ORIGINAL PAPER

DOI: 10.26794/2587-5671-2022-26-4-199-210
UDC 331.56(045)
JEL J21, J58

Verification of Okun's Law on Russian Data

Yu.K. Zaytsev
Institute of Applied Economic Research RANEPA, Moscow, Russia

ABSTRACT

The **purpose** of the study is to assess the empirical relationship between economic growth and unemployment in the Russian economy. The research **methodology** is based on an econometric analysis of time series representing data on unemployment and economic growth to identify an empirical relationship between these variables. In the article author continued the work on identifying the relationship between the unemployment rate and GDP in Russia based on empirical data. Based on the results of the optimal length model, the long-term Okun coefficient describing the relationship between GDP and unemployment is calculated. As a result of the empirical assessment, the Okun coefficient was obtained equal to 0.87, which is consistent with the previous studies based on the data of the Russian economy. The discrepancies can be explained by the pandemic factor in 2020. It is **concluded** that the value of the long-term Okun coefficient confirms the stable relationship between the GDP and the unemployment rate. However, its value for Russia is somewhat inferior to estimates for most developed countries and is comparable to indicators for emerging market countries. The results of the study can be used in the construction of short-term forecasts of the response of unemployment changes to fluctations in GDP, as well as in the development of macroeconomic policy measures in Russia as a whole.

Keywords: unemployment rate; employment; economic growth; Oaken's law; coronavirus pandemic; time series; empirical estimation; Russian Federation

For citation: **Zaitsev Yu.K. Verification of Okun's law on Russian data. *Finance: Theory and Practice.* 2022;26(4):199-210. DOI: 10.26794/2587-5671-2022-26-4-199-210**

INTRODUCTION

The problem of unemployment and its impact on key macroeconomic indicators, including gross domestic product (GDP), was the subject of research by many post-Keynesian scientists in the XX century [1, 2]. Arthur Okun is one of the economists who contributed to the empirical relationship between unemployment and GDP. He presented his research on the relationship between unemployment and economic growth in 1962. According to the author, the increase of the unemployment rate by 1% reduces the country's GDP by about 2% [3].

Over the last 50 years, many other empirical works have appeared in which the authors have tried to identify the relationship between unemployment and GDP and to prove previously established empirical relationship [4]. Theoretical aspects of the Okun's law have been researched to determine its practical implications for different countries of the world.

Overall, the Russian labour market was characterized by positive development trends in the pre-pandemic period. In particular, in Russia the employment rate was above the average, and the unemployment rate was below the average for the OECD countries [72.1 and 5.9% respectively (as of 2018)]. Flexible labour market legislation, weak unemployment insurance and continued economic recovery were factors reducing unemployment.[1]

The main purpose of this article is to reveal the relationship between the unemployment rate and GDP in Russia. The main question of the research: if high unemployment has a negative impact on GDP?

The novelty of this article is primarily related to the attempt to test Okun's law in relation to Russian data. As will be shown in the literature review, there are a number of works devoted to proving the applicability of the Okun's law to Russia. However, the research takes into account recent events and recent data on the Russian economy. Unemployment rates for both men and women are taken into account when analysing data for greater accuracy. This article will therefore also focus on the gender dimension.

In order to achieve this goal, such tasks as the review of the literature, data analysis (with a special focus on the single root test, cointegration test), empirical analysis (with an emphasis on finding the optimal lag length, performing diagnostic tests). Diagnostic tests will be related to autocorrelation tests, heterosufficiency tests, normality tests. All of them will help to check the correctness and quality of assessments. In conclusion, the main results of the research will be determined. Thus, the structure of the article reflects the main tasks that are set to achieve the goal and answer the research question of the article.

REVIEW OF LITERATURE

The main theoretical assumptions for this research are based primarily on the Okun's law. The main idea of the law is to establish an empirical link between the GDP growth rate and the unemployment rate [5]. The law is defined by the following equation:

$$\frac{Y - Y^*}{Y^*} = -\beta(U - U^*),$$

where Y^* — potential GDP; U — actual unemployment; U^* — natural unemployment; β — empirical ratio of GDP sensitivity to cyclical unemployment (Okun coefficient). The coefficient is dimensionless and shows the relationship between the degree of deviation of actual unemployment from its natural level and actual GDP from its potential level.

The Okun's law connects fluctuations in unemployment to fluctuations in GDP. According to this law, annual real GDP growth of about 2.7% holds unemployment rate at a stable natural level. Every subsequent 2.5% increase in GDP decrease the unemployment rate by 1%. Every additional 2.5% decrease in GDP increases the unemployment rate by

[1] The new OECD Jobs Strategy How does Russia compare? OECD. 2018. URL: https://www.oecd.org/russia/jobs-strategy-RUSSIA-EN.pdf (accessed on 25.07.2022).

Table 1

Key data on the volume of GDP and the unemployment rate in the Russian economy during the period of 1992–2020

Variable	1994		2009		2015		2020	
	Value	Change to previous period,%	Value	Change to previous period, %	Value	Change to previous period, %	Value	Change to previous period, %
GDP at current prices, bln USD	395	–12.57	1223	–7.8	1363	–1.97	1483	–2.95
Unemployment rate, %	7.2	+1.9	8.2	+2	5.6	+0.4	5.9	+1.3

Source: compiled by the author.

1% [3]. In fact, it is not a law, but a trend with many constraints across countries, regions, the world as a whole and time periods [6].

Theoretically, unemployment exceeds natural levels with negative socio-economic consequences. The higher the unemployment rate, the more real GDP will lag behind the nominal and the economy will produce less. In addition, the exceedance of the unemployment rate at the natural level leads to a decrease in tax revenues to the State budget, an increase in the cost of unemployment benefits in the economy [7].

Economists J. Villaverde and A. Maza try to analyze the Okun's law for Spain and its seventeen regions during the period 1980–2004. They found that the impact of GDP on unemployment in the Spanish regions varied. The Okun coefficient varies from a minimum of 0.3 for Asturias to a maximum of 1.55 in Castile-La Mancha [8].

The Okun coefficient of 2.5 mainly characterizes the US and some European economies (e.g., the United Kingdom and France) [9]. Empirical researches show that this coefficient is lower in emerging market economies, including Russia. For example, according to the calculations of Russian economists [10], the value of the Okun coefficient for Russia is 1. Other researches on the Russian economy produced different results. Dobrozhinskaya has set that the Okun coefficient was 3 in 2018 in own research. Due to the high unemployment rate, Russia lost about 3.1 bln rub [11]. However, according to the calculations of M. Kazakova, the Okun coefficient was almost insignificant. According to her estimates, the change in unemployment. According to Kazakova, the Okun coefficient was –0.2 [12].

This article will continue an attempt to identify the relationship between the unemployment rate and GDP in Russia based on empirical data.

ANALYSIS OF DATA

The inverse relationship between unemployment and GDP can be determined on the basis of stylized facts. For example, along with the fall in GDP, there was a rise in unemployment, during periods of economic shock in 1994, 2008, 2015, 2020 years. The highest unemployment rates for this period are presented in *Table 1*.

Table 2

Discription of veriables

Variable	Variable description	Comment / Source of information
GDP	Volume index	Based on seasonal variations Source: IMF International Financial Statistics
Unemployment rate	Unemployment rate, ILO methodology, %	Based on seasonal variations. The difference in unemployment is used for modelling purposes

Source: compiled by the author.

Nevertheless, despite the established link between unemployment and GDP at the level of stylized facts, there is a need for a more in-depth analysis of the time data on unemployment and GDP and their relationship through econometric methods.

The International Monetary Fund (IMF) and Federal State Statistics Service (Rosstat) databases will serve as data sources for analysis. GDP data are taken from IMF International Finance Statistics.[2] The research uses seasonally adjusted index of volume of GDP for modelling purposes. Rosstat is the source of unemployment (total, male and female) data.[3] The unemployment rate is calculated by Rosstat on the basis of International Labor Organization (ILO) methodology.[4] The data for both variables cover the period from 1995 [the beginning of the modern consecutive collection of statistics for Russia (after the break-up of the USSR) to the end of 2020]. Data description is presented in *Table 2*. Time series were adjusted for seasonality. The GDP indicator was taken as a logarithm and the unemployment rate was considered without a logarithm.

For econometric modelling and statistical correlation between unemployment and GDP growth, time series analysis of modelling data is needed.

In particular, a visual analysis of GDP, overall unemployment, and gender data showed that series have a deterministic trend (*Appendix 1, Fig. 1–3*). The same can be said about data for a series of LGDP variables where visual analysis does not reveal certain trends.

The ADF-test helped confirm the validity of the visual analysis. With a value level of 1% the time series for LGDP, d(UR_total) have a single root. Other time series such as UR (total), UR (male) and UR (female) are stationary (*Appendix 2, Table 1*).

The autocorrelation process was analyzed on the basis of the autocorrelation of residuals (form of autocorrelation) (*Appendix 1, Fig. 2*). A partial autocorrelation was found which indicates that the autocorrelation function is decreasing for the variable that characterizes the overall unemployment rate. This is also confirmed by the form the residuals are distributed (*Appendix 1, Fig. 3*). Moreover, autocorrelations of 1st, 3rd and 5th orders are of high importance. This assumption is further tested in regression equation with autoregressive variables $X(-1)$, $X(-3)$ and $X(-5)$ (*Appendix 2, Table. 2*). The evaluation confirmed the visual analysis assumption.

The residuals distribution graph also shows that the autocorrelation function is decreasing (*Appendix 1, Fig. 3*).

The Engle-Granger cointegration test correctly identified, whether the time

[2] IMF International Financial Statistics. URL: https://data.imf.org/?sk=4C 514D 48-B 6BA-49ED-8AB 9–52B 0C 1A0179B (accessed on 31.08.2021).

[3] Official website of the Federal State Statistics Service. Rosstat. URL: http://www.gks.ru/ (accessed on 31.08.2021).

[4] ILO Indicator description: Unemployment rate. URL: https://ilostat.ilo.org/resources/concepts-and-definitions/description-unemployment-rate/ (accessed on 31.08.2021).

Table 3

Variables for Estimating the Optimal Length

Dependent Variable: D(UR)				
Method: Least Squares				
Date: 06/27/21 Time: 20:28				
Sample (adjusted): 1996Q4 2020Q4				
Included observations: 97 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.018828	0.076807	0.245131	0.8070
D(UR(−1))	−0.142883	0.108135	−1.321345	0.1901
D(UR(−2))	−0.226868	0.108799	−2.085200	0.0402
D(UR(−3))	−0.005176	0.112342	−0.046075	0.9634
D(UR(−4))	0.321385	0.107997	2.975880	0.0038
D(UR(−5))	0.155949	0.112982	1.380303	0.1712
D(UR(−6))	−0.004297	0.107615	−0.039933	0.9682
D(UR(−7))	−0.116678	0.099798	−1.169136	0.2457
DLOG(GDP)	−32.23280	11.36062	−2.837240	0.0057
DLOG(GDP(−1))	−25.53007	11.37397	−2.244604	0.0275
DLOG(GDP(−2))	−3.316407	12.23670	−0.271021	0.7871
DLOG(GDP(−3))	−11.24537	12.22278	−0.920034	0.3603
DLOG(GDP(−4))	7.091200	12.11674	0.585240	0.5600
DLOG(GDP(−5))	8.505420	11.35478	0.749061	0.4560
DLOG(GDP(−6))	10.98067	11.96251	0.917923	0.3614
R-squared	0.433752	Mean dependent var		−0.038351
Adjusted R-squared	0.337075	S.D. dependent var		0.746959
S.E. of regression	0.608175	Akaike info criterion		1.984579
Sum squared resid	30.32992	Schwarz criterion		2.382730
Log likelihood	−81.25209	Hannan-Quinn criter.		2.145572
F-statistic	4.486629	Durbin-Watson stat		1.967222
Prob(F-statistic)	0.000007			

Source: compiled by author.

series are following the same stochastic trend for LGDP and UR variables, and whether the coefficients are evaluated in a consistent way, and whether the problem of false regression does not appear. The results of the pairing tests show that at 10% the variables LGDP and UR indicate no cointegration. This helped to conclude that all variables UR (general, female and male) and LGDP are not cointegrated at a level of significance of 10%. Moreover, GDP is a more exogenous variable than unemployment. This suggests that GDP has an impact on employment.

Overall, the analysis showed the adequacy of the time series under consideration for subsequent econometric evaluation.

EMPIRICAL RESULTS

For econometric modeling of interrelationship between time series the optimal log length is determined. To do this, a set of variables was generated. Estimation of optimal length identified six variables, four of which are statistically significant (*Table 3*).

On the basis of the results of the optimum length model, the long-term Okun coefficient was calculated using the formula:

$$c(DLOG(GDP)) + c(DLOG(GDP(-1))) + c(DLOG(GDP(-2))) + c(DLOG(GDP(-3))) + c(DLOG(GDP(-4))) + c(DLOG(GDP(-5))) + c(DLOG(GDP(-6)))) / (1 - (c(D(UR(-1))) + c(D(UR(-2))) + c(D(UR(-3))) + c(D(UR(-4))) + c(D(UR(-5))) + c(D(UR(-6))) + c(D(UR(-7)))).$$

Its value is 0.86. This estimate is close to the estimate received by economists Gurvich and Vakulenko in 2015 [10]. Differences may be due to the different time periods considered by the authors, as well as to the different factors affecting the labour market. In particular, the weaker impact of GDP on the labour market identified in this article may be related to government support for the labour market during the coronavirus pandemic crisis. Moreover, unemployment in Russia was lower than in some OECD countries. For example, the US unemployment rate exceeded 8.3% in 2020 [13].

To assess the significance of linear regression, an F-test was performed. According to the F-test, the null hypothesis (H0) assumes that the regression equation is statistically insignificant and the estimate is unreliable. For the F-test we compare the F-statistics from the best equation, which is 4.49, and the value from the F-distribution table with (m; $nK - 1$) degrees of freedom, which is 3.94 at a 5% significance level. This means that the actual t-criterion value of the Student's is greater than the table value. H0 irrelevance regression rejected.

CONCLUSION

For Russia, the Okun's law applies in both the short and long term. The study showed that the long-term Okun coefficient is negative and different from zero, and the variables LGDP and UR-total are considered cointegrated, meaning that the relationship between the variables is stable.

Country factors related to the Russian labour market may influence the evaluation results. These include: hidden unemployment not recorded in official data (reduced working hours, unpaid leave, no unemployment benefits and no union institution), and a large informal employment sector. Along with these factors, the Russian labour market is not responding to the crisis by increasing unemployment, but rather by reducing wages in real terms.

As in other countries, the relationship between GDP and unemployment increases during periods of crisis and declines (to such an extent that it may become insignificant) during periods of economic growth [14]. Overall, the Okun coefficient for Russia is slightly lower than the estimates for most developed countries and comparable to that for emerging market countries [15, 16].

Further direction of the analysis may be connected with the comparison of the obtained results for Russia with other countries. Of course, there are estimates of the Okun coefficient for other countries such as Switzerland (–0.24), Japan and Austria (–0.16 and –0.14 respectively), the US (–0.4), Spain (–0.85) [12]. In many countries, the relationship between GDP and unemployment increases during periods of crisis and decreases (as it may become insignificant) during periods of economic growth [10]. However, these results are not fully comparable with those calculated in this research for Russia. However, the Okun coefficient for Russia is slightly lower than the available estimates for most developed countries and more comparable with that for emerging market countries [17].

The observed differences in Okun's law coefficients between countries (and

apparently between periods) are determined by the institutional characteristics of the labour market (such as the strength of union institution in the negotiation, the level of employee protection, etc.), as well as the nature of the economic shocks that have occurred in the Russian economy. The Russian economy is characterized by more shocks (due to both national and international factors) that prevailed in Russia during the period under review. In comparison with Russia, the number of shocks in developed countries is relatively balanced. Therefore, estimates of Okun coefficients may be more related to the conditions under which Russia's economy developed during the period under review. This issue is often highlighted by researchers who consider that the evaluation of the Okun's law should also take into account external factors (including economic shocks) that could explain the relationship between unemployment and production [10].

Moreover, the formulation of meaningful conclusions from the comparative analysis of the Okun coefficient in Russia and other countries does not seem appropriate without a proper examination of the characteristics of the labour markets in these countries, which could be the subject of further research. For example, the problem may be related to the comparability of time periods during which studies have been conducted for Russia and other countries. Also important are the structural characteristics of the Russian labour market, which differs significantly from those of the OECD countries in terms of income levels, low labour productivity (due to the low level of capital stock in the economy), low labor market security, etc. [18]. Sanctions and other import barriers make it difficult to transfer of technology from abroad [19]. Weak investment climate, in particular weak property rights, they hinder innovation. In this regard, a further possible area of research could be to test the hypothesis of whether the Okun's law has common features for other economies under consideration.

However, the results of the Okun's law assessment for Russia may be of practical importance in the construction of forecasts of the reaction of unemployment to GDP change, as well as in the development of macroeconomic policy measures in Russia as a whole. In particular, estimates can be useful in determining costs to support employment and in the fight against inflation.

ACKNOWLEDGEMENTS

The article is based on the results of budgetary-supported research according to the state task carried out by the RANEPA. RANEPA, Moscow, Russia.

REFERENCES

1. Baily M.N., Okun A.M. The battle against unemployment and inflation: Problems of the modern economy. New York: W.W. Norton & Co.; 1965. 211 p.
2. Verbruggen H. Book review: Robert J. Gordon. Productivity growth, inflation, and unemployment, The collected essays of Robert J. Gordon. Cambridge University Press, Cambridge. 2004, pp. I–XII, 1–504. *De Economist*. 2005;153(2):227–230. DOI: 10.1007/s10645–005–2936–1
3. Okun A.M. Potential GNP: Its measurement and significance. Cowles Foundation Paper. 1962;(190). URL: https://milescorak.files.wordpress.com/2016/01/okun-potential-gnp-its-measurement-and-significance-p0190.pdf
4. Ball L., Leigh D., Loungani P. Okun's law: Fit at 50? IMF Working Paper. 2013;(10). URL: https://www.imf.org/external/pubs/ft/wp/2013/wp1310.pdf
5. Furhmann R. Okun's law: Economic growth and unemployment. Investopedia. 2022. URL: https://www.investopedia.com/articles/economics/12/okuns-law.asp
6. Akhundova O.V., Korovkin A.G., Korolev I.B. Interrelation of GDP and unemployment dynamics: Theoretical and practical approach. *Nauchnye trudy: Institut narodnokhozyaistvennogo prognozirovaniya RAN = Scientific Articles: Institute of Economic Forecasting. Russian Academy of Sciences.* 2005;3:471–495. (In Russ.).

7. Aghion P., Howitt P. Growth and unemployment. *The Review of Economic Studies*. 1994;61(3):477–494. DOI: 10.2307/2297900
8. Villaverde J., Maza A. Okun's law in the Spanish regions. *Economics Bulletin*. 2007;18(5):1–11.
9. Jardin M., Gaétan S. How Okun's law is non-linear in Europe: A semi-parametric approach. Rennes: University of Rennes; 2011. 14 p. URL: https://www.euroframe.org/files/user_upload/euroframe/docs/2011/EUROF11_Jardin_Stephan.pdf
10. Vakulenko E., Gurvich E. The relationship of GDP, unemployment rate and employment: In-depth analysis of Okun's law for Russia. *Voprosy ekonomiki*. 2015;(3):5–27. (In Russ.). DOI: 10.32609/0042–8736–2015–3–5–27
11. Dobrozhinskaya A. Okun's law and modern Russian economy. *Skif. Voprosy studencheskoi nauki = Sciff. Issues of Students' Science*. 2019;(5–2):133–135. (In Russ.).
12. Kazakova M. Okun's law: Theoretical foundations and estimates for Russia. *Ekonomicheskoe razvitie Rossii = Russian Economic Development*. 2017;24(11):27–36. (In Russ.).
13. Morath E., Hilsenrath J., Chaney S. Record rise in unemployment claims halts historic run of job growth. *The Wall Street Journal*. Mar. 26, 2020. URL: https://www.wsj.com/articles/the-long-run-of-american-job-growth-has-ended-11585215000
14. Ibragimov M., Karimov J., Permyakova E. Unemployment and output dynamics in CIS countries: Okun's law revisited. EERC Working Paper. 2013;(04).
15. Tombolo G., Hasegawa M. Okun's law: Evidence for the Brazilian economy. *Economic Research Guardian*. 2014;4(1):2–12.
16. D'Apice P. Path dependence and the persistence of high unemployment in the Slovak Republic. *ECFIN Country Focus*. 2014;11(3):1–9. URL: https://ec.europa.eu/economy_finance/publications/country_focus/2014/pdf/cf_vol11_issue3_en.pdf
17. Cevik E. I., Dibooglu S., Barişik S. Asymmetry in the unemployment — output relationship over the business cycle: Evidence from transition economies. *Comparative Economic Studies*. 2013;55(4):557–581. DOI: 10.1057/ces.2013.7
18. Kargi B. Okun's law and long term co-integration analysis for OECD countries (1987–2012). *International Research Journal of Finance and Economics*.2014;(119):77–85. URL: https://www.econstor.eu/bitstream/10419/97030/1/_119_08-libre.pdf
19. Zaytsev Yu. K. The impact of the sanctions regime on foreign direct investments in Russia. *Vestnik Rossiiskogo universiteta druzhby narodov. Seriya: Ekonomika = RUDN Journal of Economics*. 2018;26(4):760–772. (In Russ.). DOI: 10.22363/2313–2329–2018–26–4–760–772

Appendix 1

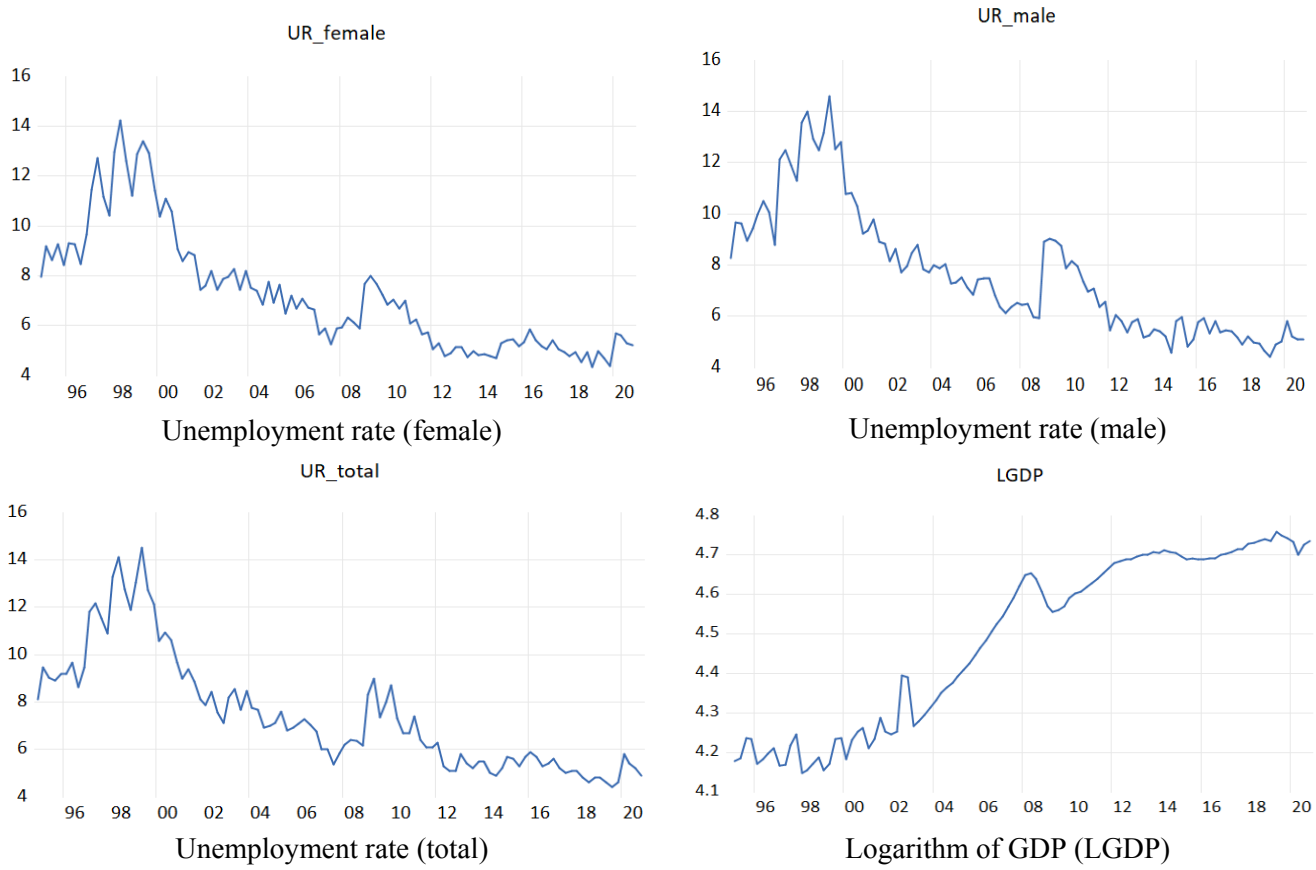
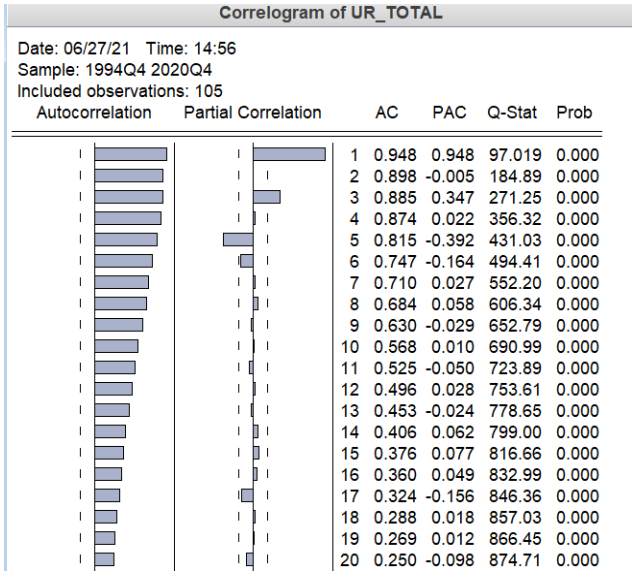
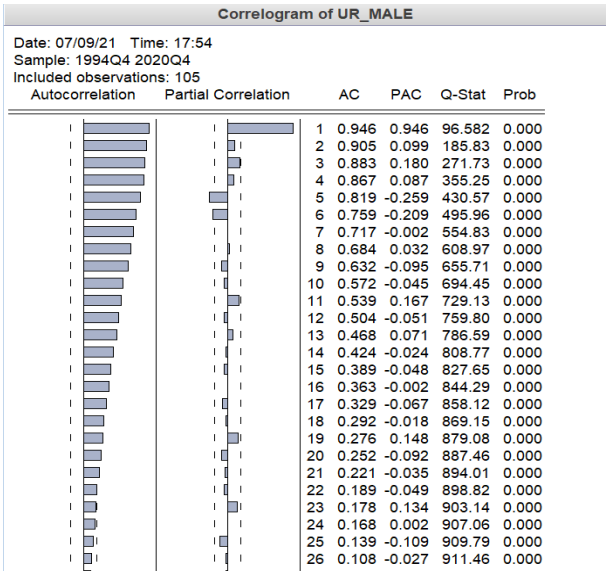


Fig. 1. **Data distribution for variables considered in the study**

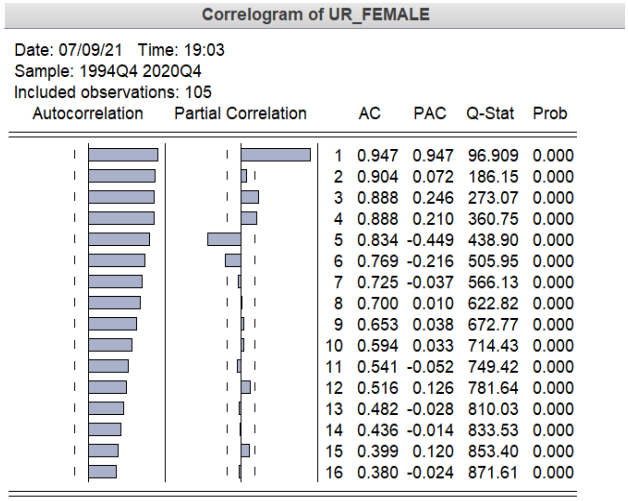
Source: compiled by the author.



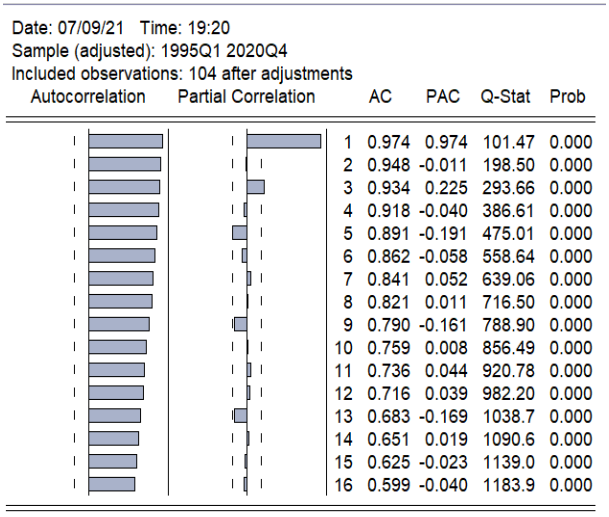
Autocorrelogram for data on unemployment rate (total)



Autocorrelogram for data on unemployment rate (male)



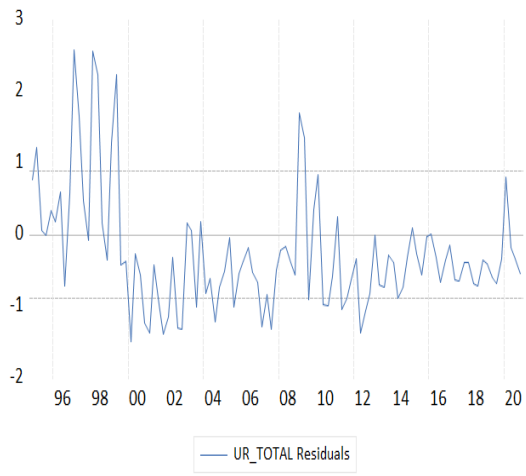
Autocorrelogram for data on unemployment rate (female)



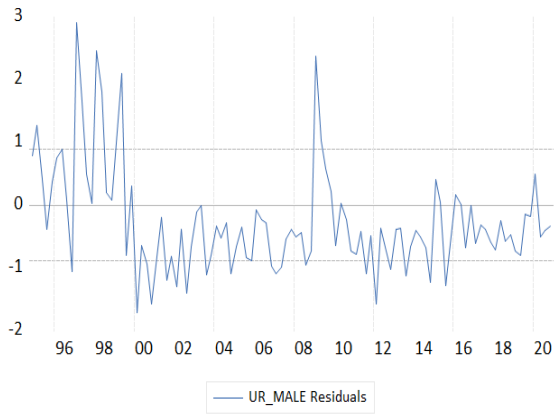
Autocorrelogram for data on LGDP variable

Fig. 2. **Autocorrelograms of data for variables considered in the study**

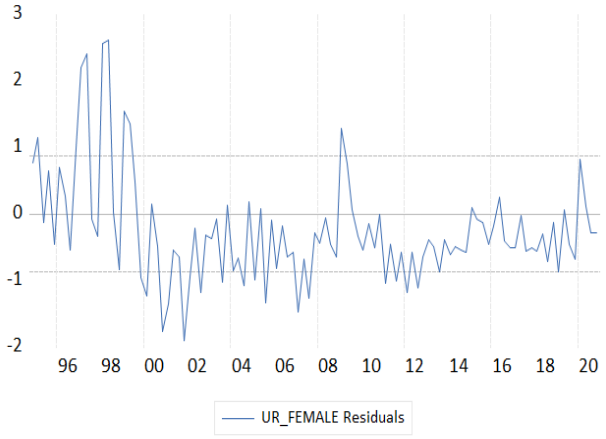
Source: compiled by the author.



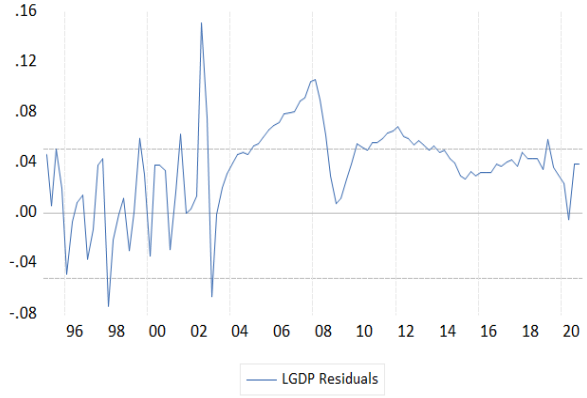
Residuals distribution for data set of unemployment rate (total) variable



Residuals distribution for data set of unemployment rate (male) variable



Residuals distribution for data set of unemployment (female) variable



Residuals distribution for data set of LGDP variable

Fig. 3. **Distribution of residuals for a dataset of variables considered in the study**

Source: compiled by the author.

Appendix 2

Table 1

ADF-tests

Time series name	Deterministic	Lag length (AIC)	t-stat	Significance level (–, *, **, ***)	Conclusion	H0: accepted/rejected
LGDP	C	5	–0.7	***	Unit root	
d(LGDP)	C	5	0.17	***	Unit root	
UR_total	C	5	–1.66	*	Stationarity	Rejected
d(UR_total)	-	5	–0.69	***	Unit root	
UR_ male	C	5	–1.53	*	Stationarity	Rejected
d(UR_ male)		5	–2.1	**	Stationarity	Rejected
UR_ female	C	5	–1.7	*	Stationarity	Rejected
d(UR_ -female)	-	5	–2.10	**	Stationarity	Rejected

Source: compiled by the author.

Table 2

Autocorrelation function assessment results

Dependent Variable: UR_TOTAL
Method: Least Squares
Date: 06/27/21 Time: 15:17
Sample (adjusted): 1996Q1 2020Q4
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.232427	0.232554	0.999456	0.3201
UR_TOTAL(-1)	0.847429	0.074395	11.39099	0.0000
UR_TOTAL(-3)	0.311586	0.079677	3.910602	0.0002
UR_TOTAL(-5)	-0.195289	0.074778	-2.611575	0.0105

R-squared	0.923126	Mean dependent var	7.399300
Adjusted R-squared	0.920724	S.D. dependent var	2.461923
S.E. of regression	0.693180	Akaike info criterion	2.144123
Sum squared resid	46.12781	Schwarz criterion	2.248330
Log likelihood	-103.2061	Hannan-Quinn criter.	2.186297
F-statistic	384.2665	Durbin-Watson stat	1.901514
Prob(F-statistic)	0.000000		

Source: compiled by the author.

ABOUT THE AUTHOR

Yury K. Zaytsev — Cand. Scu. (Econ.), Senior Research Fellow, Institute of Applied Economic Research, RANEPA, Moscow, Russia
https://orcid.org/0000-0003-2458-7419
yuriy.zaitsev@gmail.com

Conflicts of Interest Statement: The author has no conflicts of interest to declare.

The article was submitted on 18.04.2022; revised on 30.04.2022 and accepted for publication on 17.05.2022.
The author read and approved the final version of the manuscript.