Simulation System for Making Political and Macroeconomical Decisions and Its Development

A A Vnukov¹, A.E. Blinov¹

¹National research University Higher school of Economics, 20 Myasnitskaya ulitsa, Moscow 101000 Russia

Abstract. Object of this research are macroeconomic indicators, which are important to describe economic situation in a country. Purpose of this work is to identify these indicators and to analyze how the state can affect these figures with available instruments. Here was constructed a model where the targets can be calculated from raw data – tools in the field of economic policy. Software code that implements all relations among the indicators and allows to analyze with high accuracy, sufficiently successful economic policies and with the help of some tools, you can achieve better results. This model can be used to forecast macroeconomic scenarios. The corresponding values of the objective (outcome) variables are set as a consequence of the configuration data of the previous period, subject to external influences and depend on the instrumental variables. The results may be useful in economical predictions. The results were successfully checked on real scenarios of Russian, European and Chinese economics. Moreover, the results can be applied in the field of education. Program is available to use as “economical game” the educational process of the University, in which you can virtually implement various macroeconomic scenarios, draw conclusions about their success.

1. Introduction
What are the benefits of business games as tools for modeling and analysis of economic processes? It is possible to recreate the actual events in the framework of the model very accurately, while simulation modeling is highly appropriate to conduct in cases where real experiments are impossible, because of serious costs or impossibility of backsliding and repeating the process once more. Of course, one of cases is when decisions are made on macroeconomic level. Creating dynamic models incrementally and with the ability to analyze the changes due to each specific conversion, allow to find the causes of economic problems with high accuracy and to make preconditions for economic stability and prosperity.

As in the business economic game, you can simulate different conditions and scenarios without severe time and economic and political risks, that’s why such models are very useful for application and analysis. Good scientific tool for economical game helps to make simulation in realistic conditions. The traditional mathematical modelling is complemented by modern computer technologies, and also get wide economic experience and the external environment that allows the model to reproduce reality. Moreover, economic-mathematical models are useful for understanding the principles of governance, and can help students to improve their knowledge in this field and to make researches through a variety of scenarios themselves. [2] [3] [5]

2. Task
Accomplish a model of the general economic development of a country, using modern programming language. Describe possible scenarios of state economy’ transformation.
Analyze the model’ success with specific examples. To make changes to the original mathematical General economic model of the country to the current economic situation with the aim of the study scenarios. To ensure the possibility of changing the model, the initial conditions in the software.

3. Data
We will use existing macroeconomic model, which was implemented in the environment of "Transform" as an economic game. Unfortunately, the aforementioned software is not compatible with modern operating systems. The objective of this work is to write code to apply the model on modern computing machines. Furthermore, the goal of this work is to determine which indicators have the most important impact on changes in the economic situation, and secondly, to analyze how it is related to possible actions by the state. The theme of affecting macroeconomic stability and the methods of achieving it, is very crucial, because each state at different stages of development (e.g., industrial society, transition to a post-industrial, developing country) is facing a key issue of economic policy – how to regulate economic life or by basic solutions, such as nationalization of enterprises or decisions, expressed numerically – for example, the change in the key interest rate. In the best case, the state respects a middle ground between the commitment to a planned economy, that is the ideology of absolute control of economic processes and production by state structures and market economy, in which the current market conditions creates everything, without exception, macro - and microeconomic situations. [1] [4] [6]

The “Transform” module on Pascal Delphi contains 3 large opening Windows: monitor, decision-making, and graphs. In the monitor window contains a variety of group decision-making, carrying out different governance and modelling with the forecast. In the window of decision-making in the column on the left displays the restrictions and conditions in the form of upper and lower limits of recommended values for output constraints computed target variables and fields allowed values of the input conditions of instrumental variables. In the middle column for all variables visible, their short names, and at the bottom of their list is a window to the full variable pointed to by the cursor. In the right-hand group of columns displays the initial condition (year 0) and all the years of the modelling forecast, which introduced instrumental variables and the calculated target variable values. The chart window is organized as follows. In the left part of the window there is a tree with two branches to select a target and separately for choice of instrumental variables. The right most part of the window is used for graphical representation of the selected target or instrument variable.

These three Windows can be open and close their boundaries across the width of the corresponding window and display data and graphs can be dynamically changed by the movement of the cursor.

Figure 1. “Transform” module on Pascal Delphi.
When you run the software possible to select the operating language of data: English, German and Russian that allowed you to use the program in research and international education programs.

The “Transform” module for VBA after running visually reflected on the screen from left to right the following information. The left column contains the restrictions and conditions respectively for the target and instrumental variables. In the next column to the right contains the decoding variables in Russian full name of each variable. In the third column are the short names of all groups of variables and constants used in this version of the software. The remaining right part of the screen is gradually filled with speakers, which are the starting initial conditions (year 0) and successive years of decision making on simulation of the development of economic scenarios for the country (year 1, year 2, etc.).

In Figure 1 and 2 shows the modules of “Transform” module on Pascal Delphi and our module for VBA. Our model consists of more than 200 variables, which we will divide into several groups:

1. Target variables. These are the indicators based on which we draw conclusions about the financial and economic welfare of the country; the values of which for the successful development of the state should remain within certain limits. Target variables help evaluate the success of modeling.

2. The instrumental variables. These are variables that we can change. In fact, it is the input data for the formulas to calculate the target variables.

3. Intermediate variables. On the basis of their calculated target parameters, in fact, is intermediate between the instrumental and target values. Using intermediate variables the user can evaluate more precisely, what is the reason for the unsuccessful simulation results, where the errors.

4. Constants of development of the world market. Constants indicating the level of development of the world market. They are defined for the whole simulation period. They are used to calculate the target and instrumental parameters.

5. Constants used in various iterative algorithms for computing the intermediate and target variables. A number of variables that the user entering the instrumental variables cannot change this - constants involved in the calculation of intermediate variables and thus affect the objectives of the modelling forecast, which evaluate, for example, the elasticity, i.e. the effect of some factors on others.

![Figure 2. “Transform” module for VBA.](image_url)

![Figure 3. Modelling structure.](image_url)
Also shown in figure 3 variables, there are variables through which the external influence on the macroeconomic system, e.g. a change in interest rates in the markets provide external loans.

4. Model
It is possible to consider the General and simplified mathematical model. Both models are step-by-step models, in which for step N mathematical formulas and expressions tie the values of a set of target variables with values sets target, tool and intermediate variables of step N-1 step N. At each step can be performed any number of calculations to determine values of a specific set of targeted, instrumental variables and intermediate step N, then the selected values are captured and used for calculations in step N+1.

For the management and monitoring plans are used to target and instrumental variables, and intermediate variables only for calculations. The model has the ability to monitor individual processes within the planning target and instrument variables of these processes and to monitor processes on a joint action plan to achieve the strategic goals defined by the integrated target of the calculated and measured variables and parameters. On the value of the target and instrumental variables can be specified restrictions ("corridors" change of variables), the boundaries of which are either invalid or undesirable.

The system model management and monitoring to design and predict the operational and strategic development plans involves the use of linked systems of equations and mathematical relationships that describe a variety of macroeconomic processes.

To visualize the model applies a simplified computational scheme that contains the most important relationships between variables. It uses recursive relationships, functional chains, input and output variables related by mathematical formulae.

Variables are connected with each other with lots of formulas. For example, real Gross National Product is expressed with its previous value and with its raise. So real income does.

\[
\text{VNPReal}(n) = \text{VNPReal}(n-1) \times (1 + \text{VNPRaise})
\]
\[
\text{IncomeReal}(n) = \text{IncomeReal}(n-1) \times (1 + \text{IncomeRealRaise})
\]

The model includes not only the formula connecting the variables, constants and functions, but also the initial conditions of the simulation, various constraints and conditions for a targeted, instrumental, exogenous and intermediate variables, and constants. Our model can be modified to change the formulas, their number, terms and conditions, if necessary.

5. Real scenarios
For example, as for model, with interest rate raise, unemployment will also raise, Gini coefficient will also grow up, but rate of state social expenses should descend. We could see this situation in China, where government elevated interest rate during 2008-2011.

The following are the equations used for plotting. Here are some of them.

\[
\text{SOC.EXPEND}.1 := \text{SOC.EXPEND}.0 \times (1 + \text{SOC.EXPEND.G.1})
\]
\[
\text{SOC.EXPEND.Q.1} := \frac{\text{SOC.EXPEND}.1}{\text{GNP}.1}
\]
\[
\text{SECUR.EXPEND}.1 := \text{SECUR.EXPEND}.0 \times (1 + \text{SECUR.EXPEND.G.1})
\]
\[
\text{SECUR.EXPEND.Q.1} := \frac{\text{SECUR.EXPEND}.1}{\text{BUDG.EXPEND.TOT}.1}
\]

Below are the equations used for plotting. Here are some of them.

The three first and three second expression describing the growth rate of expenditures for social needs and security.

Variables SOC.EXPEND.0 and SECUR.EXPEND.0 are the monetary expression of the corresponding social spending and security in the previous period. Variables SOC.EXPEND.G.1 and SECUR.EXPEND.G.1 - the tools the nominal growth rate of social spending and security in the current period. Spending on social services represent expenditures for social sectors, except pensions to the elderly and the unemployed. Expenditure on internal and external security does not include the
payment of salaries of staff. Variables SOC.EXPEND.1 and SECUR.EXPEND.1 are the monetary expression of the corresponding social spending and security in the current period. They affect the target variables SOC.EXPEND.Q.1 and SECUR.EXPEND.Q.1, the corresponding relations of social spending and safety in the current period to the GDP (gross domestic product). Variables SOC.EXPEND/EXPEND.Q.1 and SECUR.EXPEND/EXPEND.Q.1 Express the ratio of expenditure on social services and safety in the current period to budget all expenses.

To build other charts used by a significant number of equations that calculates the corresponding target variables, and expressing: the GINI coefficients of the bundle.Q.1, the unemployment rate is UNEMPLOYED.1, all taxes TAX.TOT.FACT.Q.1, gross national product GNP.$.1, revenue officials OFFICER.INC.PC.1, the payments to the retired PENSIONER.INC.PC.1, the income of unemployed UNEMPL.INC.MIN.Q.1.

![Gini coeff, Social expenses rate (%), Unemployment (%)](image)

**Figure 4.** China example.

Other example is from French economics. New president E. Macron is going to increase security costs and to decrease level of taxes. Experts think that social expenses will not raise as fast as industrial ones. Moreover, unemployment will grow up. On the other hand, raise of real income and GNP is expected. We can see these changes from our model too in figures 5 and 6.

![Unemployment (%), Social expenses (%), Security expenses (%), Tax rate](image)

**Figure 5.** French example.

The model predicts the growth of real incomes and GDP. But the real growth may be less and in General will not happen, for example, due to changes in the external economic situation and of the restrictions or sanctions.
In Russia in April 2017 was already the second time this year the key interest rate was cut. Military expenses are growing currently. We will simulate this situation using our model:

As we can see from this table, GNP and welfare will start decreasing during the third year. As for Gini coefficient, property inequality will grow permanently.

| Table 1. Russian example. |
|----------------------------|
|                            |
| Percent rate (%)           | Year 1  | Year 2  | Year 3  |
| Gini                       | 25%     | 25,13%  | 28,53%  |
| Real GNP (% from 0-year)   | 100     | 102,09  | 99,61   |
| Real income (% from 0-year)| 100     | 103,08  | 99,97   |
| Social expenses (%)        | 11,5%   | 11,09%  | 9,92%   |
| Security expenses (%)      | 31%     | 32%     | 33%     |

6. Conclusion

In this work the model of the economic game Transform is realised. Written code implements all the relationships between indicators and allows to analyze with high accuracy successful economic policies. This model can be used for forecasting macroeconomic scenarios and in the process of learning mathematical disciplines, as it offers the opportunity to simulate the real economic scenarios and to compare them with each other.

7. References

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