

# 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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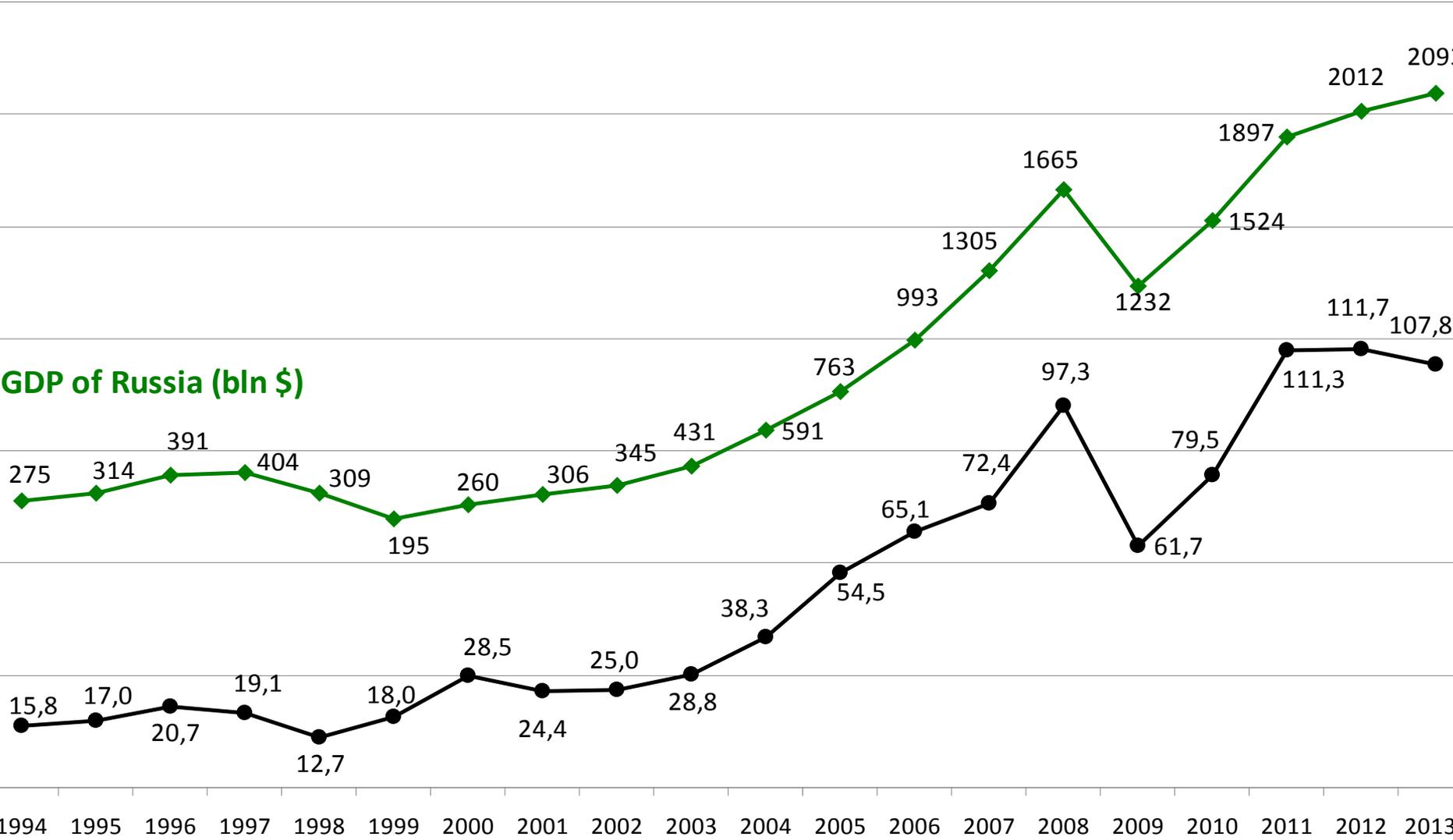
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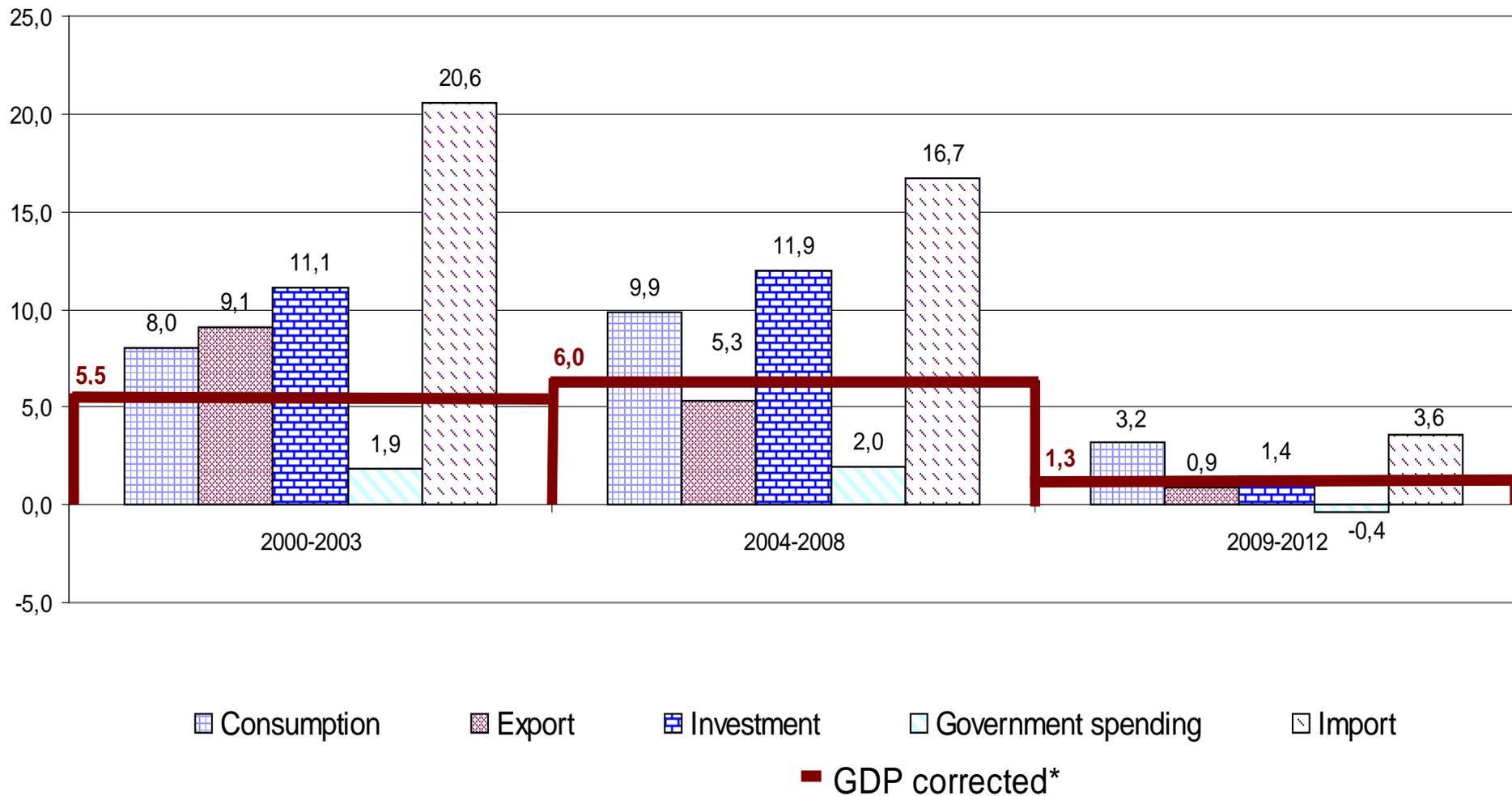
# Main issues under consideration in this presentation

1. How macroeconomic policy effects on the GDP of Russia?
2. What are macroeconomic consequences of transition monetary policy to Inflation Targeting for the Russian Economy?

# Correlation between GDP of Russia and oil price

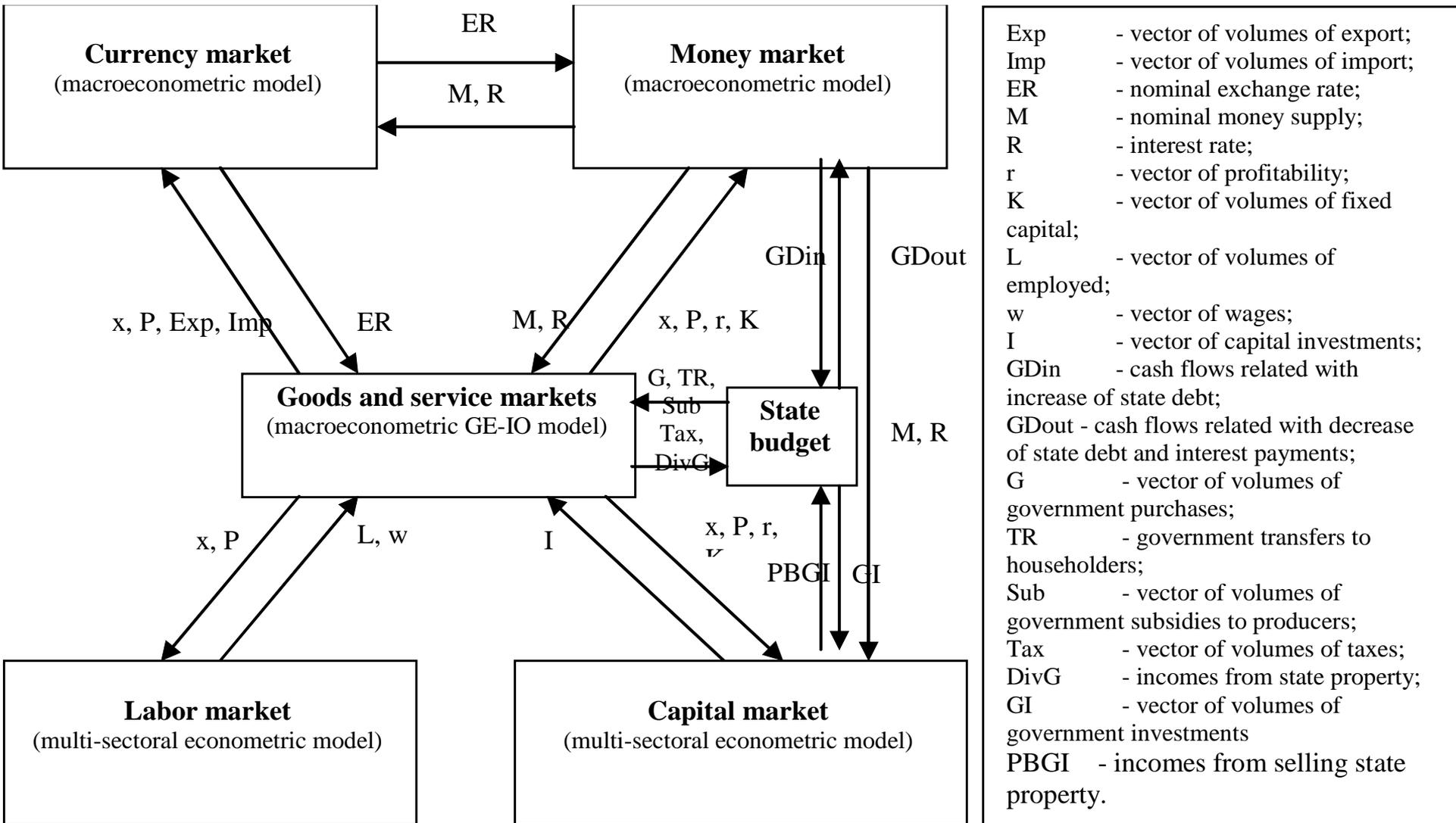


# Average annual change rates of the Russian GDP (corrected\*) and its components, in percent



\* reduced on changes in inventories and statistical difference

# Methodology. Concept of macroeconomic GE-IO model with aggregated money and currency markets and shocks of monetary and fiscal policy



- Exp - vector of volumes of export;
- Imp - vector of volumes of import;
- ER - nominal exchange rate;
- M - nominal money supply;
- R - interest rate;
- r - vector of profitability;
- K - vector of volumes of fixed capital;
- L - vector of volumes of employed;
- w - vector of wages;
- I - vector of capital investments;
- GDin - cash flows related with increase of state debt;
- GDout - cash flows related with decrease of state debt and interest payments;
- G - vector of volumes of government purchases;
- TR - government transfers to householders;
- Sub - vector of volumes of government subsidies to producers;
- Tax - vector of volumes of taxes;
- DivG - incomes from state property;
- GI - vector of volumes of government investments
- PBGI - incomes from selling state property.

# Influence of macroeconomic policy on the Russian GDP

Quarterly aggregated macroeconomic model of the Russian Economy have been constructed for this purpose:

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

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

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

where

$\pi_t$ , - change rate of GDP's deflator in quarter  $t$  to the same quarter of the previous year

$R_t$  - annual nominal interest rates in quarter  $t$ ;

$y_t$  - real GDP change rate in quarter  $t$  to the same quarter of the previous year in constant prices

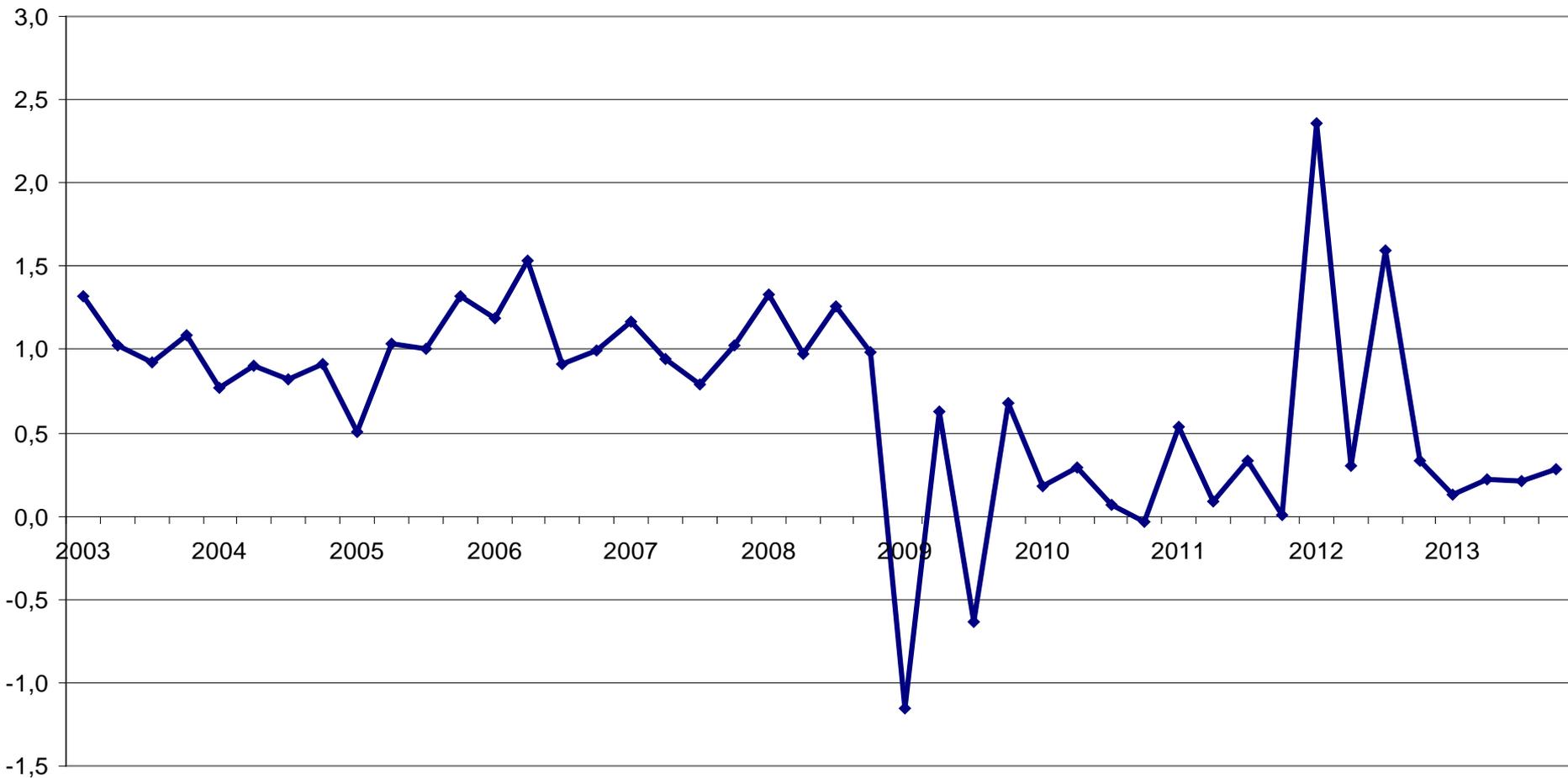
$m_t$  - change rate of money supply M2 in quarter  $t$  to the same quarter of the previous year, in percent;

$rER_t$  - 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;

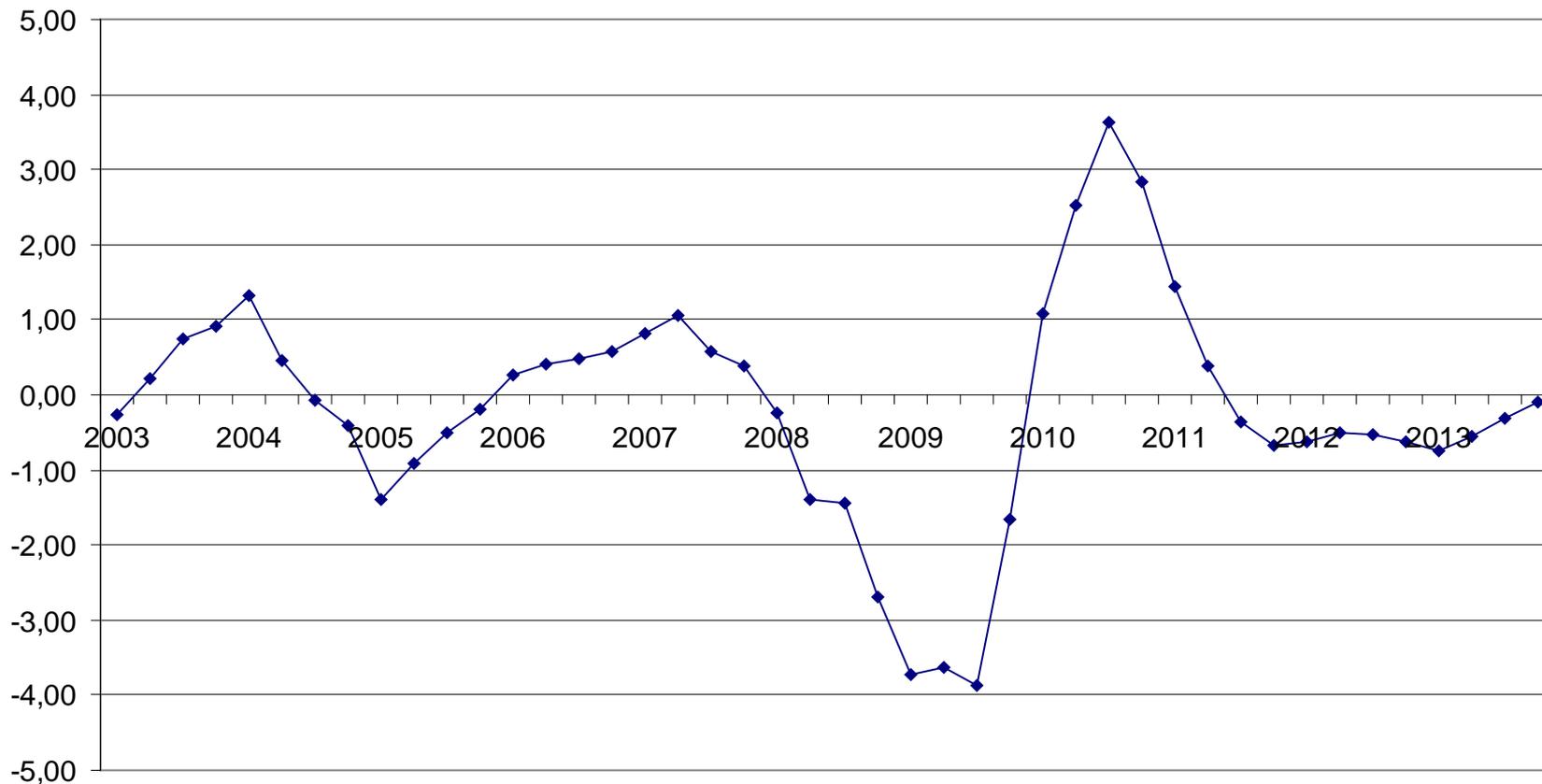
$e_t$  - deviation of actual change rate of real GDP in quarter  $t$  to the same quarter of the previous year from calculated.

# 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



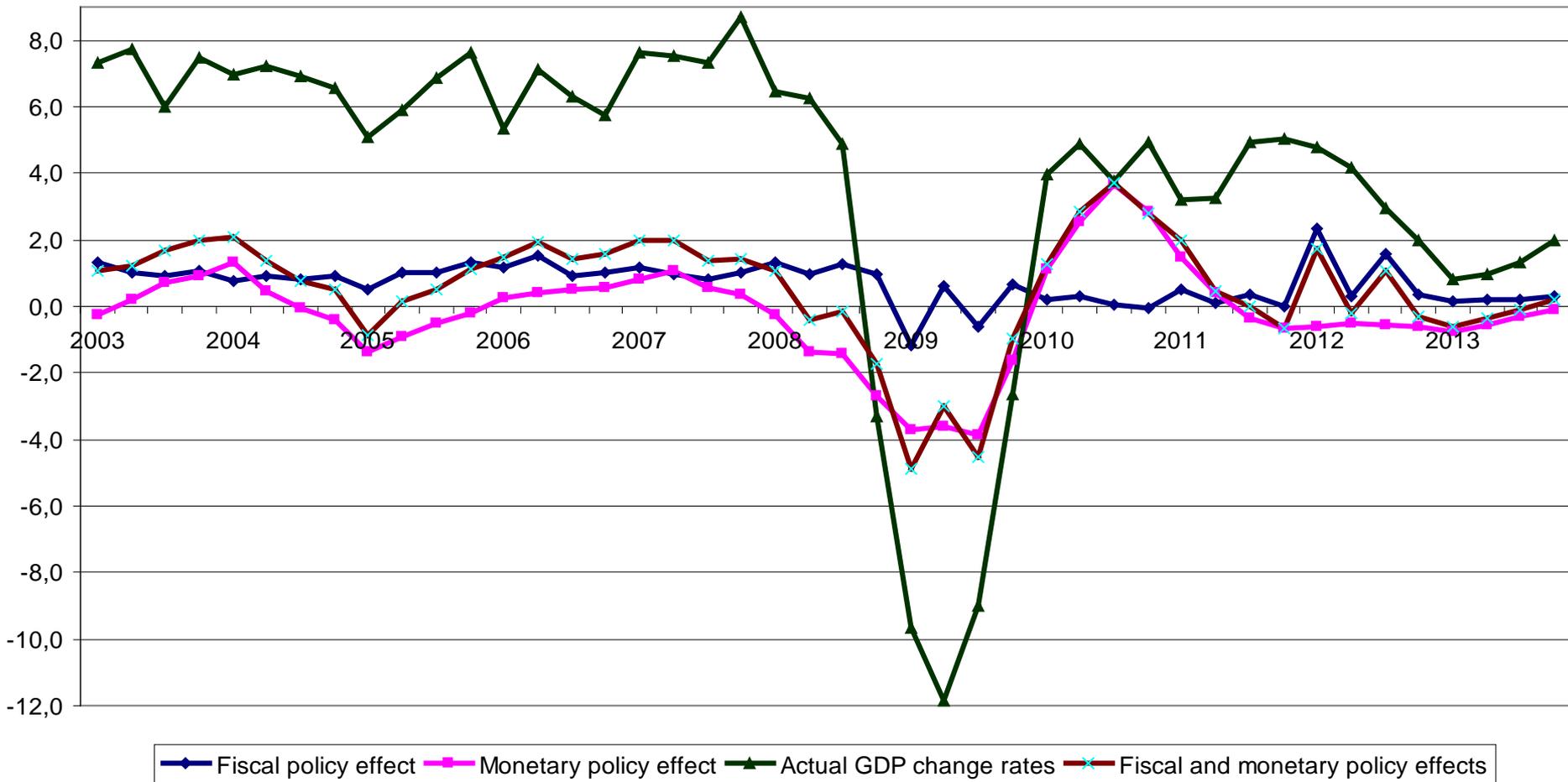
\* related only with changes in real wages in state sector and government spending

# 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

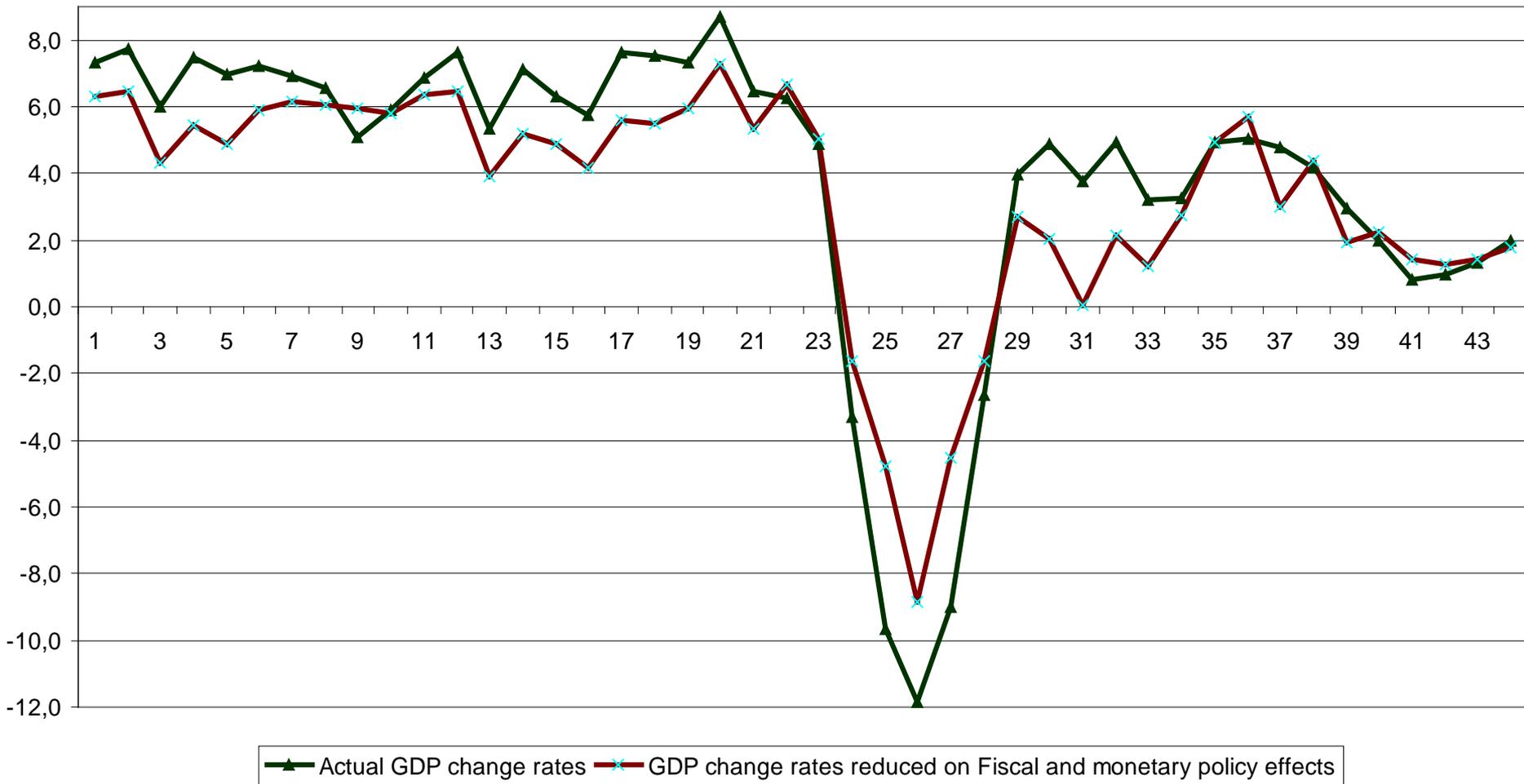


\* as changes in money supply M2 annual growth rates

# 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



# Actual and reduced change rates of real GDP of the Russian Federation in 2003-2013, in percent to the same quarter of the previous year



⇒ No stabilization policy in Russia

# What are macroeconomic consequences of transition monetary policy to Inflation Targeting for the Russian Economy?

Macroeconometric GE IO model of the Russian Economy with aggregated money and currency markets have been constructed for this purpose:

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

$$\ln(x_{i,t} / x_{i,t-4}) = \beta + e_{x_i,WR} \cdot \ln(WR_{t-t} \cdot x_i^w) \quad i = 1, \dots, n \quad (2)$$

$$i = 1, \dots, n \quad (3)$$

$$x_{i,t} \leq Cap_{i,t}$$

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

$$\ln(x_{i,t} / x_{i,t-4}) = \beta + e_{x_i,WR} \cdot \ln(WR_{t-4}) + \dots \quad i = 1, \dots, n \quad (2)$$

$$i = 1, \dots, n \quad (3)$$

where

$$x_{i,t} \leq Cap_{i,t}$$

$n$  – 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  $i$ ,  $i, j = 1, \dots, n$ ;

$\beta$ ,  $\alpha$ ,  $\gamma$  – 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;

$WR_{t-4}$  – real exchange rate of the Russian rouble to US dollar in quarter  $t-4$ ;

$W_{t-4}$  – real wage in quarter  $t-4$ ;

$WR_{t-4}$  – average annual real interest rate (deflated with deflator of GDP) for credits for non-financial sector in quarter  $t-4$ ;

$\alpha$ ,  $\beta$ ,  $\gamma$  – 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);

$\beta_{i,t}$  – 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.

	Real exchange rate (Rub in USD)	Real wage	Real interest rate	R <sup>2</sup>
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

# Model for aggregated money market

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

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

where

$IRN_t$  – average annual interest rate for 1 year 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  $t$ .

# Model of currency market

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

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:

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

$$Ex_t = ExNonO\&G_t + OilPrice_t * ExpOilVol_t/dOil_t \quad (8)$$

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  $t$ .

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

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.

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.

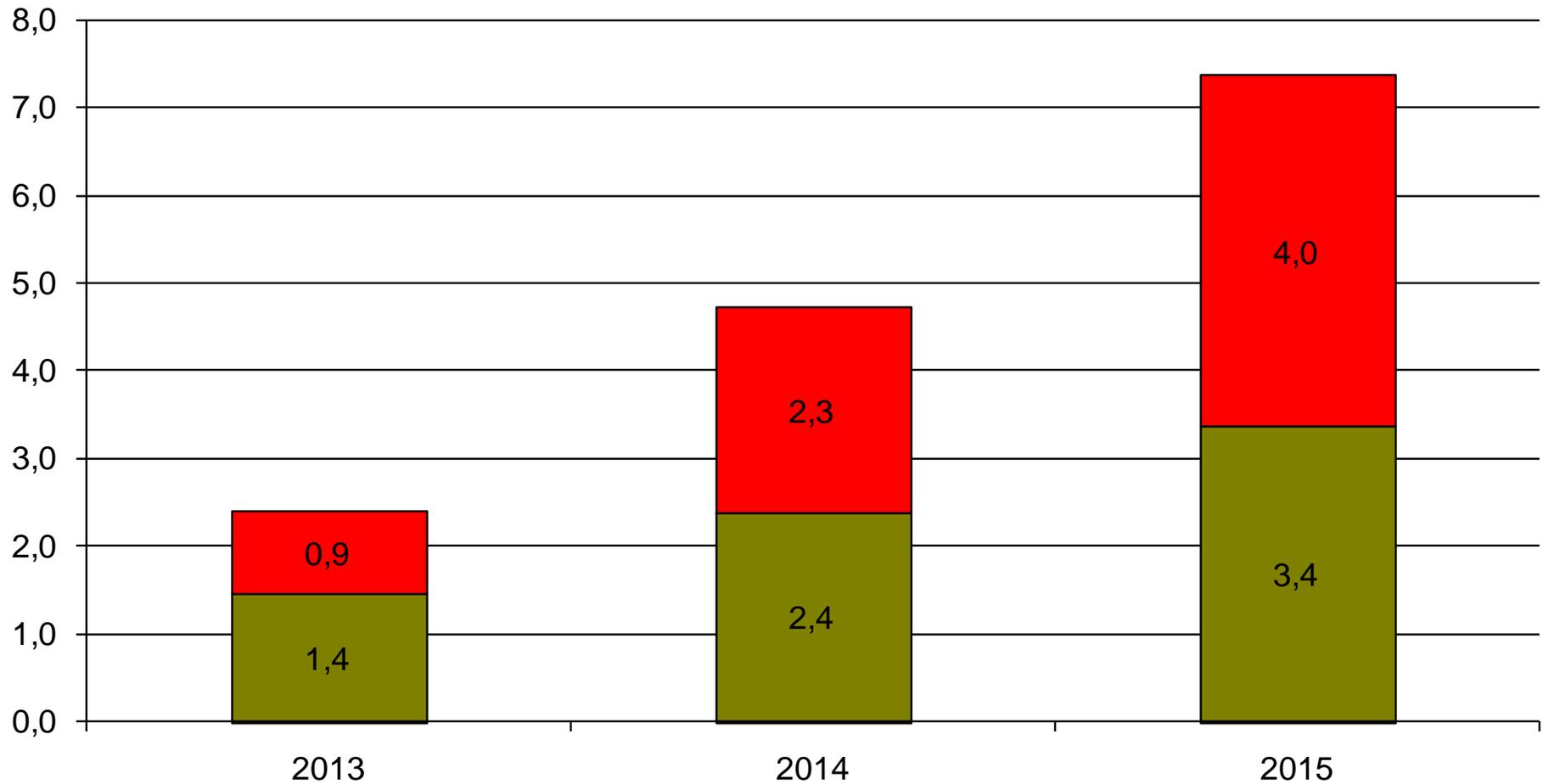
The third scenario “Monetary easing” implies high growth rates of money supply to stimulate the Russian economy.

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

	Actual data			Forecast								
				1 <sup>st</sup> scenario “Inflation targeting”			2 <sup>nd</sup> scenario “Neutral policy”			3 <sup>rd</sup> 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

# Estimation of GDP losses from the inflation targeting in Russia in 2013-2015



■ Change rate of the Russian real GDP in Inflation targeting scenario, % to the Russian GDP in 2012

■ the Russian real GDP losses in Inflation targeting scenario in according to Neutral policy scenario, % to the Russian GDP in 2012

**Thank you for your attention!**