Econometric model of economic growth, inflation and international trade in Russian Federation: what are the prospects for future?

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Abstract: The paper describes an econometric model of Russian economy which is tailored to analyze current trends in Russian economy and to forecast its dynamics for the next three years. The model showed that if all exogenous variables change with the rates they had during last two years the annual growth rate of Russian economy for the next two years will be about 1.5% while inflation is falling to 2.3% annually. Active monetary policy increases the economic growth slightly but helps to improve investment in fixed capital. Active fiscal policy has negative impact on growth.

Keywords: Econometric model; Russian Federation; economic growth; inflation; international trade.

1. INTRODUCTION

Our goal is to analyze and explain current trends in Russian economy and to forecast its dynamics for the next 2-3 years using an econometric model. Among the econometric models of Russian economy we mention first of all those made by Basdevant (2000), Aivazian et al. (2006, 2013a, 2013b) and Benedictow et al. (2013). We used the experience of Austrian' economy model construction by Schneider et. al. (2006) also.

The parameters of our model were estimated by Ordinary Least Squares (OLS) and by Maximum Likelihood – Autoregressive Conditional Heteroskedasticity (ML – ARCH) methods. The model was estimated on quarterly time series for the period Q1 1999 to Q4 2017.

2. MODEL

The full version of the model consists of 24 equations and 48 identities that describe the relationships between 84 variables (12 exogenous and 72 endogenous variables). Its detailed description one can find in Mitsek (2018) and on the web page https://gu-ural.ru/faculties/business-and-management/stranichka-dekana-publikatsii/. A description of a simplified version of the model is presented below and in Appendixes A and B.

Equations and identities 1 – 3 and 5 – 9 belong to production sector of the model.

Equation 1 shows that fixed capital stock depends on gross capital formation, and some other variables.

Equation 2 shows that number of employees depends mostly on the number of economically active population.

Equation 3 is the production function but production volume here depends not only on capital and labor but on the gross capital formation deflator and on money mass that reflect the impact of capital-embodied technological progress and liquidity conditions.

Identity 5 determines the nominal volume of GDP. Identities 6 – 9 determine the marginal revenues of factors of production and elasticity of GDP on them.

Equations and identities 4, 19, 28 and 64 belong to prices' sector of the model.

Equation 4 shows that GDP deflator index depends on monetary base, on export and import prices, on the GDP volume, on the dollar exchange rate and on inventory change, on energy prices and on transportation tariffs.

Equation 26 shows that CPI depends mostly on the GDP deflator and on ruble index of import prices.

Equation 28 shows that the gross fixed capital formation deflator depends on the GDP deflator, on money mass, on dollar exchange rate, on government consumption deflator, on energy prices, on transportation tariffs, on the volume of fixed capital and on the state of world economy which is represented by GDP index of OECD countries as a proxy in the model.

Equation 64 shows that internal energy price index depends on the GDP deflator, on the gross fixed capital formation deflator, on the money mass, on the GDP volume and on tradable sector value-added index, and on dollar exchange rate.

Equations and identities 10 – 18, 20 belong to the social sector of the model.

Equation 10 shows that average gross wage per worker depends on net marginal revenue on labor first of all, but also on government purchases and on gross fixed capital formation deflator, and on dollar exchange rate. Identity 11 defines the total wages in the economy, identity 16 its volume net of taxes, identity 12 – the number of unemployed, identity 14 – the volume of households' nominal incomes, identities 17 and 18 – the share of wages and social transfers in total citizens' incomes, respectively.

Equation 13 shows that index of households' consumption depends on citizen's incomes, on the share wages and social transfers in the former, on CPI, on dollar exchange rate, on government consumption and on the volume of households' bank deposits. Identity 20 determines the nominal volume of households' consumption.

Equations and identities 21 – 23, 25 – 27 and 29 belong to investment sector of the model.

Identity 22 and 23 determine the volume of gross and net corporate income respectively.

Equation 25 shows that investment in fixed assets at companies' own expense depends on marginal revenue on fixed capital and on net corporate income first of all. The private investment is supported by the government one but the current government expenditures have negative impact on it. The private investment depends negatively on indebtedness to banks and on competition from import but positively on average wages reflecting capital-to-labor substitution.

Equation 26 shows that investment in fixed assets at the expense of state budget depends mostly on the government revenues and on liquidity conditions, but transportation' tariffs and import have negative impact on it.

Equation 27 shows that investment in fixed capital by means of bank loans depends on total bank loans to companies and on net marginal revenue on fixed capital first of all. But it depends on government investment and investment from companies' own sources also. The GDP index, the government purchases, the volume of import, transportation tariffs and energy prices also has an impact on such type of investment.

Identity 21 determines the amount of gross capital formation as a sum of investment from all sources of funding and identity 29 its index in real terms.

Equations 30 - 43 represent a bank sector of the model which determines the volume of bank deposits and loans both nominated in rubles and in foreign currencies. These variables depend mostly on incomes' volume and on monetary policy indicators.

Equation and identities 44 – 53 represent a foreign economic sector of the model.

Equation 44 shows that dollar exchange rate index depends mostly on the GDP level and on money mass. Export and import prices both have rather weak influence on it. Identities 45 and 46 determine the ruble indexes of export and import prices, respectively.

Equation 47 shows that the volume of exports depends positively on export prices and on GDP index of OECD countries. But it depends negatively on the Russia's GDP index and its components as representatives of internal demand. Identity 48 determines the nominal volume of export.

Equation 49 shows that the volume of import depends positively on household's demand but negatively on the GDP volume. Identity 50 determines the nominal volume of import, identity 51 the value of net export, identities 52 and 53 – the volume of export and import duties collected, respectively.

Identities 15 and 54 – 62 belong to the government sector of the model and determine the volume of different taxes collected, government purchases and social transfers and the approximation of budget deficit.

Equations 24 and 63 belong to monetary sector of the model. The MIACR interest rate in the equation 24 depends presumably on the key loan rate of the Bank of Russia. Equation 63 shows that the money mass depends on the monetary base and on the nominal GDP level and on the dollar rate negatively.

Identity 65 determines the inventory change which is included as variable in the equation 4.

3. FORECASTS

As ex-post-forecast simulations showed good properties of the model we used it for the analysis and forecasting for the years 2018-2019.

In the 1st (basic) forecast variant we allowed the *exogenous* variables to change with the average rates similar to their past dynamics. In this variant the average annual growth rate of Russian GDP will be +1.5 % while inflation about 2.3 % annually.

Under the assumption of rapid increase of export prices the average annual investment growth increases but only slightly while inflation increases significantly. The import prices' increase has not significant impact on the GDP and inflation change. Active monetary policy has a positive impact on investment in fixed capital. Aggressive fiscal policy has a strong negative impact on gross capital formation.

Five variants of forecast for main endogenous variables are shown in Appendix C. Graphs for main variables in the basic variant are represented in Appendix D.

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Appendix A. A LIST OF MODEL VARIABLES

Exogenous variables

CAP: Capital account balance (in dollars)

IND_G: Government purchases' index in constant prices
IND_OECD: OECD countries' total GDP index
KEY: The Bank of Russia' key loan rate
MB: Monetary base
N: Economically active population, age 15-72
NONTAX: Nontax government revenues
PEXPD: Dollar index of export prices
PG: Government consumption' price index
PIMD: Dollar index of import prices
TARIF: Transportation services' tariffs' index

Endogenous variables

C: Households' consumption in current prices
CH: Consumer bank loans, total
CPI: Consumer price index
CR: Ruble bank loans to companies
CT: Bank loans to companies, total
CV: Foreign currency bank loans to companies
DEF: a proxy of the state budget balance
DEP: Total bank deposits
DEPCB: Commercial banks' obligations to the Bank of Russia
DEPR: Total bank ruble deposits
DEPRF: Companies' bank ruble deposits
DEPRP: Households' bank ruble deposits
DEPV: Total bank foreign currency deposits
DEPVF: Companies' bank foreign currency deposits
DEPVP: Households' bank foreign currency deposits
DI: Gross fixed capital formation price index
DOLLAR: Ruble to dollar exchange rate index
EXP: Export (volume of) in current prices
EXPDUT: Export duties in current prices
G: Government purchases in current prices
I: Gross fixed capital formation in current prices
IB: Investment in fixed capital through bank loans in current prices
IG: Investment in fixed capital from state budget in current prices
IMP: Import (volume of) in current prices
IMPDUT: Import duties in current prices
INCOME: Households' total net income
IND_C: Households' consumption index (in constant prices)
IND_EXP: Export's index in constant prices
IND_I: Gross fixed capital formation' index in constant prices
IND_IMP: Import's index in constant prices
IND_Q: the GDP index in constant prices
INTAX: Indirect taxes paid in current prices
IO: Investment in fixed capital on companies' own expense in current prices
K: Fixed capital volume in current prices
L: Number of employed
M: Money mass
MIACR: Moscow interbank loan rate
NATTAX - taxes for the use of natural resources paid
NMRK: Net marginal revenue on fixed capital
NMRL: Net marginal revenue on labor
NROK: Net profit
NWL: Total wages net of personal and social taxes
NX: Net export
P: the GDP deflator index
PEN: Energy inputs' price index
PEXP: Ruble index of export prices
PIM: Ruble index of import prices
PQ: Nominal GDP
PTAX: Corporate income tax paid in current prices
REV: Total taxes paid in the economy
ROK: Gross profit
S: Inventory change
SNWLIN: a share of net total wages in households' total net income
STRIN: a share of social transfers in households' total net income
TRANSFER: Government transfers in current prices
TTAX: total corporate taxes in current prices
U – unemployed number
W: Gross wages per 1 employee
WL: Total gross wages paid in the economy
ε_K: Elasticity of GDP on fixed capital
ε_L: Elasticity of GDP on labor

Appendix B. A LIST OF MODEL EQUATIONS AND IDENTITIES

A SIMPLIFIED VERSION[1]

$$K = f_K(I, DI, W, PEN, TARIF) \quad (1)$$

$$L = f_L(N) \quad (2)$$

$$IND\_Q = f_Q(K, L, DI, M) \quad (3)$$

$$P = f_P(MB, IND\_Q, PG, PEXPD, PIMD, TARIF, DOLLAR, S, PEN) \quad (4)$$

$$PQ = P \times IND\_Q \quad (5)$$

$$\varepsilon_K = \frac{\partial(IND\_Q)}{\partial K}\frac{K}{IND\_Q} \quad (6)$$

$$\varepsilon_L = \frac{\partial(IND\_Q)}{\partial L}\frac{L}{IND\_Q} \quad (7)$$

$$NMRK = \varepsilon_K \frac{PQ - INTAX - PTAX - NATTAX}{K} \quad (8$$

$$NMRL = \varepsilon_L \frac{PQ \times (1 - STTAX)}{L} \quad (9)$$

$$W = f_W(NMRL, G, DI, DOLLAR) \quad (10)$$

$$WL = W \times L \quad (11)$$

$$U = N - L \quad (12)$$

$$IND\_C = f_C(CPI, G, DOLLAR, INCOME, SNWLIN, STRIN, DEPP) \quad (13)$$

$$INCOME = PQ - REV + TRANSFER \quad (14)$$

$$REV = INTAX + PTAX + NATTAX + + PERTAX + SOCTAX \quad (15)$$

$$NWL = WL - PERTAX - SOCTAX \quad (16)$$

$$SNWLIN = NWL / INCOME \quad (17)$$

$$STRIN = TRANSFER / INCOME \quad (18)$$

$$CPI = f_{CPI}(P, PIM) \quad (19)$$

$$C = IND\_C \times CPI \quad (20)$$

$$I = IO + IG + IB \quad (21)$$

$$ROK = PQ - WL - INTAX \quad (22)$$

$$NROK = ROK - PTAX - NATTAX \quad (23)$$

$$MIACR = f_{MIACR}(KEY) \quad (24)$$

$$IO = f_{IO}(NMRK, NROK, IG, G, CT, DI, IMP, W) \quad (25)$$

$$IG = f_{IG}(REV, IMP, M, CAP, MIACR, TARIF, G, DI) \quad (26)$$

$$IB = f_{IB}(NMRK, CT, IO, IG, G, IMP, DI, TARIF, PEN, IND\_Q) \quad (27)$$

$$DI = f_{DI}(P, DOLLAR, PG, M, TARIF, IND\_OECD, PEN, K) \quad (28)$$

$$IND\_I = I / DI \quad (29)$$

$$DEPRP = f_{DEPRP}(M, INCOME, P, G) \quad (30)$$

$$DEPRF = f_{DEPRF}(M, P, DEPCB, G, TRANSFER, IND\_Q) \quad (31)$$

$$DEPVP = f_{DEPVP}(M, P, INCOME, G, SWLIN, DEPCB) \quad (32)$$

$$DEPVF = f_{DEPVF}(DEPRF, DEPCB, TRANSFER, G, DOLLAR) \quad (33)$$

$$DEPR = DEPRP + DEPRF \quad (34)$$

$$DEPV = DEPVP + DEPVF \quad (35)$$

$$DEP = DEPR + DEPV \quad (36)$$

$$DEPP = DEPRP + DEPVP \quad (37)$$

$$DEPF = DEPRF + DEPVF \quad (38)$$

$$CR = f_{CR}(DEPR, DEPV, TTAX, G, P) \quad (39)$$

$$CV = f_{CV}(DEPV) \quad (40)$$

$$CT = CR + CV \quad (41)$$

$$CH = f_{CH}(DEPR, P) \quad (42)$$

$$DEPCB = k_{DEPCB}(CT + CH) \quad (43)$$

$$DOLLAR = f_{DOLLAR}(IND\_Q, M) \quad (44)$$

$$PEXP = PEXPD \times DOLLAR \quad (45)$$

$$PIM = PIMD \times DOLLAR \quad (46)$$

$$IND\_EXP = f_{IND\_EXP}(PEXPD, IND\_Q, IND\_QTR, IND\_G, TTAX, IND\_OECD) \quad (47)$$

$$EXP = IND\_EXP \times PEXP \quad (48)$$

$$IND\_IMP = f_{IND\_IMP}(IND\_Q, IND\_C) \quad (49)$$

$$IMP = IND\_IMP \times PIM \quad (50)$$

$$NX = EXP - IMP \quad (51)$$

$$EXPDUT = k_{EXPDUT} \times EXP \quad (52)$$

$$IMPDUT = k_{IMPDUT} \times IMP \quad (53)$$

$$PTAX = k_{PTAX} \times ROK \quad (54)$$

$$INTAX = k_{INTAX} \times PQ \quad (55)$$

$$NATTAX = k_{NATTAX} \times PQ \quad (56)$$

$$TTAX = INTAX + PTAX + NATTAX \quad (57)$$

$$PERTAX = k_{PERTAX} \times (WL + NROK - SOCTAX) \quad (58)$$

$$SOCTAX = k_{SOCTAX} \times WL \quad (59)$$

$$G = IND\_G \times PG \quad (60)$$

$$TRANSFER = k_{TRANSFER} \times PQ \quad (61)$$

$$DEF = REV - G - TRANSFER \quad (62)$$

$$M = f_M(MB, PQ, DOLLAR) \quad (63)$$

$$PEN = f_{PEN}(P, DI, M, IND\_Q, DOLLAR) \quad (64)$$

$$S = PQ - C - I - G - NX \quad (65)$$

Appendix C. FORECASTS' RESULTS

Table C.1. First (basic) forecast variant, 2018-2019

Exogenous variable dynamics	
CAP	Equal to 2014-17 average
IND_G	+0.5% average annual growth
IND_OECD	12-lags' autoregression
KEY	7.5%
MB	+8.1% average annual growth
N	Constant
PEXPD	Constant
PG	+5.0% average annual growth
PIMD	Constant
TARIF	+7.2% average annual growth
Main endogenous variables (average annual change, %)[2]	
IND_Q	+1.5
P	+2.3
IND_I	-7.0
IND_C	-2.1
INCOME	+1.6

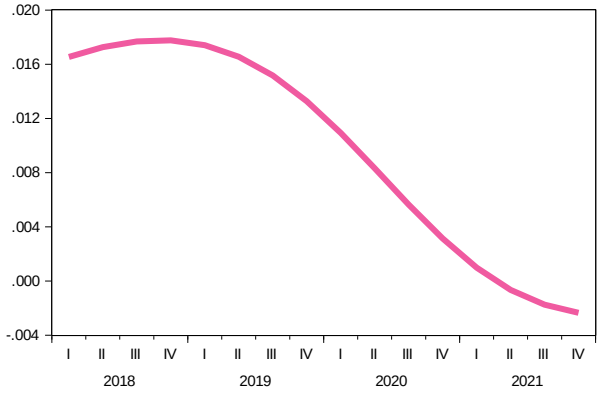
Table C.2. Other forecast variants change of the average annual rates from the basic variant, percent points, 2018-2019

#	Exogenous variable –		Main endogenous variables (average annual change, %)[3]				
			IND_Q	P	IND_I	IND_C	INCOME
2	PEXPD	+20.0	-0.6	+3.0	+0.9	-0.1	+1.0
3	PIMD	+6.0	+0.2	-0.5	-0.2	-0.5	-1.0
4	MB	+13.0	+0.5	+0.0	+1.0	+0.1	+0.6
5	G	+7.0	-0.1	+0.4	-1.1	+1.0	+0.2

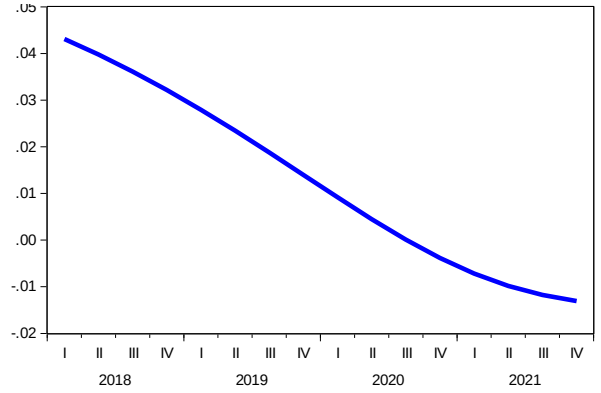
Notes: each forecast variant (# is variant's number) differs from first one only by the change in the dynamics of one exogenous variable. The figures in the table show how the change in the dynamics of one exogenous variable changes the dynamics of main endogenous variables in comparison with the basic forecast variant.

Appendix D[4]

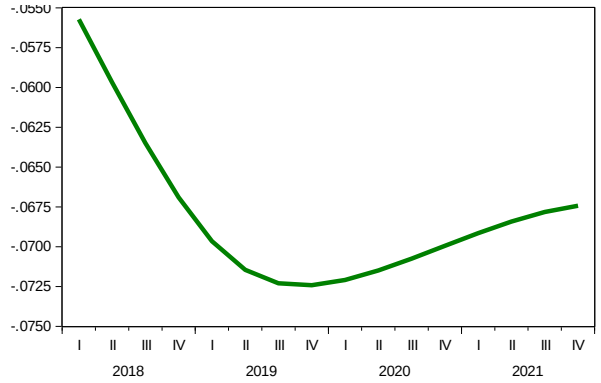
Graph D1. THE GDP INDEX AVERAGE ANNUAL RATE FORECAST; smoothed by Hodrick – Prescott filter (λ = 1600)



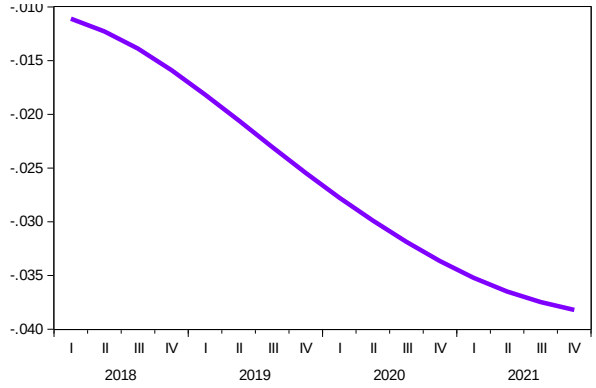
Graph D2. THE GDP DEFLATOR AVERAGE ANNUAL RATE FORECAST; smoothed by Hodrick – Prescott filter (λ = 1600)



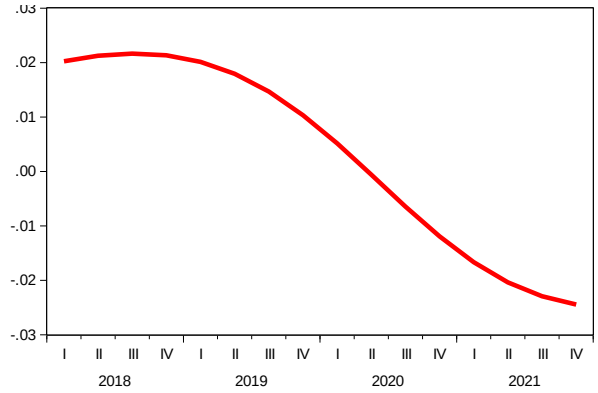
Graph D3. THE GROSS FIXED CAPITAL FORMATION INDEX AVERAGE ANNUAL RATE FORECAST; smoothed by Hodrick – Prescott filter (λ = 1600)



Graph D4. THE HOUSEHOLDS' CONSUMPTION INDEX AVERAGE ANNUAL RATE FORECAST; smoothed by Hodrick – Prescott filter (λ = 1600)



Graph D5. THE HOUSEHOLDS' INCOMES AVERAGE ANNUAL RATE FORECAST; smoothed by Hodrick – Prescott filter (λ = 1600)



[1] Here we present a simplified version of model. The equations' description includes only those variables the elasticity of dependent variable on which is greater than 0.1 by absolute value. The full version of the model is presented on the site https://gu-ural.ru/faculties/business-and-management/stranichka-dekana-publikatsii/

[2] Smoothed by Hodrick – Prescott filter (λ = 1600); all figures but GDP deflator in constant prices

[3] All figures but GDP deflator in constant prices

[4] All figures but GDP deflator in constant prices