Modeling of the impacts of monetary and fiscal policy in the Russian economy with GE-IO model of Russia with aggregated money and currency markets*

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Key words: inflation targeting, money supply, monetary policy, fiscal policy, general equilibrium, macroeconometrics, input-output model, economic forecast

0. Introduction

Gradual exhaustion of raw-export model of economic development in Russia (see, for example, (Baranov, 2013)) imposes new requirements to government economic policy as well as new demands on comprehensive study, estimation and scientific substantiation of new alternative models of the Russian economy's development, which could replace existing one, to the Economics. The extension of economic models constructed for the Russian economy and applied to estimate consequences of different scenarios of economic development is one of the important issues of scientific substantiation of an economic development model and relative priorities in economic policy. In this regard the issues of extension of dynamic input-output models which allow detailed simulating economic dynamics and branch structure acquire a special role. However most of soviet-time input-output models of the Russian economy have a well-known restriction for applying them to simulate market interrelations and finance flows between sectors and branches of national economy. The extension of dynamic input-output models to consider resource restrictions, mainly sectors' finance restrictions, is another issue for research.

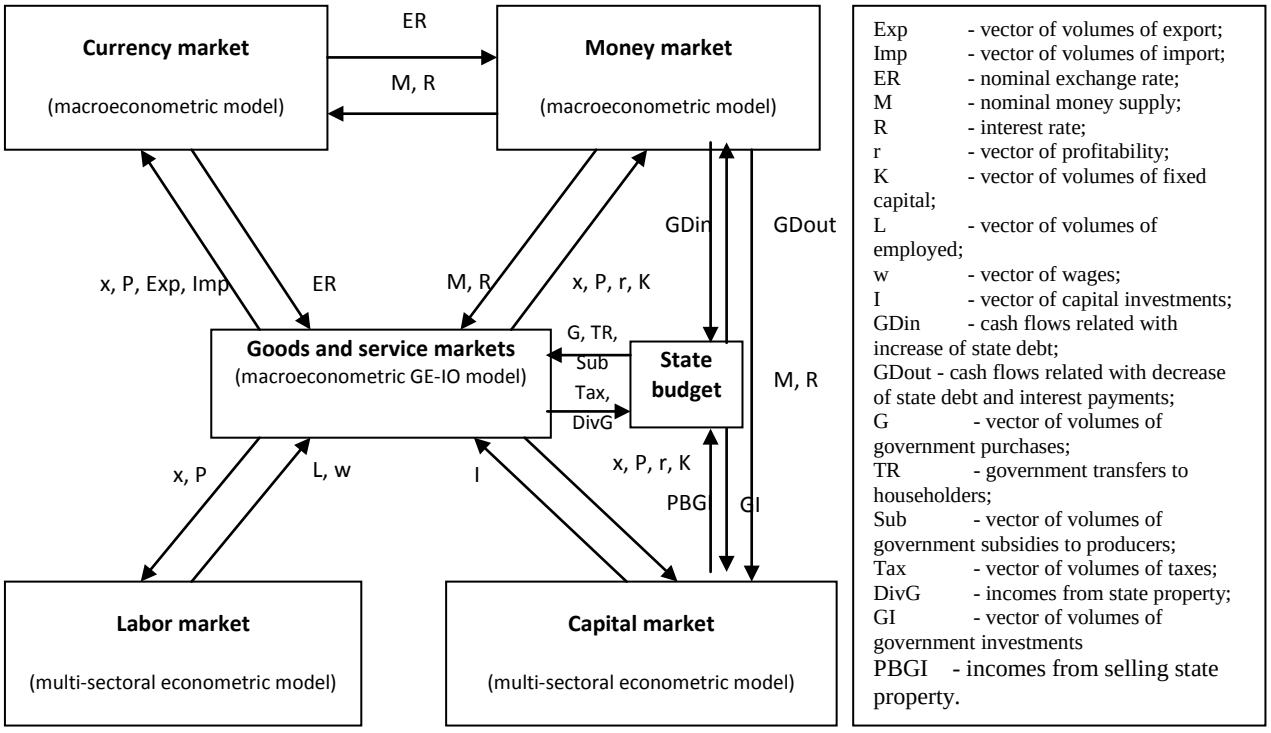
For this purposes, in this paper we present a concept of extension of macroeconometric general equilibrium input-output model of the Russian economy with aggregated money and currency markets[1]. The extension allows to consider macroeconomic and intersectoral relations influenced by monetary and fiscal shocks. Key equations, empirical estimations and applications of this model are also presented in the paper.

1. Macroeconometric GE-IO model of the Russian economy with aggregated markets

[1] A basic version of this model is described in (Gilmundinov, 2012).

A basic version of the macroeconometric general equilibrium input-output model of the Russian economy with aggregated money and currency markets is described in (Gilmundinov, 2012). The extension of the model is based on combining of macroeconometric input-output approach suggested by C. Almon (Almon, 1989), computable general equilibrium approach suggested by L. Johansen (Johansen, 1974) and neo-classic and neo-Keynesians macroeconomic models used to describe aggregated markets (see, for example, (Gali, 2008)).

Theoretical concept of the extension of the macroeconometric general equilibrium input-output model of the Russian economy with aggregated money and currency markets is shown on Scheme 1. The model includes IO equations for product markets with input-output coefficients to simulate inter-sectoral relations, as well as econometrically estimated equations for aggregated monetary and currency markets and sectors' output elasticities to simulate an inter-sectoral competition and links between aggregated markets.



Scheme 1. A Concept of macroeconometric GE-IO model with aggregated money and currency markets and shocks of monetary and fiscal policy

A core of the model is an macroeconometric GE-IO model with 28 sectors in the current version (see equations (1) below). The GE-IO model simulates volumes of total outputs for each sector of economy based on simulating of total demand (see equations (2) below) and production capacities (see equations (3) below). Total demand and capacity constraints are based on inward and backward links with macroeconometric models, which describes aggregated markets. (only money and currency markets in the current version). Links between GE-IO model and macroeconometric models of aggregated markets are based on the endogenization of some key variables of aggregated markets which have influence on sectoral outputs (interest rate, exchange rate, inflation rates). In the current version of the model we assume only three variables of aggregated markets linked with total demand (real exchange rate, real wage, and real interest rate).

$$x_{i,t} = \sum_{j=1}^{n} a_{i,j} \cdot x_{j,t} + y_{i,t} \qquad i = 1,\ldots,n \qquad (1)$$

$$Ln(x_{i,t} / x_{i,t-4}) = e_{x_i,ExR\$R} \cdot Ln(ExR\$R_{t-\tau_{x_i}^{ExR\$R}} / ExR\$R_{t-\tau_{x_i}^{ExR\$R}-4}) +$$
$$+ e_{x_i,WR} \cdot Ln(WR_{t-\tau_{x_i}^{WR}} / WR_{t-\tau_{x_i}^{WR}-4}) + e_{x_i,IRR} \cdot Ln(1 + IRR_{t-\tau_{x_i}^{IRR}}) + e_i^0 \qquad i = 1,\ldots,n$$

(2)

$$x_{i,t} \le Cap_{i,t} \qquad i = 1,\ldots,n$$

(3)

where

n – number of sectors (n = 28 in the current version);

$x_{i,t}$ – volume of total demand for product of sector i in quarter t in constant prices;

$y_{i,t}$ – volume of final demand for product of sector i in quarter t in constant prices;

$a_{i,j}$ – coefficients of direct expenditures of sector j for products of sector i, $i, j = 1,\ldots, n$;

$\tau_{x_i}^{ExR\$R}$, $\tau_{x_i}^{WR}$, $\tau_{x_i}^{IRR}$ – time lags in influence of changing in real exchange rate, real wage, and real interest rate on total demand for product of sector i estimated by constructing regression equations;

$ExR\$R_{t-\tau_{x_i}^{ExR\$R}}$ – real exchange rate of the Russian ruble to US dollar in quarter $t - \tau_{x_i}^{ExR\$R}$;

$WR_{t-\tau_{x_i}^{WR}}$ – real wage in quarter $t - \tau_{x_i}^{WR}$;

$IRR_{t-\tau_{x_i}^{IRR}}$ – average annual real interest rate (deflated with deflator of GDP) for credits for non-financial sector in quarter $t - \tau_{x_i}^{IRR}$;

$e_{x_i,ExR\$R}$, $e_{x_i,WR}$, $e_{x_i,IRR}$ – elasticity coefficients of total demand for product of sector i to real exchange rate, real wage, and real interest rate, accordingly, estimated by constructing regression equations (see Table 1);

e_i^0 – a constant term of regression equation for total demand for product of sector i;

$Cap_{i,t}$ – production capacities for total output of sector i in quarter t estimated by constructing of production function.

As it follows from equations above the current version of the model is mainly demand-side. More updates for production capacity constraints and other supply-side equations will be presented at the next conferences.

Notwithstanding this equilibrium variables of aggregated markets in equations (2) make the model GE type by harmonizing equilibriums of different aggregated markets.

Table 1

Elasticity coefficients of total demand for product of sector i to real exchange rate, real wage, and real interest rate for main sectors of the Russian Economy
(in parentheses time lags are specified, in quarters)

	Real exchange rate (Rub in USD)	Real wage	Real interest rate	R^2
Agriculture	-0,06 (1)		-0,19 (3)	0,20
Coal	0,95 (0)	-0,58 (0)	1,16 (0)	0,63
Oil		0,26 (0)	0,30 (0)	0,17
Natural Gas	-0,44 (4)	0,53 (0)	-0,28 (0)	0,78
Other minerals	-0,25 (4)		-0,54 (0)	0,30
Food, beverages, etc.	-0,10 (4)	0,41 (0)		0,63
Clothes	-0,30 (4)	0,51 (0)	-0,26 (0)	0,65
Pulp industry	-0,31 (4)	-0,07 (0)	-0,58 (0)	0,83
Oil refinery			-0,20 (0)	0,25
Chemistry industry	-0,39 (4)	-0,06 (2)	-0,60 (0)	0,61
Construction materials	-0,30 (4)	1,20 (0)	-0,67 (0)	0,79
Ferrous metallurgy	-1,10 (3)	0,36 (0)	-0,96 (3)	0,81
Non-ferrous metallurgy	-0,27 (4)	0,46 (0)	-0,47 (0)	0,68
Metal products	-0,45 (4)	0,46 (0)	-0,50 (0)	0,65
Machinery	-0,57 (4)	0,79 (0)	-1,43 (0)	0,62
Other industrial products	-0,11 (4)		-0,56 (0)	0,71
Energy	-0,13 (4)		-0,34 (0)	0,49
Water supply	-0,13 (4)		-0,34 (0)	0,49
Construction	0,15 (4)	0,75 (0)	-0,75 (0)	0,61
Trade	0,06 (3)	0,67 (0)	-0,43 (0)	0,92
Transport		0,41 (0)	-0,40 (1)	0,53
Communication		0,41 (0)	-0,40 (1)	0,53
Finance and Insurance	-0,27 (2)	1,28 (0)	-1,08 (2)	0,86
Real Estate and Consulting	-0,30 (1)	1,02 (0)	-0,79 (1)	0,62
R&D	0,08 (4)	0,47 (0)	-0,20 (0)	0,76
Education		0,14 (0)		0,59
Health, Culture, etc.		0,08 (0)		0,41
Utilities	0,06 (4)	0,30 (0)	-0,33 (0)	0,78

Empty fields means absence of statistically significant estimations (level of significance is 10% or more)
Sources: Author's estimations based on official statistics for the Russian economy in 2003-2010

To get estimations of the model parameters we've estimated a technological matrix $\{a_{i,j}\}_{i,j = 1,\ldots, n}$ for year 2010 and elasticity matrix $\{e_{i,k}\}_{i = 1,\ldots, n; k \in \{0;\ ExR\$R;\ WR;\ IRR\}}$ by constructing multiple regressions using quarterly statistics of Russia in 2003-2010 (see Table 1). The period 2003-2010 was chosen for estimation because of two reasons. Firstly the Russian economy's

development met in 2003-2010 in the main with demand constraints what has good correspondence with demand-side type of the model. In the second place, the Russian national accounts had been transited for a new classification of economic sectors from 2003, as a result sectoral data before 2003 are not comparable with data after 2003.

Estimations given in Table 3 could be interpreted as estimations of competitiveness of sectors to deterioration of conditions on corresponding aggregated market. It allows us to use the theory of inter-sector competition to interpret the results of calculations in the model and to explain changes in the structure of the Russian economy.

To construct model for aggregated money market we use well-known Baumol-Tobin model to simulate money demand and new-keynesian concept of inflation based on adaptive learning. In a model of inflation we assume that inflation expectation include non-monetary factors. Based on quarterly statistics for 2003-2010 we've estimated two following regressions:

$$\begin{aligned}\mathrm{Ln}((1+IRN_t)/(1+IRN_{t-4})) &= -0{,}02+0{,}16*\mathrm{Ln}(P_{t-4}/P_{t-8}) - \\ &- 0{,}08*\mathrm{Ln}(\,(M_t/P_t)\,/\,(M_{t-4}/P_{t-4})\,) + 0{,}16*\mathrm{Ln}(X_{t-5}/X_{t-9}) \quad (R^2 = 80{,}2\%)\end{aligned} \tag{4}$$

$$\begin{aligned}\mathrm{Ln}(P_t/P_{t-4}) &= 0{,}146*\mathrm{Ln}(M_t/M_{t-4}) + 0{,}979*\mathrm{Ln}(P_{t-1}/P_{t-5}) - \\ &- 0{,}321*\mathrm{Ln}(P_{t-2}/P_{t-6}) \qquad (R^2 = 67{,}1\%)\end{aligned} \tag{5}$$

where

IRN_t – average annual interest rate for 1year or less credits for non-financial sector in quarter *t*;

P_t – GO deflator index in quarter *t*;

M_t – money supply (M2) in quarter *t*;

X_t – real GO in quarter *t*.

The model for money market allows to endogenize interest rate and inflation rate, and as a result endogenize links between aggregated money market and product market. Money supply is the only exogenous variable in this case.

A model of currency market is based on estimation of currency inflows and outflows in the Russian Balance of payments and allows to simulate dynamic of exchange rate of the Russian ruble to USD. Based on quarterly statistics for 2003-2010 we've estimated following regression:

$$\begin{aligned}\mathrm{Ln}(ExR\$N_t/ExR\$N_{t-4}) &= -0{,}04+1{,}20*\mathrm{Ln}(1+dPrivateReserves_t/CurrenceInflows_t) - \\ &- 0{,}49*\mathrm{Ln}(1+dCurrenceInflows_t/CurrenceInflows_t) \quad (R^2 = 79{,}5\%)\end{aligned} \tag{6}$$

where

$ExR\$N_t$ – average exchange rate of the Russian ruble to USD in quarter *t*;

$dPrivateReserves_t/CurrenceInflows_t$ – ratio of change in net foreign currency reserves of private sector to total foreign currency inflows in the Russian economy in quarter *t*;

$dCurrenceInflows_t/CurrenceInflows_t$ – ratio of net foreign currency inflows in the Russian economy to total foreign currency inflows in the Russian economy in quarter *t*.

To make exchange rate endogenous regression for import of goods and services (7) and normative model for export of goods and services (8) are constructed:

$$\mathrm{Ln}(1+Im_t/P_t*X_t) = 0{,}125 + 0{,}025*\mathrm{Ln}(ExRR_t/ExRR_{t-4}) \ (PV = 99{,}7\%) \tag{7}$$

$$Ex_t = ExNonO\&G_t + OilPrice_t*ExpOilVol_t/dOil_t \tag{8}$$

where

$ExRR_t$ – real exchange rate of Russian ruble to USD.
Im_t – volume of import of goods and services in rubles in quarter *t*;
Ex_t – volume of export of goods and services in rubles in quarter *t*;
$ExNonO\&G_t$ – volume of non oil&gas export of goods and services in rubles in quarter *t*;
$OilPrice_t$ – average actual export price of the Russian oil in USD per barrel in quarter *t*;
$ExpOilVol_t$ – volume of oil export in barrels in quarter *t*;
$dOil_t$ – average share of oil export in total oil&gas export in quarter *t*.

Flows of capital and financial instruments accounts of Balance of payments and non oil&gas export of goods and services are exogenous. For purpose of macroeconomic forecasting this flows are defined exogenously according to considered scenarios of economic development and macroeconomic policy, retrospectives and expert estimations.

The regressions above have a good correspondence with theoretical framework as well as statistical tests shows a good significant level for main statistical hypotheses.

2. Scenarios of forecast of the Russian economy development in 2013-2015 with different scenarios of monetary policy

The macroeconometric GE-IO model of the Russian economy with aggregated money and currency markets presented above allows to estimate influence of changing in monetary policy on the dynamics and structure of the Russian economy. Transition of the Russian Central Bank to the inflation targeting to suppress inflation rate to 4% in 2015 in conditions of slowdown in economic growth makes this issue to be very relevant. For example, according to our estimates 1 percentage growth of real interest rates has as a result 0.39% decreasing of GDP growth rates and 1.05% decreasing of Investments in fixed capital growth rates.

2010 is a basis year for our calculations. Calculation for the period 2011-2012 is the simulating the Russian economy with actual values of all parameters of the model except total output growth rates. 2013–2015 is a forecasting period. To ensure comparability of the results of calculations for different scenarios of monetary policy we construct base variant of forecast for 2013-2015. The key assumptions for base variant of forecast for 2013-2015 are as follows.

1. Annual growth rate of actual export prices of the Russian oil is 2%.
2. Annual growth rate of real wages in 2013 is 5.5%, in 2014-2015 – 5.0%.
3. Annual growth rate of GDP deflator of USA is 1.5%.
4. Annual growth rate of volume of non oil&gas export is 5.1% in USD.
5. Share of crude oil in total oil&gas export is 52.2%.
6. Annual growth rate of oil&gas extraction is 1.0%.
7. Net outflows of capital from Russia will increase from 72.4 bln USD in 2013 upto 79.8 bln USD in 2015.
8. Simulating of inflation rates is based only on assuming of monetary factors and adaptive learning. A role of non-monetary measures of suppressing inflation is out consideration.

The base variant of forecast do not take into consideration impact of anti-Russia sanctions and Ukraine's crisis on the Russian Economy.

Three scenarios of the Russian Economy development in 2013-2015 are considered to estimate an impact of the squeezing of money supply. In the first scenario "Inflation targeting" it is suggested that annual inflation rates will be suppressed to 4.0% in 2015. The second scenario "Neutral policy" assumes that Central bank of Russia would not intrude in money market to

decrease inflation. The third scenario "Monetary easing" implies high growth rates of money supply to stimulate the Russian economy. All three scenarios are suggested similar dynamics of oil prices and real wages to carry "ceteris paribus" comparative analysis. The first two scenarios suggest endogeneity of money supply, which depends from the Russian Central bank's inflation targets, inflation rates are exogenous. The third scenario suggests endogeneity of inflation rates and exogeneity of money supply.

3. Results of calculation: influence of monetary shocks on the Russian economy in 2013-2015

The results of calculation are presented in the Table 2. Data given in the Table 2 show that gradual transition to inflation targeting in Russia in 2011-2012 had led to significant growth in real interest rates from -4.4% in 2011 to 2.5% in 2012 and 4.5% in 2013.

To achieve 4.0% inflation rate in 2015 Central bank of Russia should decrease change rate of money supply from 11.9% in 2012 to only 0.9% in 2015. As a result there would be a sharp decrease in real GDP growth rates from 3.4% in 2012 to 1.0% in 2015. Fixed capital producers and capital investments get the most negative impact from the inflation targeting. Average annual change rate of capital investments would be -3.1% in this scenario. The main reason of this is significant growth in real interest rates from 2.5% in 2012 to 5.6% in 2015. According to the results of calculations the inflation targeting policy leads to significant fall in growth rates of the Russian GDP in 2013-2015 approximately 1.3% in comparison to "Neutral policy" scenario. It causes raising real GDP losses from 0.9% in 2013 to 4.0% in 2015 in relation to "Neutral policy" scenario (see Fig. 1). Total real GDP losses in 2013-2015 are equal to 7.2% of GDP in 2012.

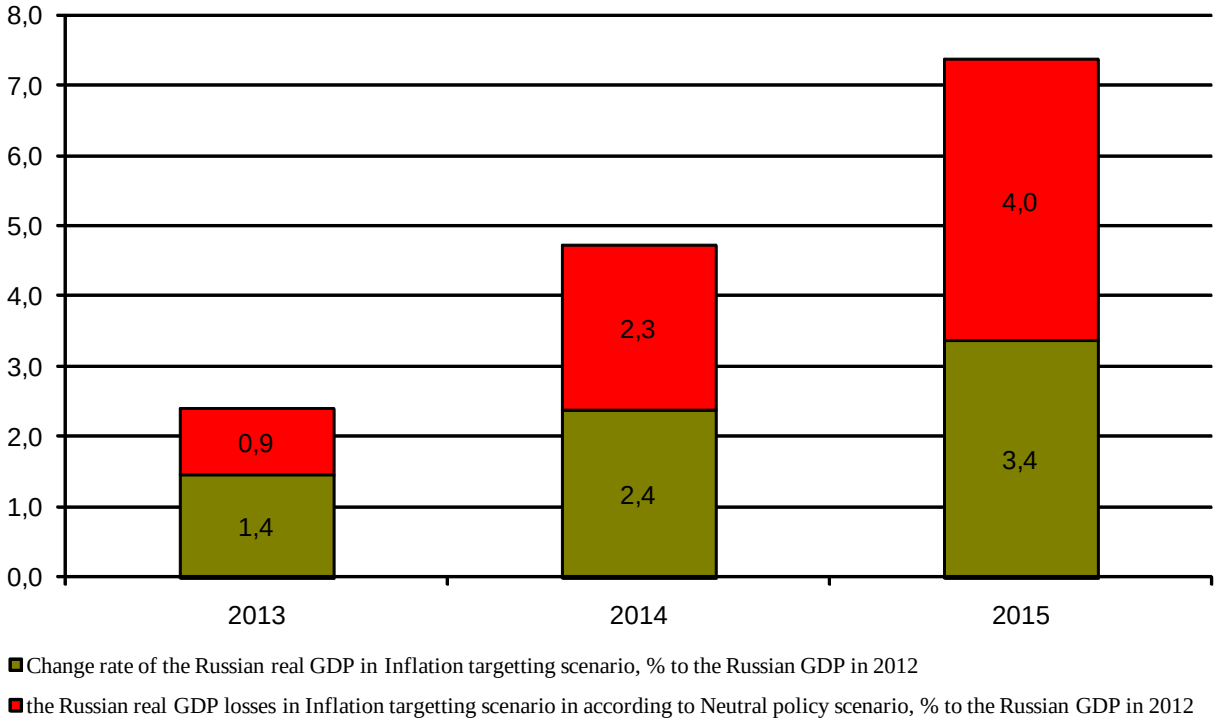


Figure 1. Estimation of GDP losses from the inflation targeting in Russia in 2013-2015
Sources: results of calculations

Table 2

Dynamics of some key macroeconomic indicators of the Russian economy in 2010-2015

	Actual data			Forecast								
				1st scenario "Inflation targeting"			2nd scenario "Neutral policy"			3rd scenario "Monetary easing"		
	2010	2011	2012	2013	2014	2015	2013	2014	2015	2013	2014	2015
Average export price of the Russian oil, USD per barrel	74,1	101,7	103,1	99,6	101,6	103,7	99,6	101,6	103,7	99,6	101,6	103,7
Money supply change rate, %	31,1	22,3	11,9	14,6	10,0	6,8	20,7	20,1	20,0	30,0	30,0	30,0
GDP change rate, %	4,5	4,3	3,4	1,4	0,9	1,0	2,4	2,3	2,5	3,2	3,8	4,4
Capital investments change rate, %	6,3	10,8	6,6	-2,2	-3,7	-3,6	0,4	-0,2	0,5	2,6	3,8	5,1
Average nominal exchange rate, Russian rubles per USD	30,4	29,4	31,1	31,8	32,5	33,3	32,0	33,2	34,8	32,4	34,4	37,4
GDP deflator change rate, %	14,2	15,9	7,5	6,4	5,6	4,0	7,2	9,1	9,0	8,3	13,6	13,8
Average annual nominal interest rate, %	13,4	10,4	11,2	11,4	11,3	9,8	9,6	11,3	10,9	8,4	11,6	10,4
Average annual real interest rate, %	-0,4	-4,4	2,5	4,5	5,4	5,6	2,2	2,0	1,7	0,1	-1,8	-2,8

Sources: 2010-2012 – Rosstat, Central bank of Russia; 2013-2015 – results of calculation in GE-IO model of the Russian economy with aggregated money and currency markets

The results of calculations allow us to conclude that the inflation targeting policy would be suitable for the Russian economy only in condition of high investing activity. But in the current conditions in the Russian economy characterized by an extremely low investment activity and technological backwardness it would be cause too large GDP losses and decline in capital investments.

Thus, the obtained results substantiate the inconsistency of the existing model of macroeconomic policy in Russia with monetary-oriented suppression of inflation and structural policy aimed at modernizing and stimulating innovation.

According to the results of our calculations macroeconomic policy's shocks have significant impact on development and structure of the Russian economy in current conditions. The most significant impact is related to monetary shocks. For example, the easing of a monetary policy by the increasing of annual growth rates of money supply from 20% to 30% lead to increase annual growth rates of the Russian economy in short-term period from 2.3-2.5% to 3.2-4.4% relatively.

The estimates of impact of fiscal policy received by simulation in the present version of GE-IO model show restricted influence of its indiscriminate measures. In the same time specific measures of fiscal policy applied for certain sectors have a significant influence on dynamics of some processing industries and constructing. However the present version of the model has some restriction for apply to detailed consideration dynamic aspects of influence of macroeconomic policy on branch outputs. We plan to solve this in our further studies.

4. Some estimates of influence of fiscal shocks on the Russian economy

The current version of the model used for estimation of the influence of monetary shocks in this study has not developed enough to get full insight on the consequences of fiscal shocks for the Russian economy. For this purpose it needs development and incorporating of the multisectoral model of state budget, reproduction of fixed capital, etc into the general model according to scheme 1, that has been planned at the next stages of the study.

Nevertheless we can use this model to get some preliminary estimates of direct short-term effects of changing in the Russian fiscal policy. More updates will be presented in our following papers.

Two following fiscal instruments are under our consideration in this paper: subsidizing interest rates of bank loans and growth of government purchasing of goods and services.

Subsidizing interest rates of bank loans

To get estimation of effects of subsidizing interest rates of bank loans we simulate Scenario "Inflation targeting" for 2013 with decreasing calculated annual nominal interest rate at 1 percentage point. As a result of simulation growth rate of GDP in constant prices in 2013 rises from 1.45% to 1.85% in this Scenario, that is equal additional growth of GDP at 260.8 bln rubles in current prices. We also can estimate about 67.8 bln rubles of additional budget income in 2013 due to growth of fiscal base and accelerating of the Economy as a result of the subsidizing[2]. To estimate additional expenditures of the state budget for this policy we use statistics of the Central Bank of Russia. According official data total volume of loans to organizations and householders by the Russian bank system is 45'003 bln rubles in 2013. It allows to get a rude estimation of state expenditures for subsidizing at the level of 450 bln rubles. So even we take into account only bank loans to organizations and householders approved by the Russian bank system the pressure on the state budget in this policy would grow at least at 193.0 bln rubles but seems to be

[2] Additional budget income is calculated by multiplying of a ratio budget income to GO in 2013 (20.8%) and additional growth of GO due to subsidizing (+325.2 bln rubles).

much more. Considering loans from abroad and issued bonds in 2013 we have to conclude that the policy of subsidizing of should be applied very selective and aimed only at investment activity. The additional investigations are required to get appropriate estimations.

Growth of government purchasing of goods and services

To estimate impact of growth of government spending of goods and services to dynamic of the Russian real GDP we use official data for components of GDP by expenditure in 2000-2012. Correcting estimation of the Russian GDP on changes in inventories and statistic errors we obtain the following results as shown in Figures 2 and 3.

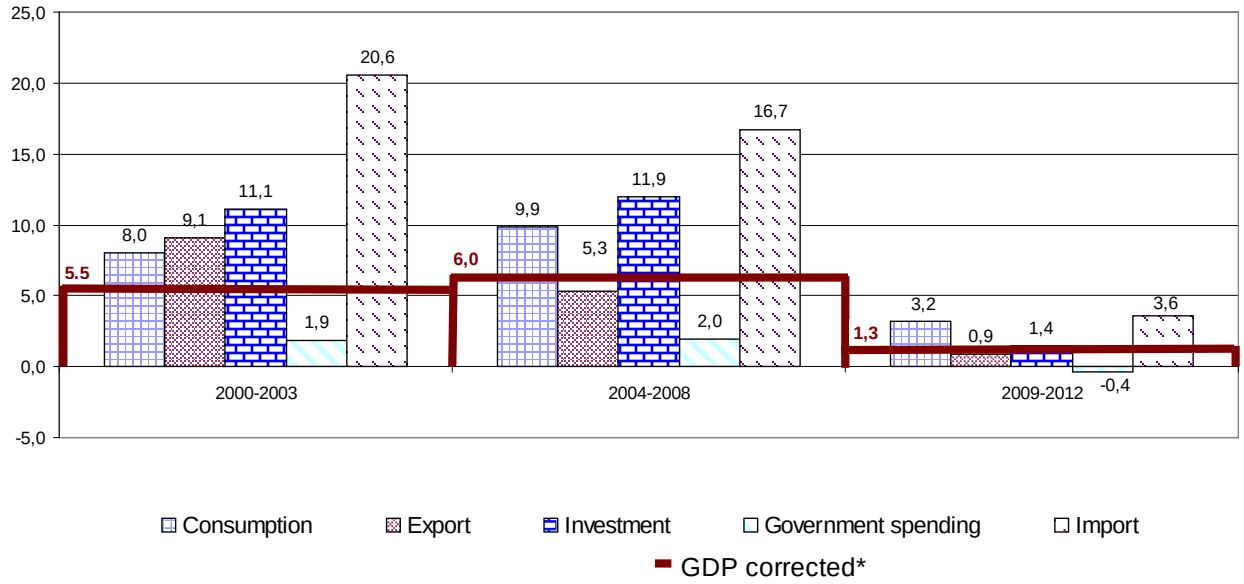


Figure 2. Average annual change rates of the Russian GDP (corrected) and its components, in percent

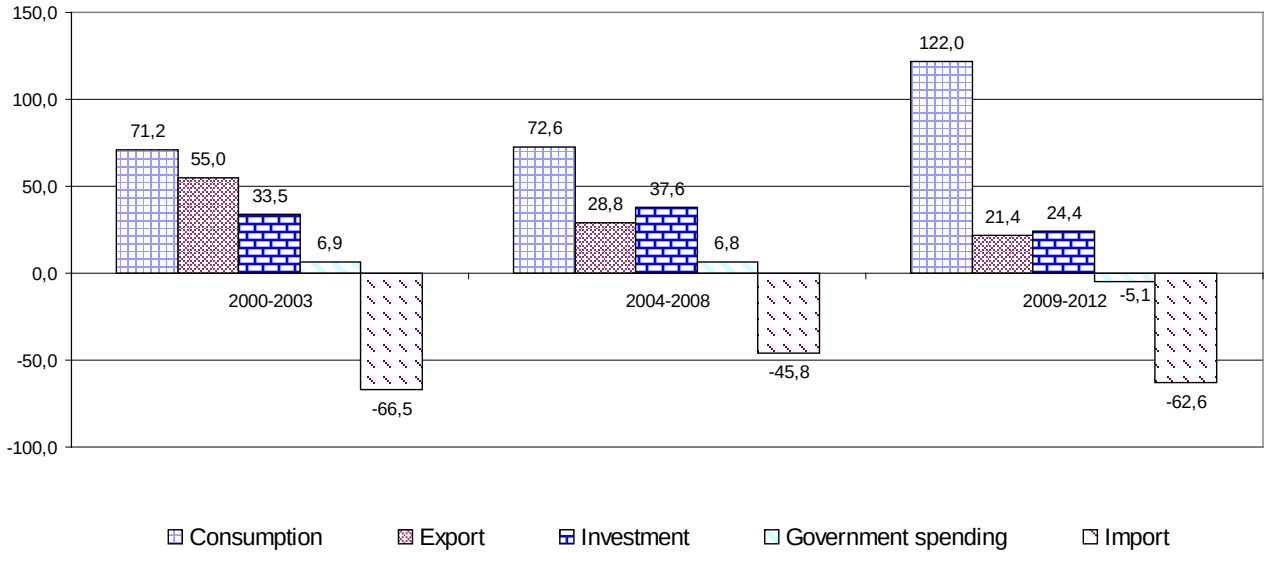


Figure 3. Contribution of the components of GDP to average annual change rates of the Russian real GDP (corrected), as a share, in percent

The assessment of effect of growth of government purchasing of goods and services is based on the concept of full costs in the Leontief model (see Table 3).

Table 3

*Estimations of full cost coefficients for main sectors of the Russian economy in constant prices of 2*010

	Full costs	Approximate direct budget income effect to 1 ruble of expenditures*
Agriculture	2,041	0,425
Coal	2,165	0,451
Oil	1,387	0,289
Natural Gas	1,554	0,324
Other minerals	2,033	0,424
Food, beverages, etc.	2,605	0,543
Clothes	2,778	0,579
Pulp industry	2,426	0,505
Oil refinery	1,859	0,387
Chemistry industry	2,752	0,573
Construction materials	2,331	0,486
Ferrous metallurgy	2,511	0,523
Non-ferrous metallurgy	2,304	0,480
Metal products	2,820	0,588
Machinery	2,597	0,541
Other industrial products	2,636	0,549
Energy	1,899	0,396
Water supply	1,939	0,404
Construction	2,290	0,477
Trade	1,731	0,361
Transport	1,911	0,398
Communication	2,623	0,546
Finance and Insurance	1,612	0,336
Real Estate and Consulting	2,303	0,480
R&D	2,061	0,429
Education	1,544	0,322
Health, Culture, etc.	1,592	0,332
Utilities	1,810	0,377

* Estimations are based on the ratio of budget income to GO of Russia in 2013 and needs to refine with detailed multisectoral model of state budget. More updates will be presented during the 22nd World INFORUM Conference.

5. Aggregated macroeconometric GE model

To assess macroeconomic effects influenced by monetary and fiscal policy in 2003-2013 we refine our estimates for change rate of GDP's deflator in quarter *t* to the same quarter of the previous year (π_t, in percent), annual nominal interest rates (R_t, in percent), and construct an equation for the real GDP change rates (y_t, in quarter *t* to the same quarter of the previous year, in percent):

$$\hat{\pi}_t = -0{,}016 + 0{,}765 \cdot \pi_{t-1} + 0{,}118 \cdot m_t + 0{,}608 \cdot (y_t - y_{t-1}), R^2 = 0{,}79$$

$$\hat{R}_t = -0{,}576 + 0{,}773 \cdot R_{t-1} + 0{,}077 \cdot \pi_{t-1} - 0{,}038 \cdot m_t + 0{,}139 \cdot y_{t-3}, R^2 = 0{,}94$$

$$\hat{y}_t = -0{,}344 - 0{,}064 \cdot rER_{t-4} + 0{,}499 \cdot rW_t - 0{,}384 \cdot (R_t - \pi_t) + 0{,}516 \cdot e_{t-1}, R^2 = 0{,}94$$

where

m_t – change rate of money supply M2 in quarter t to the same quarter of the previous year, in percent;

rER_t – change rate of real exchange rate of the Russian ruble to USD in quarter t to the same quarter of the previous year, in percent;

rW_t – change rate of real wages in quarter t to the same quarter of the previous year, in percent;

e_t – deviation of actual change rate of real GDP in quarter t to the same quarter of the previous year from calculated.

These three equations form the aggregated macroeconometric GE model of the Russian economy, which based on the same assumptions as the GE-IO model described before. The aggregated model allows to estimate contribution of fiscal and monetary shocks to dynamics of real GDP of the Russian Federation in 2003-2013 (see Figures 4 and 5, respectively, and Figure 6 for combined effects).

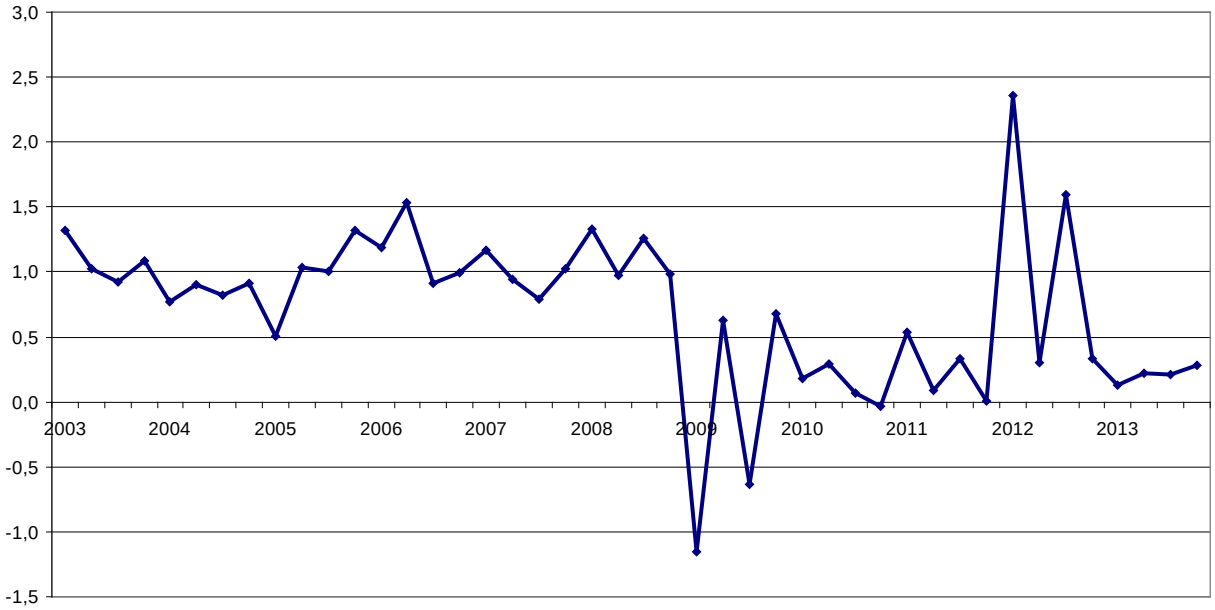


Figure 4. Contribution of fiscal shocks* to change rates of real GDP of the Russian Federation in 2003-2013, in percent to the same quarter of the previous year

* related only with changes in real wages in state sector and government spending

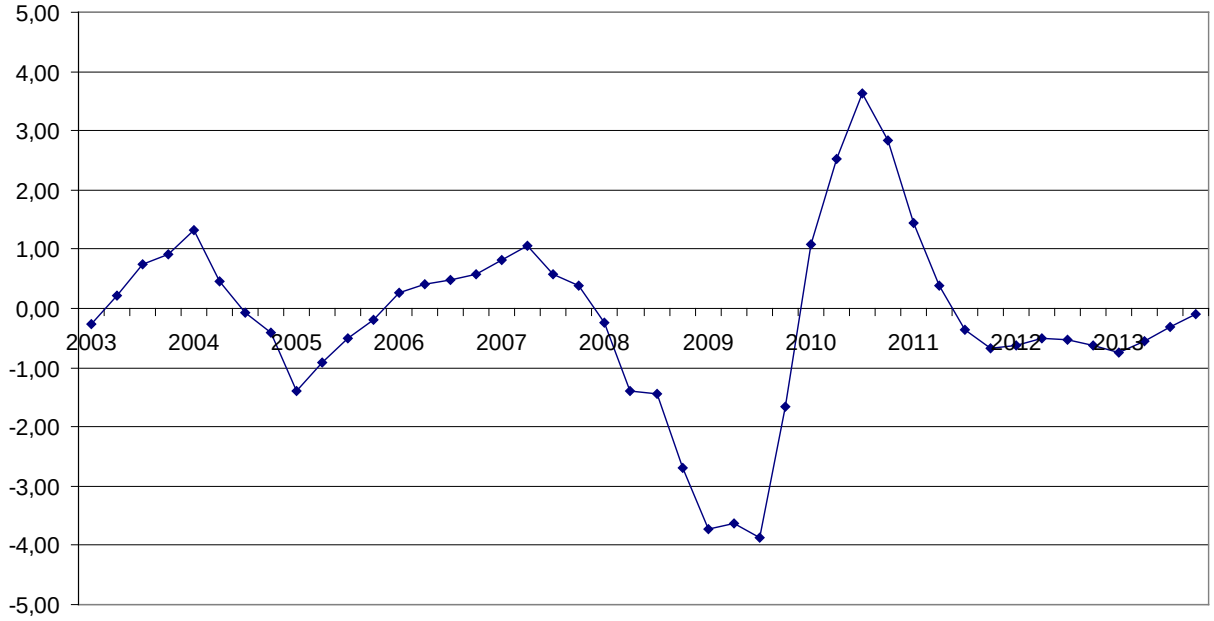


Figure 5. Contribution of monetary shocks* to change rates of real GDP of the Russian Federation in 2003-2013, in percent to the same quarter of the previous year
* as changes in money supply M2 annual growth rates

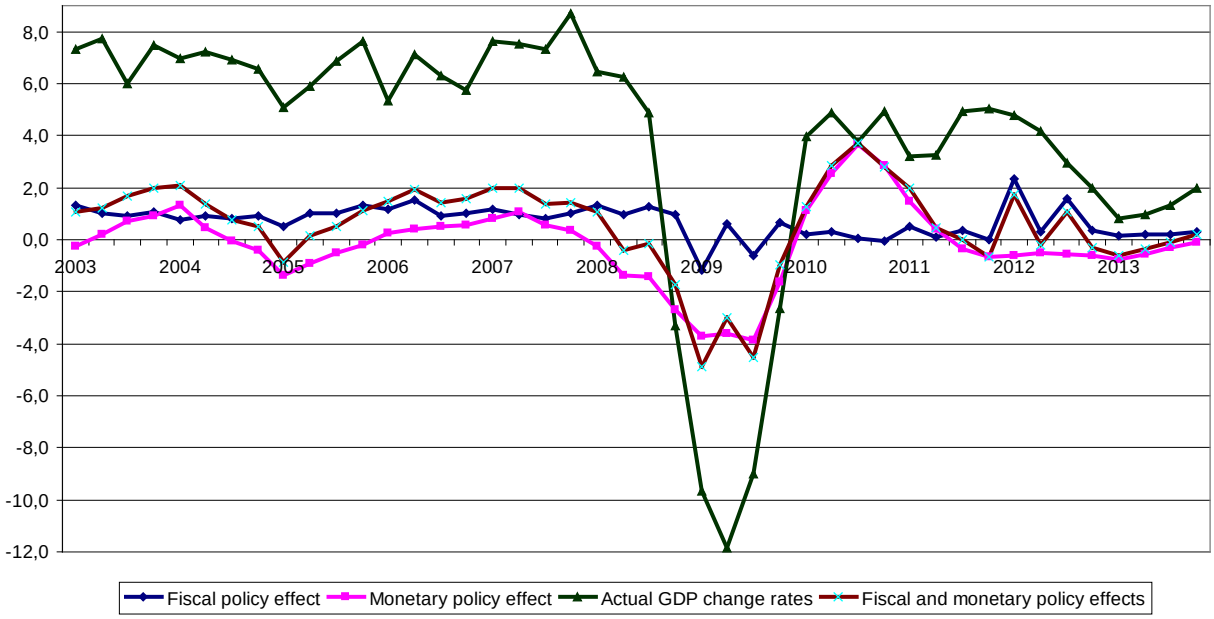


Figure 6. Contribution of fiscal and monetary shocks to change rates of real GDP and dynamics of real GDP of the Russian Federation in 2003-2013, in percent to the same quarter of the previous year

6. Conclusion

The above applications of the macroeconometric general equilibrium input-output model of the Russian economy with aggregated money and currency markets and its aggregated version for estimation of effects of macroeconomic policy show high relevance and usefulness. Considering of situation at aggregated markets and macroeconomic shocks in the model allows

to simulate different scenarios of macroeconomic policy and obtain estimations for policy making. But the presented version of the model is very simple and requires more extension, especially in incorporating of the multisectoral model of state budget and model of reproduction of fixed capital into the general model according to scheme 1.

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