods. The model is presented in the following figure and the description is as follows:

A) A great deal of information can be received from press, radio, television and Internet, e.g.: news from firms, their plans, management, economic information such as (EPS, P/E, ROE), future earning potentials, dividends, income, debt, returns, income statement, balance sheet, earning and financial comments and so on. As well the values dealing with the history of data of prices might be obtained with various samplings, i.e. to obtain a time series. The time series can be processed by means of mathematics analyses with their advantages and disadvantages (Dostál (2002)).

B) Data mining means the classification, sampling, sorting, cleaning, supplement and transformation of data. Data mining can include verification and simple evaluation (David et al. (2002) and Rud (2001)).

C) The information can be processed by fundamental analyses. E.g. the Delphi method enables us to evaluate the knowledge of analysts and based on the scale of influence leads into the decision making process with there advantages and disadvantages (Dostál (2002)).

D) As the input analysis the methods of determining whether the time series is deterministic, fractal or random could be used. Having proved that the time series is purely random, another search with the aim to determine the future development of price is irrelevant. We can be disappointed with the results of incorrect analyses. Hurst exponent indicates, whether the time series is normally distributed, has long “memory”, whether the time series trend is an antipersistent (persistent) or reverting (reinforcing) time series. The fractal dimension can be used for

these purposes, too. Other possibility is to use the Lyapunov exponent, which determines the range of predictability of time series. If the time series is not random and has a good predictability then it is suitable to continue in other analyses (Dostál et al. (2001), (Dostál (2002), Gupta et al. (1999), Peters (1994) and Trippi (1995)).

E) One can use the analyses by means of Elliott's waves, which applies the knowledge of psychological analysis. It is possible to determine the future tendency of future price from the types of waves (Dostál (2001) and Frost (2000)).

F) It is possible to study the time series by means of regression analysis, dynamic models, fuzzy logic, neural networks, genetic algorithms, chaos analysis, hybrid models, wavelet analysis or Kalman filter ((Alliev et al. (2002), Altroc (1995), Azof (1994), Box et al. (1976), Dostál (1998), Dostál (1999), Dostál (2000), Dostál et al. (2001), Dostál (2002), Gately (1995), Gupta et al. (1999), Klir et al. (1995), Kalman (2002), Ošmera (2002), Gupta et al. (1999), Peters (1994), Rebeiro et al (1999), Sebera et al (2001), Trippi (1995) and Zadeh (1994)).

G) It is possible to analyse time series in a post mortal way. We can do a regression analyses and calculation of indexes which exist in a huge number over past data. (E.g.: Bollinger Bands, Stochastic Oscillator, On Balance Volume etc.). We can simulate buying and selling signals in the past in order to obtain a view of the behaviour of the price depending on time and to estimate the possible future development of the price (Dostál (2002) and (Rebeiro et al (1999)).

H) It is possible to make a calculation of prediction of time series by means of the dynamic models represented by means of non seasonal and seasonal ARIMA (Autoregressive Integrated Moving Average) models and by various types of "smooth" models (Alliev et al. (2002), Box et al. (1976), Dostál (1998), Dostál (1999), Dostál (2002) and Rebeiro et al (1999)).

I) Another possible calculation is that of trend identification of prediction of time series by means of fuzzy logic. The trend prediction of time series is calculated on the basis of fuzzy rules. The process of fuzzification, fuzzy inference and defuzzification are used (Alliev et al. (2002), Altroc (1995), Dostál (2002), Klir et al. (1995), Rebeiro et al (1999) and Zadeh (1994)).

J) You can make a calculation of prediction of time series by means of neural networks. The sigmoid and hyperbolic tangent seems to be the best for prediction (Alliev et al. (2002), Azof (1994), Dostál (1999), Dostál (2000), Dostál (2002), Gately (1995) and Rebeiro et al (1999)).

K) Another possible calculation is that of the trend identification of prediction of time series by means of genetic algorithms. The trend prediction is calculated on the basis of logical rules when the maximum profit is being searched by means of optimalization. The various algorithms can be used for prediction of time series, for example parallel evolutionary ones (Dostál (2002) and Ošmera (2002)).

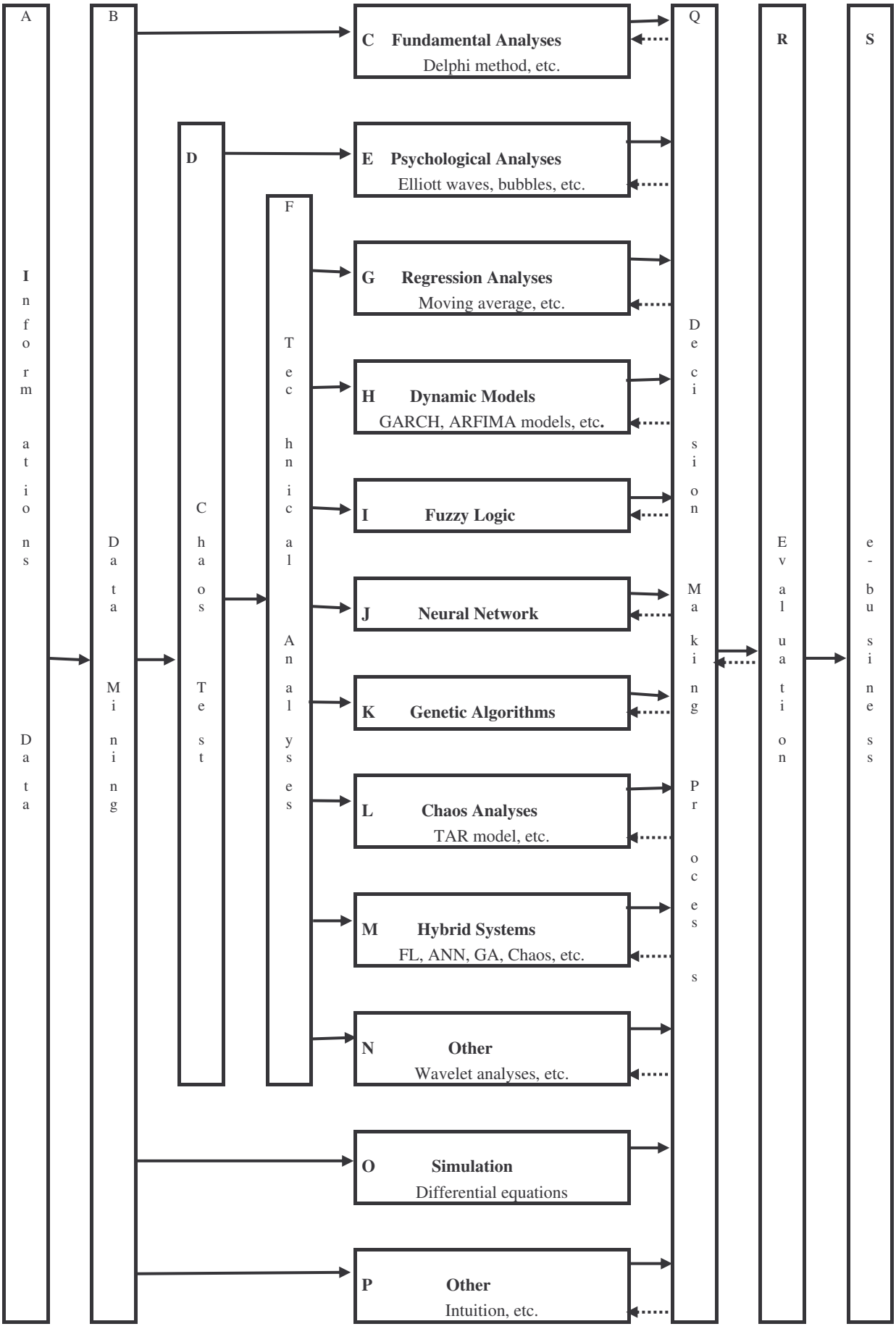
L) The chaos analysis represents the calculation and evaluation of Hurst and Lyapunov exponents as mentioned in section D. The TAR (Threshold Autoregressive) model and ARFIMA (Autoregressive Fractional Integrated Moving Average) model can be mentioned in this section (Dostál et al. (2001), Dostál (2002), Gupta et al. (1999) and Trippi (1995)).

M) The hybrid systems can be created by the combination of fuzzy logic, neural networks, genetic algorithms and the theory of chaos. There can be various combinations where the neural – fuzzy- genetic – chaos one is the most complicated (Alliev et al. (2002) and Rebeiro et al (1999)).

N) It is possible to analyse time series in a post mortal way by wavelet analyses. We can use for decomposition of time series the wavelet function according Daubechies. The future values can be estimated by means of Kalman filter (Dostál (2002), Kalman (2002) and Sebera et al (2001)).

O) The simulation is the process that describes the behaviour of the analysed system (stock market) by means of differential equations. The stock market as a financial system which can be described as a system with a positive and negative feedback. The positive (negative) feedback amplifies the increase (decrease) of prices (Barvíř (2002) and Dostál (2003)).

P) Other outputs can be based on the intuitive prediction or "exotic" analyses can be mentioned. E.g. the influence of the sun and phases of the moon on prices of shares (Dostál (2002)).


A
Information Data
B
Data Mining
C Fundamental Analyses
Delphi method, etc.
D
Chaos Test
E Psychological Analyses
Elliott waves, bubbles, etc.
F
Technical Analyses
G Regression Analyses
Moving average, etc.
H Dynamic Models
GARCH, ARFIMA models, etc.
I Fuzzy Logic
J Neural Network
K Genetic Algorithms
L Chaos Analyses
TAR model, etc.
M Hybrid Systems
FL, ANN, GA, Chaos, etc.
N Other
Wavelet analyses, etc.
O Simulation
Differential equations
P Other
Intuition, etc.
Q
Decision Making Processs
R
Evaluation
S
e-business

Q) The decision making process is very complicated. As there can be even contradictory outputs from these analyses, it is suitable to apply the fuzzy logic for their evaluation.

R) It is necessary to evaluate and compare the results of prediction with the actual values in a post mortal way. The quality of prediction models can be evaluated, for example by means of MAPE (mean absolute percentage error). In this way it is possible to change the weight of individual analyses. The decision making process is a dynamic one where the continuous and on line evaluations become the necessity (Dostál (2002)).

S) The buying and selling signals can be realised in various ways e.g. by means of e-business via Internet or in other ways (Baird et al. (1999)).

3. BUILD UP MODEL

The decision making process has been made by means of fuzzy logic in a following manner. The outputs of fundamental analyses demonstrate the level of news, balance sheet and economic data such as EPS, P/E and ROE: the best, better, good, neutral, bad, worse, the worst. The outputs of psychological analyses are the prospective trend created by the behaviour of crowds on the stock market: neutral, high, medium, low increase or decrease. The outputs of the technical analyses are processed in the form of vague description from regression analyses, dynamic models, fuzzy logic, neural networks, genetic algorithms and chaos analyses. The intra-daily, daily, weekly and monthly predictions and judgement of prices, indexes and their trend developments represent values: neutral, high, medium, low increase or decrease. The outputs of simulation and other methods can indicate the prospective trend of time series: neutral, high, medium, low increase or decrease. The following figure presents the scheme of fuzzy logic decision making process, where the symbols of individual analyses C,E,G,H,I,J,K,L,M,A,O,P are used for inputs and Q for output.

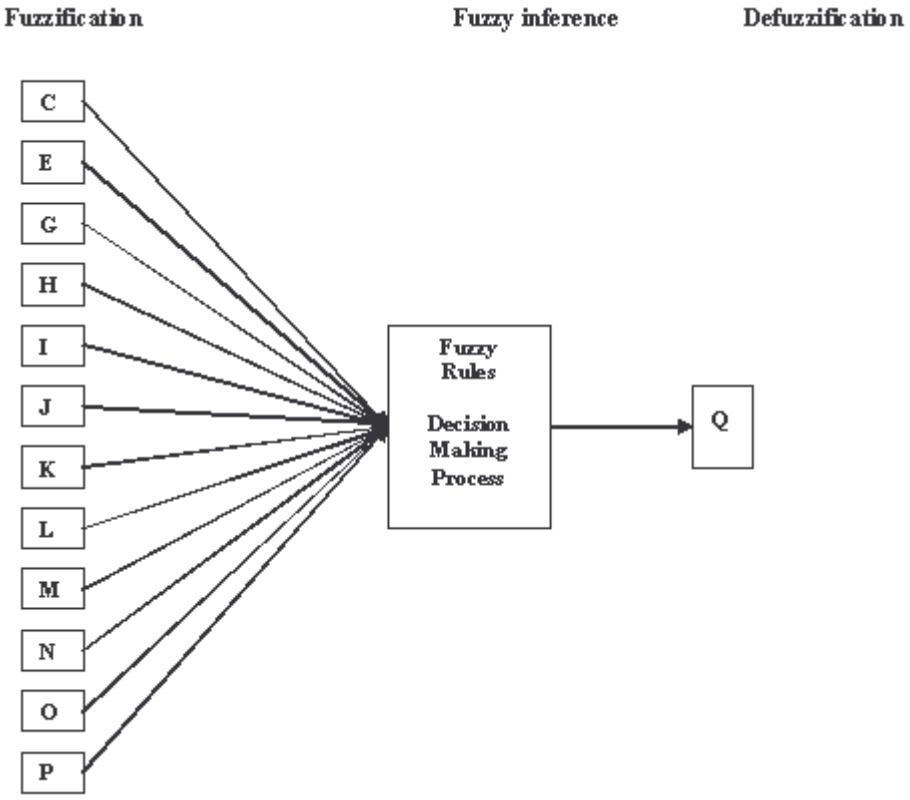


Figure: The scheme of fuzzy logic decision making process

All the inputs of fuzzy logic (output results from all analyses) are processed by fuzzy rules. The fuzzy rules are in the form: If A then B. The evaluation of prediction errors from various analyses has been used for setting the weights included in fuzzy rules. The analyses with more (less) accurate predictions have higher (lower) weight in the decision making process ((Altroc (1995), Dostál (2000), Dostál (2002) and Ošmera (2002).

4. CASE STUDY

The practical realisation of decision making machine is presented in the following figure.

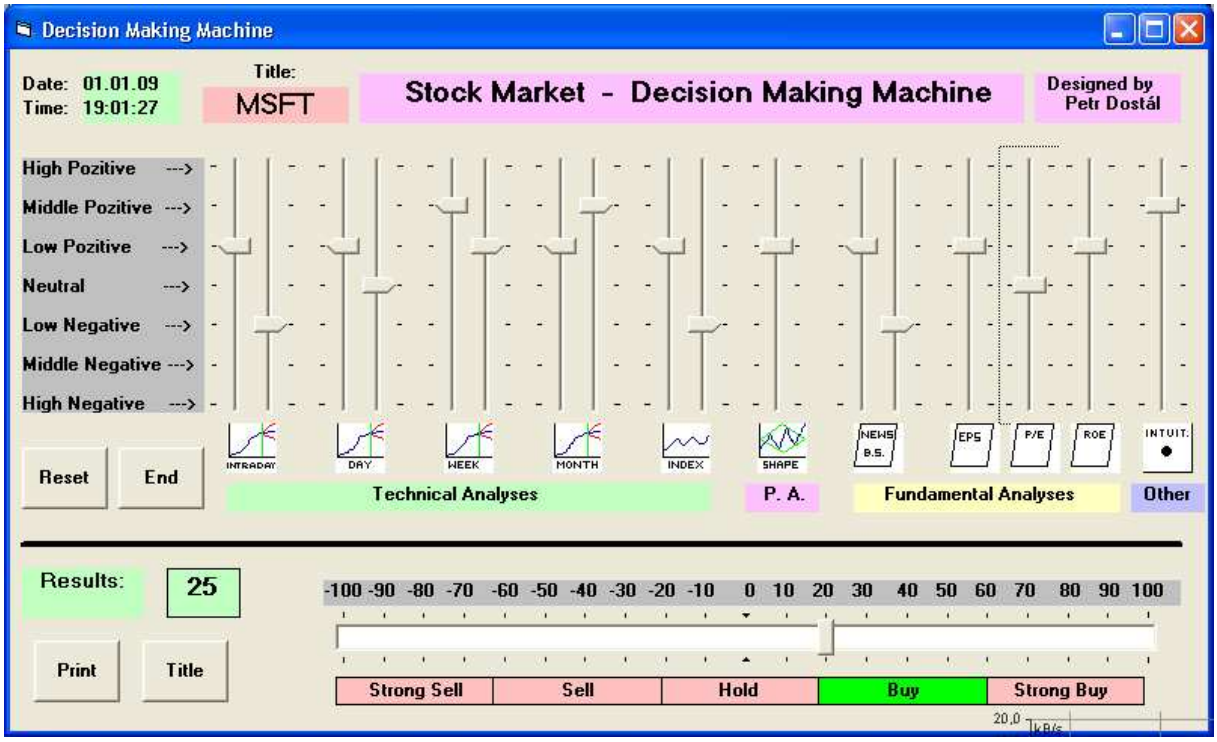


Figure: The display of decision making machine

The projected decision making machine works in a following manner. The outputs of the single analyses and predictions are transferred to the following attributes: High Positive, Middle Positive, Low Positive, Neutral, Low Negative, Middle Negative and High Negative.

• The outputs of the technical analyses are processed in the form of vague description from regression and chaos analyses, prediction of trend by means of dynamic models, fuzzy logic models, neural networks and genetic algorithms. The intra-daily, daily, weekly and monthly prediction of values of indexes, prices of shares, commodities and currency ratios represents their trend developments.
• The outputs of psychological analyses are the prospective trend created by the behaviour of crowds on the stock market.
• The outputs of fundamental analyses demonstrate the level of news, balance sheet and economic data such as EPS, P/E and ROE.
• The outputs of other analyses can include further analyses that are not mentioned here including intuition and that leads to indication of the prospective trend of time series.

All the inputs of fuzzy logic (output results from all analyses) are represented by attributes and their membership functions. The fuzzy rules are influenced by the degree of support. The evaluation of prediction errors from various analyses are used for the setting of degrees of support. The analyses with more (less) accurate predictions have higher (lower) weight in the decision making process. The fuzzy - neural system can be used where the shape of membership function of inputs and output and degree of support is set up by the process of learning of neural network that is included in fuzzy system.

The output of fuzzy rules is produced in the form of scale in range from -100% to +100% (from immediate buy to immediate sell) or via five attributes (ranges): strong buy, buy, hold, sell, strong sell. In our study case the decision making machine suggested to sell the share of Microsoft company. It is evaluated with 25% on the scale.

CONCLUSIONS

The aim of the research is to project the methodology to fix best the future development of prices of shares, currency ratios or commodities during operations in the world market. The decision making machine reaches fruitful results. The disadvantage is that the model is complicated and continuous evaluation and tuning must be done.

The correct analyses and evaluation give the correct answer how to work with the prices of shares, commodities or currency rates. The methodology enables to improve the accuracy of decision making process during the operation on the world stock markets. The prediction of financial time series and behaviour of stock market is so difficult that it is quite often suitable to use this methodology.