OPPORTUNITY OF APPLICATION OF ARTIFICIAL INTELLIGENCE METHOD IN ECONOMICAL FORECASTING

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One of the functional tasks of macroeconomics is the characterization of policy. Macroeconomic policy relying on the theoretical analysis of basic macroeconomic indices in a considerable degree could weaken economic recessions, undesirable growth of unemployment and inflation. Actually, macroeconomic policy creates a model of future development of economics.

Logic of the analyst is based on the analysis of market changes: on dynamics of demand and supply, level of prices and interest rate, variation of currency rate etc. Change of basic indices is shown in tendencies and trends.

The majority of economic analysis methods are directed to recognition of these tendencies. Analyst forwards the following postulates: economic reality is shown in marker reactions; development of prices and interest rates, currency rates, employment etc. obey tendencies; operating tendency is developing logically in the certain time interval, but it does not turn into its antithesis immediately.

Market dynamics research is connected to rational behaviour of economic agent, its psychology. Behavioural logic of economic agent directed to the achievement of own economic interest practically does not change for years. Present decision-making is often performed according to the principle: the future is the continuation of the past. Therefore, the calculation and construction of future expectation model is a dominant determinant of the present decisions. The future has a price; therefore, it is important to formalize expectation.

Statistical, adaptive and rational expectations are distinguished in economic theory. All expectations have the certainty factor. It can be characterized as a random variable x_t in period t. Expected value of the third random variable in time can be written as t + 1. Therefore, random variable looks as x_t +1. Random forecasting error ε often called as "white noise" shows the reliability of expectation, if ε =0, then we have a case of perfect forecast, the less ε is, the more accurate the forecast is. Expectations are built on the fact that the difference between the expected value of variable and its real value is unpredictable:

$$x_t+1- tx_t+1=\varepsilon_t+1.$$

Adaptive expectations happen when economic agent is gradually changing errors during re-evaluating of any wrongly evaluated variables. It increases or reduces its values:

$$x_t + 1 - t - 1x_t = \alpha(x_t - t - 1x_t),$$

where α-is a degree of forecast regulation opportunity .

Deficit of adaptive expectations lies in neglecting the future management conditions.

Statistical expectation assumes that α=0. Rational expectations theory is built on the extrapolation of some tendencies postulating that the future is a continuation of the past

$$x_t+1=x_t+\beta(x_t-x_t-1),$$

where β- is a degree of tendencies of saving the past in the future.

According to rational expectations theory (RET) it is considered that the expectation of the future is also rational as the present behaviour of managing agents. For implementation of forecasts it is enough to have information and expectations of several well-informed economic agents. For example, trade unions, professional traders in the financial markets. Behaviour of well-informed agents in the market possessing considerable resources spread the expectation for real economic resources passing.

But the experience shows that the managing agents understanding a significance of rational expectations cannot properly evaluate the degree of impact of the expectation itself. So, for example, when logically expecting the reduction of tax proceeds to budget during the period of recession the businessmen taking into account beforehand the steps of stimulating fiscal policy of the government change the investment volume in advance to save revenues with the lower level of expenditures.

Logically correct forethought result of the future is transformed from the final result into factor of direct impact on economics today.

For efficient management of economics it is necessary to forecast these changes using rather complex econometric models helping to calculate feedback of policy to expectation.

Economic policy in this case is considered as practical section of economic theory. Analysis of general model of macroeconomic dynamics is convenient to be provided in terminology "objectives-means". It assumes purposeful change of system state variable for performance of impact on parameters of the system itself.

In economic policy it is possible to distinguish directions of "firm course" and freedom of action policy".

«Firm course» means that measures of impact on economics by the Government and Central Bank (CB) by main tools of macroeconomic policy, i.e. government spending (G), taxes (T), money supply (MS) etc. – are limited by frames of observance of beforehand declared quantitative parameters. For example, in Latvia, the frames of Maastricht agreements, which cannot be changed due to current economic market because they have been accepted beforehand as "economic behaviour rules", limit it.

«Freedom of action policy» or as it is called sometimes "freedom of initiative" gives opportunity of assessment or re-assessment of the situation in each separate case and certain decision-making when any qualitative frames are absent.

Experience of macroeconomic regulation of developed industrial states shows considerable advantages of "firm course" of economic policy because it reduces the risk of incompetent decision-making as a result of conflict between contradictory interests of social groups, minimizes impact of "populist programmes", election and political games. Game according to "firm course" rules increases trust of economic agents to activities of Government and CB.

In the frames of "firm course" of economic policy there are also certain nuances. Here is a choice between active and passive models. Active model is aimed to support of quantitative parameters taking into account current circumstances, for example, level of inflation and employment; passive course is aimed to straight-out successive implementation of beforehand set firm instructions into life.

Active model assumes independent activity of Government and CB.

Degree of possibility of fiscal and monetary policies impact on real market serves as efficiency criteria of macroeconomic policy: national produce level and employment. In dynamics it is a minimization of real national produce deviations from potential and real level of unemployment from a natural one; in statistics it is a maximum approximation of a current system position to its economic potential. It is possible to count macroeconomic policy to be stabilizing when it is capable to restore damaged state of the system.

Efficiency criteria is spread also to degree of reliability of economic development forecasts because economic policy in many aspects is based on retrospective analysis with the aim to define perspectives of economics development in the frames of set parameters.

Economics of Latvia as "small open" economics in terminology of Mandell-Fleming model that is double equilibrium of goods (IS) and money market (LM) united by one equilibrium cost of money can use as fiscal and monetary policies with the aim of stabilization of economics and supply of economics growth. However, impact of these tools on economics is ambiguous.

Consequences of macroeconomic policy tools impact in many aspects depend on currency rates system. International Currency Reserves (ICR) gives a wide spectrum of currency policy definitions.

The following items are named officially: fixed course, floating currency course and intermediate mode of controlled floating.[1] But in real life there are many intermediate modes of currency market reflecting realities of micro- and macro environment, legislative acts of authorities and behaviour of financial institutions etc. According to ICR, "binding" to currency basket as it is done unofficially in Latvia since February 1994, also refers to fixed currency rate mode. But at that having limits of "currency corridor" fluctuations is possible to refer to intermediate mode of "controlled floating". Degree of "floating" characterizes the level of control of capital transactions of payment balance. Enhancement of "currency corridor" is a condition of gradual transit to floating rate.

With firm fixed exchange rate CB is obliged to conduct interventions in money market and possesses all necessary reserves of foreign currency for this purpose and it prevents regulation of money supply. Increase or reduction of money supply "goes away" via balance of payment not influencing properly the level of revenue. Therefore, monetary tools of economics regulation in terms of exchange rate are not efficient.

Floating exchange rate allows exchange rate of national currency together with net export value fluctuating automatically up to the point of attainment of equilibrium of balance of payment without interference of CB.

Vice versa – fiscal policy in small open economics is reduced to zero in terms of floating exchange rate and it is mostly efficient in terms of fixed one. It is explained by fluctuation of interest rate caused by changes of government spending, outflow (in terms of suppressing policy) and inflow of capitals (in terms of stimulating fiscal policy). National currency rate will freely fluctuate influencing the net export in the direction that is reverse to the desired dynamics. Currency rate will grow or fall due to the direction of economic policy up to the point of equilibrium of balance of payment until the inner rate will differ from the world one. As a result, the equilibrium will be set in the starting-point not giving the sought result.

Rather narrow currency corridor of fluctuation of LVL, ±1% from SDR increases a significance of fiscal policy.

Successes of fiscal policy in economics of Latvia is obvious: reduction of inflation in the period 1991-1994, reduction of budget deficit from 3,8% of national produce in the period 1993-1995 to 1,4% of national produce in 1996. Economic growth of 1997-1998 accompanying by firm fiscal policy led to budget profit in 1997 in amount 1,2% of national produce. Reduction of interest rate has stimulated the development of bank sector, accumulation of money means and development of composite demand. Since 1998 a dynamic revenue and tax proceeds growth has been observing.

Monetary policy of Central Bank of Latvia as well as fiscal policy has mutual strategic aims (achievement of inner and outer balance). At that, the accumulation of bank reserves, regulation of money supply, support of interest rates and national exchange rate stand as the nearest intermediate objectives. In long-term period the most important aim is the stability of prices, in medium-term period – supply of national currency rate stability that strengthens trust to financial system and limits inflation.

Outer stability of LVL is provided by the policy of capital free travel in terms of complete convertibility of currency. Inflow of foreign capital to Latvia in considerable degree determines the value of money supply.

Specifics of the fixed rate of lat (creation of currency corridor or "controlled floating") in considerable degree increases opportunities of Central Bank to define interest rate of national currency and implement independent monetary policy that is impossible in terms of the firm fixed currency rate.

Monetary policy tools of CB of Latvia are used in the frames of terms dictated by European CB. Central Bank of Latvia has opportunities to increase money supply with the help of: purchase of foreign currency; purchase of government securities in the secondary market, REPO auction, pawn credits etc.

Reduction of money supply is possible to be achieved with the help of the following tools: sale of foreign currency, sale of government securities in the secondary market, reduction of obligatory reserves, REVERSE REPO auctions etc. Joining of Latvia the European Monetary Union (EMU) puts new long-term tasks for the economic policy: limitation of inflation in the frames of deviations of 1,5 interest points from mean indices of three leading EU Member States, support of yield of government

[1] Exchange Rate Arrangements and Currency Convertibility Developments and Issues. World Economic and Financial Surveys, 1999.

debt, namely, for debentures during one year term, interest rates cannot exceed 2% deviation barrier from mean index of three leading European countries; budget deficit cannot exceed 3% of national produce and government debt – 60% of national produce. With introduction of VKM II (exchange rate mechanism) from 31.12.2004 currency corridor is enhanced to ±15% fluctuations in relation to euro. Lat must be bind to euro rate. During money implementation by VKM II lat will be replaced by euro by 2008. It is planned to reduce gradually norms of obligatory reserves to 2% due to requirements of ECB and necessity of the support of interest rates stable level.

Before Latvia joining the EMU the enhancement of currency corridor considerably increases the role of monetary policy and opportunities of influence on the national interest rate. After Latvia joining the EMU Central Bank of Latvia can implement its independent monetary policy because the EBC performs general management and the responsibility lies on national banks. Of course, policy of Latvia should not contradict general directives of the EU and objectives of stabilizing policy.

Role of economic forecasts in elaboration of economic policy is not reduced because economic policy of Latvia is possible to be classified as active policy of "firm course".

As applied to task of formation of economic policy the greatest interest is presented by methods of macroeconomic indices forecasting of all country. In the process of implementation of economic policy objectives changes take place not only in economic situation but also the economic thinking itself. Both these processes are interconnected, but at the same time they possess relative independency. Regulation practice shows that the performance of one objective is capable not only to break the performance of another objective, but also to make it impossible. Materially in this situation it is more reasonable to use method of constant and smooth wave manoeuvring. Along with, it should be mentioned that practice of government regulation in the developed states has elaborated standard group of indices, which in totality can materially express the resulting objective of regulation. Thus, never withstanding principal non-determination of economic processes, it is possible to assert that reasonable forecasts about future always are more valuable than unreasonable. Decision-making based on reasonable use of quantitative and qualitative forecasting aids gives the advantage in comparison with those who is trying to plan future without taking into account any additional information. Application of qualitative methods allows not only increasing reliability of forecasts, but also to reduce cost of forecasting.

Forecasting usually includes: making up a forecast of economic indices (variables) characterizing state and development of analysed system; imitation of various possible scenarios of system development; solution of classification task and comparison with known examples.

As initial preconditions for grounding of choice of forecasting method the following are selected: behaviour of typical agent in the effective market is formed on the basis of rational expectations models; presentation of macroeconomic process as stochastic to chaotic in relation to forecasting lead to equivalent results; boarders of macroeconomic model application adequately correspond to formulation of qualitative hypothesis including grounding of "global" and "local" model choice; initial information for formation and check of adequacy of macroeconomic model is presented by empirical evidence.

In general case choice of forecasting method depends on a large number of factors: aims, objectives and period of forecasting; necessary level of detailing, accuracy and cost of forecast; possessed volume and structure of initial data.

As applied to the task of planning of macroeconomic policy the mentioned factors and initial preconditions define distinctive peculiarities of macroeconomic model, area of its application and limitation. For the analysis of macroeconomic dynamics trajectory it is necessary to take into account the interaction of all (if possible) observed factors. At that the size and complexity of the model are growing non-linearly with increase of the quality of variables. In its turn, it leads to the necessity of the considerable increase of the quantity of observations (input data) for the supply of the established level of statistical value of a model. Number of statistical macroeconomic data is limited by minimum discontinuity of their formation (once per three months). Time interval of observations compiles approximately 10 years. Empiricism of macroeconomic models assumes the preferred use for forecasting of econometric methods.

The mostly spread econometric methods of forecasting are based on the application of regression analysis of economic data, which are influenced by various independent factors. Influence of these factors is modelled with the help of simultaneous equations systems. Complete econometric model of simultaneous equations includes the same numbers of equations as the number of

endogenous variables. Quality of econometric models requires a special carefulness in the process of their formation. First of all, it refers to data analysis, choice of dependent and independent variables, heteroskedastic problems decision, multi-collinearity and autocorrelation.

Other group of methods uses time series for the construction of forecasting models. Methods of decompositions, moving average and exponential smoothing as well of regressive models refer to them. Forecasts of dependent variables values for the given models usually demand preliminary forecasting of future values of independent variables and are foreseen for the description of stationary time series.

For non-stationary time series models of ARIMA integrated regressive moving average can be used. ARIMA models are based on autocorrelation data structure and do not demand preliminary forecasting of independent variables. Technology of the construction of the given models with the use of Box-Jenkins methodology does not assume the existence of any special structures in the given observations of the forecasted series. In this method the iterative approach to the definition of possible appropriate models from general class and their adjustment is used.

Forecasts of perspectives done on the basis of time series assume that the development of future events will be similar to the past ones, and the structure of the past events is defied adequate description. Area of time series application is limited by data forecasting with constant and stable structure of changes. Box-Jenkins methodology provides precise short time forecasting, however it demands quite a large number of input data and considerable time consumption for the formation of a model.

Thus, the process of the formation of forecast econometric model is not unidirectional, but present complex iteration procedure. Collection, analysis and reduction of data precede the step of model construction. Model accuracy and adequacy assessment is done usually by the forecasting of the past periods. In case of discrepancy to precision requirements the data analysis process and forecasting method choice repeats again until the proper results are obtained. After renewal of data the parameters of the used forecasting model are calculated again.

Besides mentioned circumstance the application of econometric methods of macroeconomic forecasting is limited by the following reasons: influence of incompleteness of input statistical data (existence of gaps) on forecast quality; complexity of the definition of necessary set of factors, indices and assessment of their value (multi-collinearity); assessment of unknown parameters in terms of no stationary of errors (heteroskedastics and autocorrelation of "residuals"), necessity of multiple "computational run-through") of a model with the aim of obtaining of mutual, consistent and identifiable model; dependency of model quality on personal concept of analyst about informal interpretation of the analysed connections.

To our mind the mostly efficient method of the given tasks solution could be implemented on the basis of artificial intelligence systems' application, namely, neuron networks.

Artificial neuron networks assume some repetition of processes of human brain. In neuron network simultaneously a great number of models are programmed, which cover a complete set of past interrelations between all variables. Neuron network using the given model tries to relate the existing interrelations. In theoretical aspect the advantage of the use of neuron networks as forecasting tools compiles in the fact that the interrelations between values should be related beforehand. For neuron networks the assumption about type of main distribution will not be needed and, unlike many traditional methods, neuron networks can operate with incomplete data. Neuron networks with two hidden layers can model non-linear dependencies on any complexity, and also allow solving "problem of dimension" in case of a large number of variables. Application of neuron networks is mostly efficient in the situations when it is required to find hidden stochastic dependencies between output and input data. Input data could be distorted by noise. Neuron networks do not require preliminary specification of a model, because learning algorithm automatically perceives data structure on the basis of the set examples. In other words, neuron network is used when the precise type of relations between input and output is unknown. This dependency is used in the process of network learning.

For neuron network learning algorithms of two types are used (various types of networks are used various types of learning): controlled ("learning with educator") and uncontrolled ("without educator"). The most known algorithm of controlled learning is a method of reverse distribution of error, when the existing data about errors is used for correction of network balance and threshold values in such a way that the forecast error in the learned multitude is minimized. If the network is learned well, it will gain the ability to model (unknown) function connecting values of input and output variables, and, later on such network is possible to be used for forecasting in the situation when output values are unknown.

The learning process of neuron network can have a number of negative consequences for forecasting model formation. Unlike the linear models where the procedure of error minimization allows finding the unique global minimum for non-linear neuron networks the error surface has rather more complex construction including several local minimums. Opportunity of getting into local minimum in the process of neuron network learning is a payment for its wider opportunities. Desire to minimize error by all means leads to another trouble – the so-called network over learning effect.

Over learned neuron network looses ability to generalize the result for new observations. In reality, the network is learned to minimize error only in learned multitude. Networks with great number of relations model more complex functions, and, therefore they are tended to over learning. Network with small number of balance can be insufficiently flexible to model having dependency. Almost always the more complex network gives smaller error, but it can be an evidence not of a good quality of a model, but about it's over learning. For control testing of learning results of a network part of observations should be reserved and excluded from the learning sample. Problems with local minimums and choice of network size lead to the necessity to make experiments with a large number of various networks training each of them several times and comparing the obtained results. Main index of result quality is a control error. Necessity of multiple experiments leads to the fact that control multitude starts playing key role in the choice of a model, that is, it becomes a part of learning process. By this, its role as independent criterion of model quality is weakened – with a large number of experiments there is a risk to choose "happy" network giving good result in control multitude. To give the final model a proper reliability, one more test multitude of observations is reserved. Final model is tested on data from this multitude to make sure that the achieved results in learning and controlling multitudes are real.

Neuron networks can operate with numerical data lying in a certain limited range. It creates problems in cases when data have non-standard scale, when there are omitted values or data is non-numerical. Necessity of data scaling limits opportunities of forecasting in case parameters are beyond the range. Number of observations necessary for network learning depends on the network size and it should be approximately ten times bigger than a number of relations in it. For especially complex tasks even larger number of observations could be required. If data for network learning is not sufficient then it is better to use some linear model.

Thus, the main problem of the application of standard algorithms of neuron networks for macroeconomic indices forecasting is a limited volume of the observed data and heterogeneousness of learning sample.

One of the possible ways of the mentioned problem solution the application of vector regression models in neuron network can become. In these models no tries to restore a real structure of economics are done and no distinctions between endogenous and exogenous variables are drawn. Each equation of a model describes dependency of one of variables from lag values of all other variables. The biggest problems when using VAR models are connected to complexities of lag definition and use of adequate assessment methods of model parameters. The neuron networks with radial basic functions are the mostly fit for the solution of a class of tasks.

In classification tasks it is required to find out to what set class the given input set belongs. More often classification tasks are two-digit, although there are tasks with several possible states.

Application of neuron network on the basis of self-organizing Kokhonen card allows building forecast models "without educator" that considerably simplifies procedures of grouping and putting in clusters.

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