

# MSBC-2022

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The econometric modeling of the adaptation of the Russian economy to the sanctions of Western countries

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the Russian Federation

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# 1. Introduction

Researchers of the production function of the economy of modern Russia

Bessonov, 2004; Afanasyev, 2007, 2008, 2009; Afanasyev, Ponomareva, 2014, 2020, 2021; Buravlev, 2012; Kirilyuk, 2013; Kopoteva, Cherny, 2011; Svetunkov, Abdullaev, 2010, etc.

Monograph Kleiner G.B. Production functions: theory, methods, application. Moscow: Finance and Statistics, 1986.

Problem, How can the process of adaptation to Western sanctions be reflected in the production function of the Russian economy?

## 2. The specification of the production function of the Russian economy and of the model of an adaptation to the sanctions of Western countries

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The symbol  $Y_t$  denote a real GDP created in the national economy in the time interval  $t$  in existing technologies and the levels of factors of production  $(x_{1t}, x_{2t}, \dots, x_{kt})$ .

A mathematical model explaining of the variable  $Y_t$  by variables  $(x_{1t}, x_{2t}, \dots, x_{kt})$  is called the production function of the national economy:

$$Y_t = F(x_{1t}, x_{2t}, \dots, x_{kt}). \quad (1)$$

## The specification of the production function of the Russian economy

$$Y_t = a_0 \cdot e^{\gamma \cdot (t-t_0)} \cdot e^{\theta \cdot dcs_t} \cdot K_t^\alpha \cdot L_t^\beta \cdot p_t^\delta \quad (2)$$

The constant  $a_0$  is called a coefficient of the joint productivity of factors of production, and its value depends on the units of measurement of production function arguments.

The coefficient  $\gamma$  is the relative change (in fractions) of the index of scientific and technological progress for each unit of the time (specifically, for a year), so that  $\gamma$  is the contribution to the GDP growth rate of a scientific and technological progress.

Constants ( $\alpha, \beta, \delta$ ) are the values of elasticity of a variable  $Y_t$  respectively, variables ( $K_t, L_t, p_t$ ).

## The modified indicator $dcs_t$ and the model of adaptation to the sanctions of Western countries

The variable  $dcs_t$  is a modified indicator of Russia's default, the Global financial crisis and Western sanctions.

$$dcs_t = \begin{cases} 1 & \text{if } t = 1998, 2009, 2015; \\ a_1 & \text{if } t = 2016, \\ a_2 & \text{if } t = 2017, \\ a_3 & \text{if } t = 2018, \\ a_4 & \text{if } t = 2019, \\ 0 & \text{for others } t \in [1990, 2019]. \end{cases} \quad (3)$$

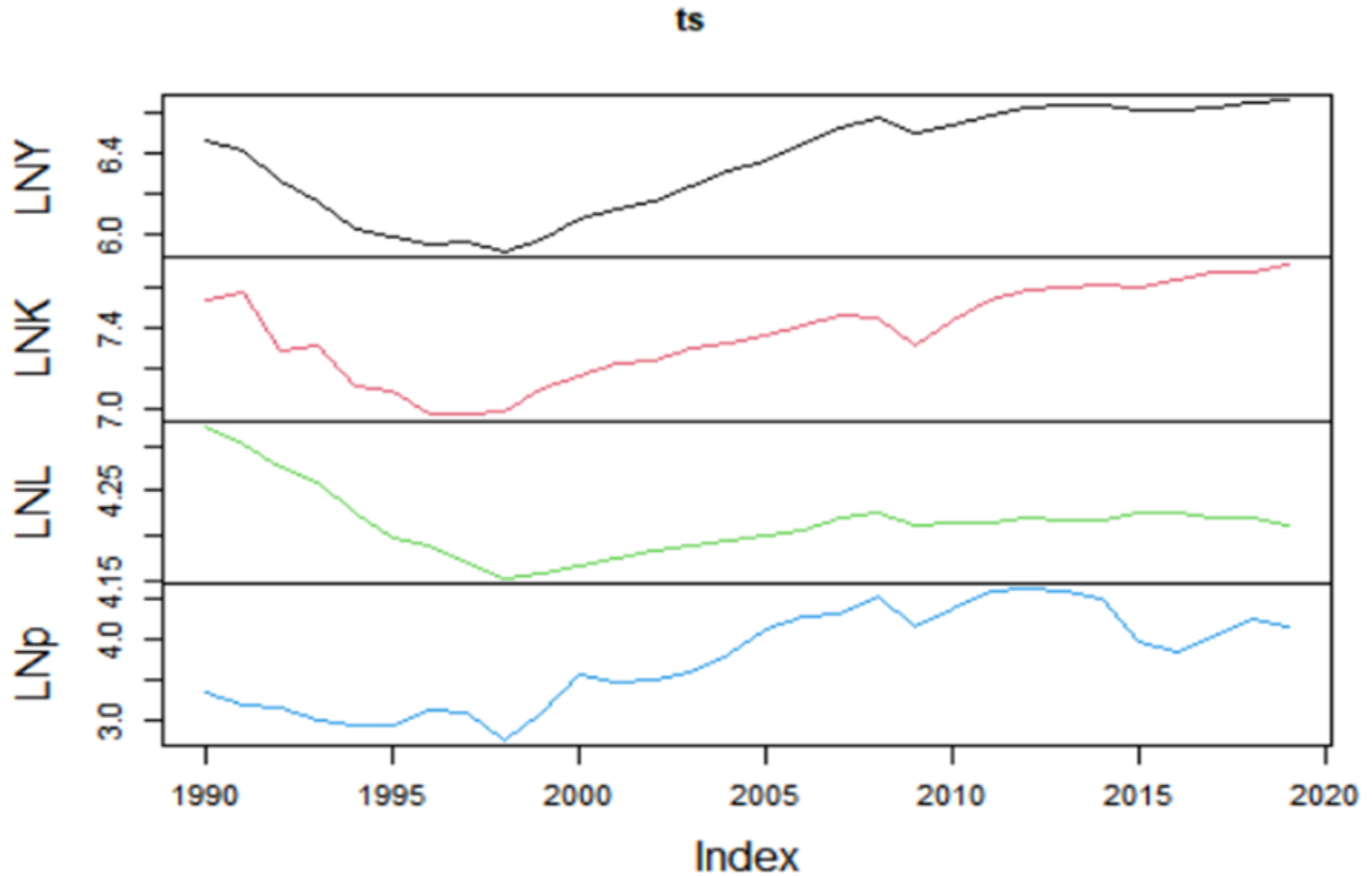
$$\begin{cases} dcs_t = \exp(-a \cdot (t - 2015)) \\ t = 2015, 2016, 2017, 2018, 2019 \end{cases} \quad (4)$$

# 3. The statistical information 1)

Год	Y (млрд. руб.)	K (млн. руб.)	Z %	K(факт.) (млрд. руб.)	L (млн раб.)	P (дол. /бар.)
1990	644	1871649	100	1871,65	75,325	28,65
1991	612	1957288	100	1957,29	73,848	24,5
1992	523	2009054	73	1466,61	72,071	23,14
1993	478	2030396	74	1502,49	70,852	19,72
1994	417	2014984	61	1229,14	68,484	18,91
1995	400	1995229	60	1197,14	66,441	18,57
1996	386	1983823	54	1071,26	65,95	22,9
1997	391	1967098	54	1062,23	64,639	22,22
1998	371	1953216	55	1074,27	63,642	15,48
1999	394	1953747	62	1211,32	63,963	22,1
2000	434	1962932	66	1295,54	64,517	35,54
2001	456	1976006	69	1363,44	64,98	31,89
2002	477	1993845	70	1395,69	65,574	32,99
2003	512	2015564	73	1471,36	65,979	36,24
2004	549	2040209	74	1509,75	66,407	45,05
2005	584	2074736	76	1576,8	66,792	62,07
2006	632	2119496	78	1653,21	67,174	72,72
2007	686	2169707	80	1735,77	68,019	76,18
2008	722	2229842	77	1716,98	68,474	94,95
2009	665	2292706	65	1490,26	67,463	64,13
2010	695	2350079	72	1692,06	67,577	79,64
2011	725	2416816	78	1885,12	67,727	99,97
2012	750	2499424	79	1974,54	67,968	101,61
2013	760	2581327	78	2013,44	67,901	99,21
2014	765	2644159	77	2036	67,813	91,59
2015	744	2673133	75	2004,85	68,389	53,65
2016	742	2696319	77	2076,17	68,43	46,98
2017	753	2730170	79	2156,83	68,127	55,91
2018	771	2762511	78	2154,76	68,016	70,01
2019	781	2853595	79	2254,34	67,388	64,37

1) Afanasyev A. A., Ponomareva O. S. The spread of Wuhan coronavirus (SARS-COV-2) in Russia: macroeconomic production function taking into account the world price of Brent crude oil. Problems of the Market Economy, 2021, No. 1, 24-46.

# The Visualization of the statistical information





## 4. The results of the evaluation of the production function of the Russian economy and of the model of adaptation to the sanctions of Western countries

$$\tilde{Y}_t = 0,00233 \cdot e^{0,0065 \cdot (t-1990)} \cdot e^{0,071 \cdot dcs_t} \cdot K_t^{0,33} \cdot L_t^{2,17} \cdot p_t^{0,19},$$

$$t = 1990, 1991, \dots, 2019. \quad (5)$$

$$\begin{cases} dcs_t = \exp(-0,3 \cdot (t - 2015)) \\ t = 2015, 2016, 2017, 2018, 2019. \end{cases} \quad (6)$$

$$dcs_t = \begin{cases} 1 & \text{if } t = 1998, 2009, 2015; \\ 0,74 & \text{if } t = 2016, \\ 0,55 & \text{if } t = 2017, \\ 0,41 & \text{if } t = 2018, \\ 0,30 & \text{if } t = 2019, \\ 0 & \text{for others } t \in [1990, 2019]. \end{cases} \quad (7)$$

# The protocol for an evaluation the production function of the Russian economy

Call:

**lm(formula = LNY ~ t.1990 + dcs + LNK + LNL + LNp, data = newdata)**

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**Coefficients:**

	<b>Estimate</b>	<b>Std. Error</b>	<b>t</b>	<b>value</b>	<b>Pr(&gt; t )</b>	
<b>(Intercept)</b>	<b>-6.063047</b>	<b>0.783047</b>	<b>-7.743</b>	<b>5.60e-08</b>	<b>***</b>	
<b>t.1990</b>	<b>0.006515</b>	<b>0.001880</b>	<b>3.466</b>	<b>0.002006</b>	<b>**</b>	
<b>dcs</b>	<b>0.071127</b>	<b>0.015882</b>	<b>4.478</b>	<b>0.000156</b>	<b>***</b>	
<b>LNK</b>	<b>0.328883</b>	<b>0.063079</b>	<b>5.214</b>	<b>2.42e-05</b>	<b>***</b>	<b>(8)</b>
<b>LNL</b>	<b>2.173818</b>	<b>0.282874</b>	<b>7.685</b>	<b>6.38e-08</b>	<b>***</b>	
<b>LNp</b>	<b>0.192923</b>	<b>0.014011</b>	<b>13.769</b>	<b>6.90e-13</b>	<b>***</b>	

**Residual standard error: 0.01929 on 24 degrees of freedom**

**Multiple R-squared: 0.9954, Adjusted R-squared: 0.9944**

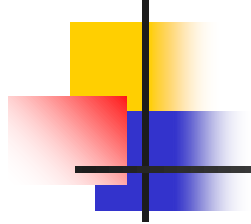
**F-statistic: 1037 on 5 and 24 DF, p-value: < 2.2e-16**

## 5. Conclusions

1. Consequently, all other things being equal, scientific and technological progress increases Russia's real GDP by about 0.6%–0.7% per year.

2. The values of the elasticity of Russia's real GDP in terms of fixed capital, labor and oil prices, respectively, are approximately 0.3%, 2% and 0.2%. Consequently, a 1% increase in the levels of the main factors of production  $K_t$  and  $L_t$  entails an increase in Russia's real GDP by about 2.5% .

3. It can be said that every year the impact of Western sanctions on the Russian economy decreases by about 25%.



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I thank you for your attention!