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INFLUENCE OF MONETARY POLICY INSTRUMENTS AND INDICATORS ON DYNAMICS OF FINANCING INNOVATION: EMPIRICAL EVIDENCE

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ABSTRACT

Today innovations are drivers of countries' economic growth, competitiveness, security, and sustainable development. Financial policy and its instruments play a significant role in innovation management, and monetary instruments are one of the most important components of financial policy. Therefore, the necessity of increasing the efficiency of financial support for innovation development actualizes the study of the impact of the monetary policy instruments and indicators on the level of financing innovation. The aim of the article is to improve the scientific basis for the study of the impact of monetary policy instruments and indicators on the dynamics of financing innovation based on empirical evidence. Information basis of the research was formed from the data for Ukraine and 12 post-soviet and other countries with similar starting economic conditions for 2010-2019, taking into account the availability of statistics from the International Monetary Fund, the World Bank, and the central banks for the whole investigated indicators at the time of the study. The software base included Excel and STATA. The methods of regression (linear regression model with panel-corrected standard errors) and correlation analysis (calculating Pearson and Spearman coefficients) were applied to identify a relationship between monetary instruments and indicators and indicator of financing innovation, confirm the hypothesis about the impact of the monetary instruments and indicators on the financing innovation and formalize this effect. To strengthen the country's innovation development, it is proved the expediency of lowering the discount rate and real interest rate, increasing "broad money" on general reserves, and increasing liquid reserves on bank assets, as well as the transition to inflation targeting. According to the calculations, for all monetary instruments and indicators, except the discount rate, the directions of influence in Ukraine and the panel from 12 other countries were opposite. This one confirms that monetary instruments in Ukraine are not fully performing their regulatory function, in the context of stimulating innovation development.

Keywords: discount rate, financial providing, financing innovation, inflation targeting, innovation development, monetary policy, R&D expenditures, real interest rate

JEL Classification: O3, E52, E63, G32

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INTRODUCTION

In modern conditions, the abilities to achieve a sufficient level of economic growth, investment attractiveness, the competitiveness of Ukraine, and ensure its sustainable development are significantly dependent on the level of innovation development of the country and the effectiveness of its financial support. The analysis of official statistics from the World Bank, the Organization for Economic Co-operation and Development, the European Union's statistical office, and the annual world, and European ratings indicate a low level of funding innovation in Ukraine compared to highly developed countries. The main reasons are the underdevelopment of financial policy instruments to stimulate innovation activities of economic entities, fundamental and applied research and development, as well as the lack of actual mechanisms for their implementation that cause Ukraine's lag in innovation development. Monetary instruments are one of the important components of financial policy. Therefore, increasing the efficiency of

financial support for innovation development actualizes the study of the impact of the monetary policy instruments and indicators on the level of financing innovation.

LITERATURE REVIEW

Some aspects of this issue were explored by Aysun & Kabukcuoglu (2019), in particular, how interest rates are related to the distribution of investment between innovation-active firms and innovation-inactive firms. The authors argue that if innovation is stimulated mainly through grants and subsidies, the share of research and development (R&D) costs increases (decreases) during the strengthening (weakening) of credit. Conversely, if tax credits are the main incentive, firms reduce (increase) their share of R&D expenditures while strengthening (weakening) credit [1]. Kobushko et al. (2017) [2], Sineviciene et al. (2018) [3], Miuller, Kuznetsova et al. (2021) [4], Serpeninova et al. (2020) [5] investigated promoting and financing innovation to increase the economic growth, security and sustainable development. Gil & Iglésias (2020) determined the long-term effects of inflation and monetary policy in the growth model, including indicators of R&D, real interest rate, economic growth, investment rate etc. [6].

The influence of monetary policy and innovation development on the national economy was also studied by Jiang & Wang (2017) [7], Svirskyi & Melykh (2017) [8], Paskevicius & Keliuotyte-Staniuleniene (2018) [9], Bello (2017) [10] etc. Chu at al. (2013) investigated monetary policy impact on economic growth and prosperity in the Schumpeterian model and found that increasing the domestic nominal rate reduces domestic R&D investment and the growth rate of domestic technologies. It was found that when each government pursues its monetary policy unilaterally to maximize the welfare of only domestic households, nominal interest rates tend to be higher than the optimal nominal interest rates chosen by cooperative governments that maximize the well-being of both domestic and foreign households. That is, the effects of monetary policy on welfare between countries are quantitatively significant [11].

Hori (2019) studied optimal monetary policy and built an endogenous growth model in which heterogeneous research and development firms are financially constrained and use cash to finance R&D investments [12]. Instead, Zhang et al. (2020) argued that nowadays behavior of domestic enterprises is significantly influenced by foreign economic policy. In particular, the authors examined the interconnection between monetary policy in the USA and investment in research and development of Chinese enterprises from 2015 to 2018 – an increase in US Federal Reserve interest rates has a positive and significant impact on R&D investment by Chinese enterprises, especially small ones [13]. Some other aspects of investigating the effects of monetary instruments are shown in research by Eddassi (2020) (the relations between interest rates, state debt and GDP) [14], Dudchenko (2020), and Barhaq & Zakutniaia (2017). (the effects of bank independence and other monetary indicators) [15-17], Zarutska et al. (2018) (banking supervision and innovation) [18], Islam & Khan (2019) (European practice in banking regulation due to different instruments and its role) [19], Mursalov (2020) (the interconnection of innovation development, monetary policy, banking regulation, financial policy) [20] etc.

As for Ukraine, this issue has not been studied, it needs further scientific development in close connection with the study of European trends.

AIMS AND OBJECTIVES

The aim of the article is to improve the scientific basis for the study of the impact of monetary policy instruments and indicators on the dynamics of financing innovation based on empirical evidence.

METHODS

The methods of regression (linear regression model with panel-corrected standard errors) and correlation analysis (calculating Pearson and Spearman coefficients) were applied to identify a relationship between monetary instruments and indicators and indicators of financing innovation, confirm the hypothesis about the impact of the monetary instruments and indicators on the financing innovation and formalize this effect [21-25]. Other scientific methods and instruments were statistical analysis, comparative analysis, analytical method, the Shapiro-Wilk test [26], time lag determination etc. Information basis was formed from the data for Ukraine and 12 post-soviet and other countries with similar starting economic conditions for 2010-2019, taking into account the availability of statistics from the International Monetary Fund, the World Bank and the central banks for the whole investigated indicators at the time of the study. Software base included Excel and STATA.

RESULTS

To study the impact of monetary policy instruments on the dynamics of financing innovation, a sample of 13 countries was formed, based on the proximity of selected countries to Ukraine (former CIS members, countries with similar starting conditions and different economic scenarios, current members of EU, etc.), and on the basis of statistics from the International Monetary Fund, the World Bank and the central banks of the studied countries for 2009-2019. The object of the study were the discount rate (Table 1), the real interest rate (Table 2), the ratio of "broad money" to total reserves (Table 3), the ratio of liquid reserves to bank assets (Table 4), the introduction of inflation targeting (Table 5) and, accordingly, the share of R&D expenditures in the country's GDP (Table 6).

Table 1. Discount rate for 2010–2019, % per year. *(Source: compiled by the authors according to the International Monetary Fund [27] and the National Bank of Ukraine [28])*

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Armenia	7.25	8.00	8.00	7.75	8.50	8.75	6.25	6.00	6.00	5.50
Azerbaijan	3.00	5.25	5.00	4.75	3.50	3.00	15.00	15.00	9.75	7.50
Belarus	10.50	45.00	30.00	23.50	20.00	25.00	18.00	11.00	10.00	9.00
Bulgaria	0.18	0.22	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.00
Czech Republic	0.75	0.75	0.05	0.05	0.05	0.05	0.05	0.50	1.75	2.00
Georgia	7.50	6.75	5.25	3.75	4.00	8.00	6.50	7.25	7.00	9.00
Hungary	5.75	7.00	5.75	3.00	2.10	1.35	0.90	0.90	0.90	0.90
Kyrgyz Republic	5.50	13.61	2.64	4.17	10.50	10.00	5.00	5.00	4.75	4.25
Moldova	7.00	9.50	4.50	3.50	6.50	19.50	9.00	6.50	6.50	5.50
Romania	6.25	6.00	5.25	4.00	2.75	1.75	1.75	1.75	2.50	2.50
Russian Federation	7.75	8.00	8.25	5.50	17.00	11.00	10.00	7.75	7.75	6.25
Tajikistan	8.25	9.80	6.50	5.50	8.00	8.00	12.50	16.00	14.00	12.25
Ukraine	8.69	7.75	7.56	7.08	9.88	23.04	17.97	13.19	17.10	17.04

The weighted average discount rate (% per year) was calculated for Ukraine based on the statistical data of the National Bank of Ukraine [28]. For other countries, the indicator of the discount rate [27] was shown according to the data of the International Monetary Fund.

The dynamics of changes in the discount rate for 2010–2019 in Ukraine and other countries is presented in Figure 1.

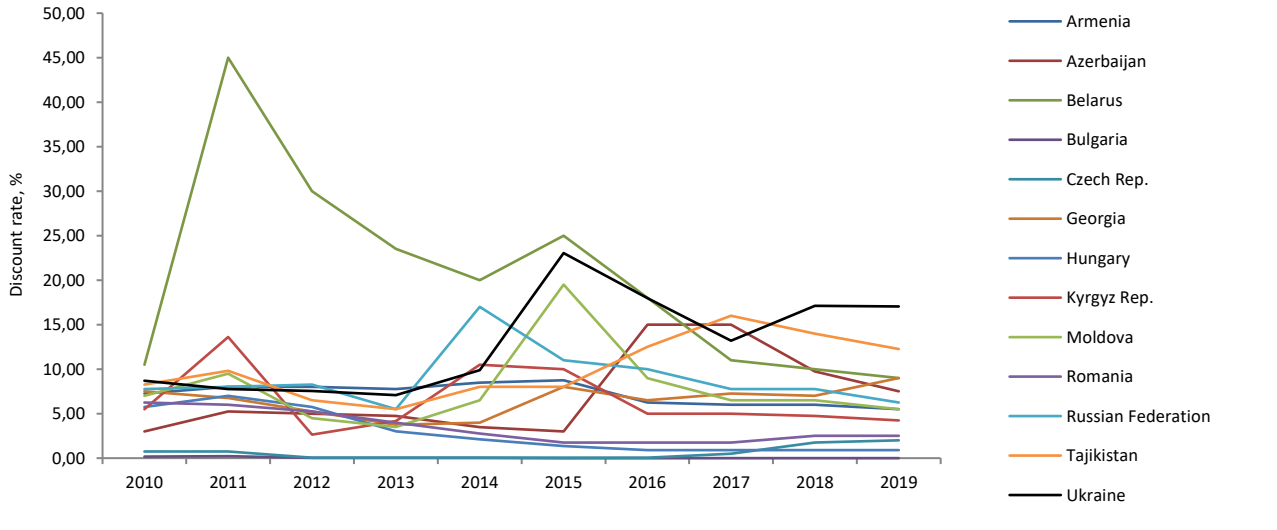

Figure 1. Analysis of the dynamics of changes in the discount rate for 2010-2019 in Ukraine and other countries.

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In most countries the dynamics are not stable, in some years there are sharp increases and decreases in the discount rate, except for the Czech Republic, Romania, Bulgaria, etc., where there are no such sharp fluctuations. Ukraine is characterized by an increase in the discount rate in 2013-2015, which can be explained by the systemic crisis in the country.

Table 2 shows the data on the real interest rate in the studied countries.

Table 2. Real interest rate for 2010–2019, % per year. *(Source: compiled by the authors according to the World Bank [29])*

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Armenia	10.61	12.92	11.28	12.22	13.78	16.18	17.04	12.00	9.73	10.53
Azerbaijan	6.04	-4.51	15.07	17.72	19.45	28.89	1.52	0.27	4.69	17.55
Belarus	-1.86	-33.60	-31.83	-1.75	0.54	1.78	5.59	0.95	-3.07	2.30
Bulgaria	9.89	4.42	8.06	9.78	7.76	4.89	3.76	1.44	0.91	-0.10
Czech Republic	7.42	5.70	3.89	3.49	2.11	3.08	2.61	2.12	0.96	0.16
Georgia	1.45	5.78	14.28	12.09	7.37	6.29	9.75	2.76	6.50	3.92
Hungary	5.08	6.01	5.62	3.23	0.83	0.44	1.11	-2.14	-2.93	-2.61
Kyrgyz Republic	12.44	1.06	13.20	17.59	10.81	19.53	17.43	12.69	15.53	20.01
Moldova	-12.71	5.77	5.58	8.05	4.38	4.18	8.14	3.87	5.49	2.62
Romania	10.17	8.04	7.04	6.90	6.61	4.05	3.18	0.85	0.48	0.23
Russian Federation	-2.96	-12.86	0.18	3.94	3.40	7.89	9.48	4.95	-2.01	4.79
Tajikistan	9.75	8.06	8.23	19.98	18.87	23.99	18.65	24.21	21.32	21.32
Ukraine	1.71	1.53	9.83	11.80	1.57	-12.28	1.62	-4.67	3.13	10.81

The real interest rate is calculated by the World Bank and is the interest rate on loans adjusted for inflation as measured by the GDP deflator. Figure 2 shows the dynamics of changes in the real interest rate for 2010-2019 in Ukraine and studied countries.

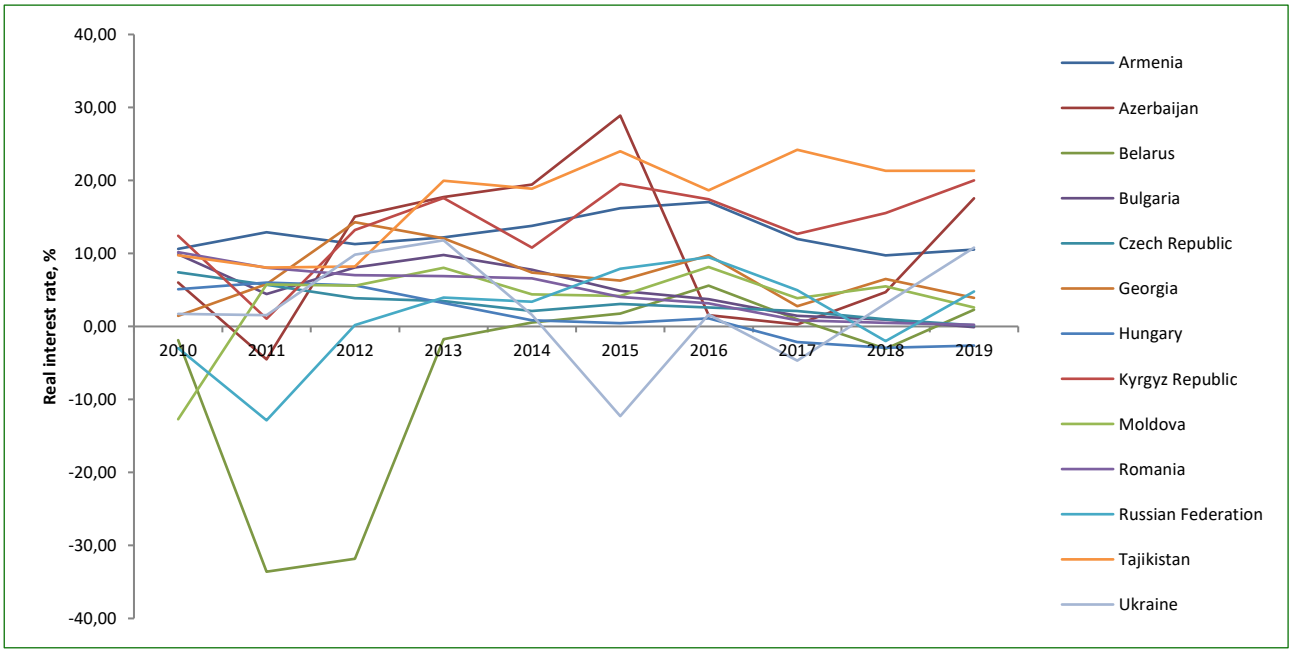

Figure 2. Analysis of the dynamics of changes in the real interest rate for 2010-2019 in Ukraine and other countries.

In Belarus. the Russian Federation, Ukraine, Azerbaijan and Hungary, real interest rates were negative during the study period. At the same time, the fall in the real interest rate was not long enough and was replaced by positive dynamics. In Ukraine, the negative trend of changes in the real interest rate was particularly noticeable in 2015 and 2017.

Table 3 provides data on the ratio of liquid reserves to bank assets for 2010-2019 in Ukraine and sample countries.

Table 3. Ratio of liquid reserves to bank assets for 2010–2019, %. *(Source: compiled by the authors according to the World Bank [30])*

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Armenia	17.15	20.43	16.83	24.18	20.47	22.00	22.32	19.72	19.56	18.81
Azerbaijan	10.25	12.06	10.06	7.22	7.51	12.82	37.94	30.53	26.58	23.41
Belarus	18.87	31.81	23.64	18.00	16.98	18.32	19.22	17.15	12.42	14.71
Bulgaria	11.26	11.17	13.38	11.80	13.49	26.07	24.58	22.42	22.39	18.11
Czech Republic	15.41	14.41	13.80	22.28	22.15	27.06	37.27	63.77	60.77	61.20
Georgia	12.94	21.26	21.87	22.34	20.61	17.48	18.26	15.85	16.61	15.54
Hungary	17.30	20.73	23.82	33.80	34.18	28.20	13.47	10.78	8.29	10.49
Kyrgyz Republic	20.12	19.53	26.02	21.00	13.86	14.13	24.37	19.73	18.89	19.01
Moldova	25.98	26.54	26.90	20.50	15.06	19.90	31.13	38.58	40.42	38.72
Romania	25.06	23.63	21.13	24.10	21.98	22.10	20.86	21.83	16.78	16.96
Russian Federation	12.11	8.19	8.84	7.70	7.26	5.55	6.56	9.43	8.87	9.01
Tajikistan	33.35	25.94	28.21	19.68	19.77	22.83	37.89	37.48	45.08	37.56
Ukraine	6.30	5.81	5.49	7.01	5.77	11.66	11.36	11.16	10.74	22.38

The ratio of bank liquid reserves to bank assets ratio is calculated by the World Bank as the ratio of national currency reserves and deposits to claims on other governments, non-financial state-owned enterprises, the private sector and other banking institutions. It is graphically presented in Figure 3.

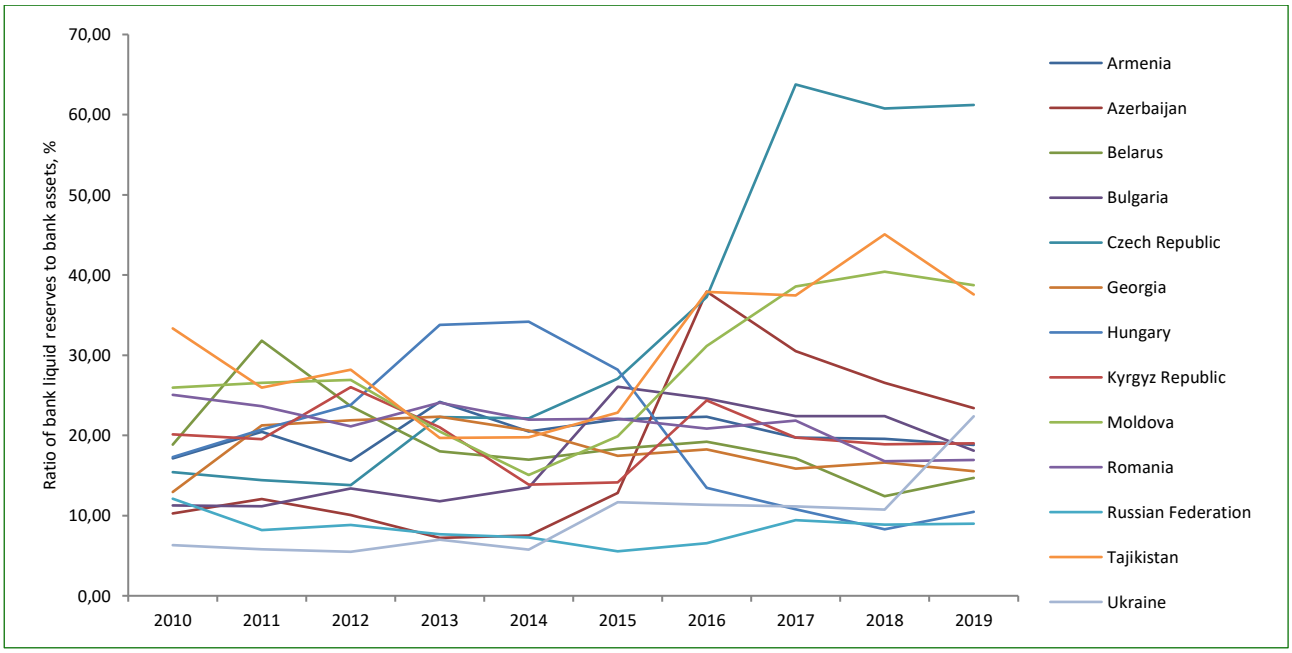

Figure 3. Dynamics of changes in the ratio of liquid reserves to bank assets in Ukraine and other countries in 2010-2019.

In the Czech Republic in 2017 there is a significant leap in the direction of increasing this indicator of monetary policy. There are also high values in Azerbaijan and Tajikistan. In Ukraine, the level of ratio of bank liquid reserves to bank assets is relatively low, which is clearly seen in the chart. At the same time, starting from 2018, there is a positive trend in Ukraine.

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Table 4 presents data on the dynamics of changes in the value of the ratio of "broad money" to total reserves in Ukraine and sample countries in 2010-2019.

Table 4. The ratio of "broad money" to total reserves for 2010-2019, %. *(Source: compiled by the authors according to the World Bank [31])*

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Armenia	1.31	1.57	1.86	1.68	2.70	2.19	2.06	2.31	2.54	2.25
Azerbaijan	2.05	1.71	1.89	1.62	1.74	2.84	1.99	1.98	2.12	2.41
Belarus	3.36	2.84	2.39	3.27	4.62	4.92	3.48	2.82	2.96	2.47
Bulgaria	1.99	2.35	1.98	2.29	2.29	1.89	1.79	1.74	1.96	2.10
Czech Republic	3.40	3.98	3.38	2.86	2.94	2.27	1.83	1.22	1.45	1.39
Georgia	1.54	1.49	1.67	2.09	2.35	2.33	2.46	2.42	2.53	2.49
Hungary	1.78	1.81	1.69	1.76	1.92	2.14	2.93	2.98	3.02	3.00
Kyrgyz Republic	0.88	0.94	1.01	1.12	1.19	1.25	1.19	1.29	1.37	1.36
Moldova	1.75	1.78	1.63	1.77	2.18	1.94	1.61	1.49	1.65	1.67
Romania	1.33	1.47	1.37	1.49	1.81	1.85	1.94	1.94	2.29	2.37
Russian Federation	1.64	1.95	1.94	2.30	2.89	2.29	2.01	2.17	2.09	1.80
Tajikistan	2.53	2.48	2.37	2.70	3.59	3.55	2.93	1.63	1.61	1.59
Ukraine	2.18	2.71	3.94	5.57	10.68	3.42	2.78	2.42	2.26	2.20

The ratio of "broad money" to total reserves is calculated by the World Bank as the ratio of the amount of currency outside banks; demand deposits other than central government deposits; time, savings and foreign currency deposits of non-central government residents; bank and traveller's cheques; other securities, such as certificates of deposit and commercial papers, to general reserves. The dynamics of change in this indicator in different countries is shown in Figure 4.

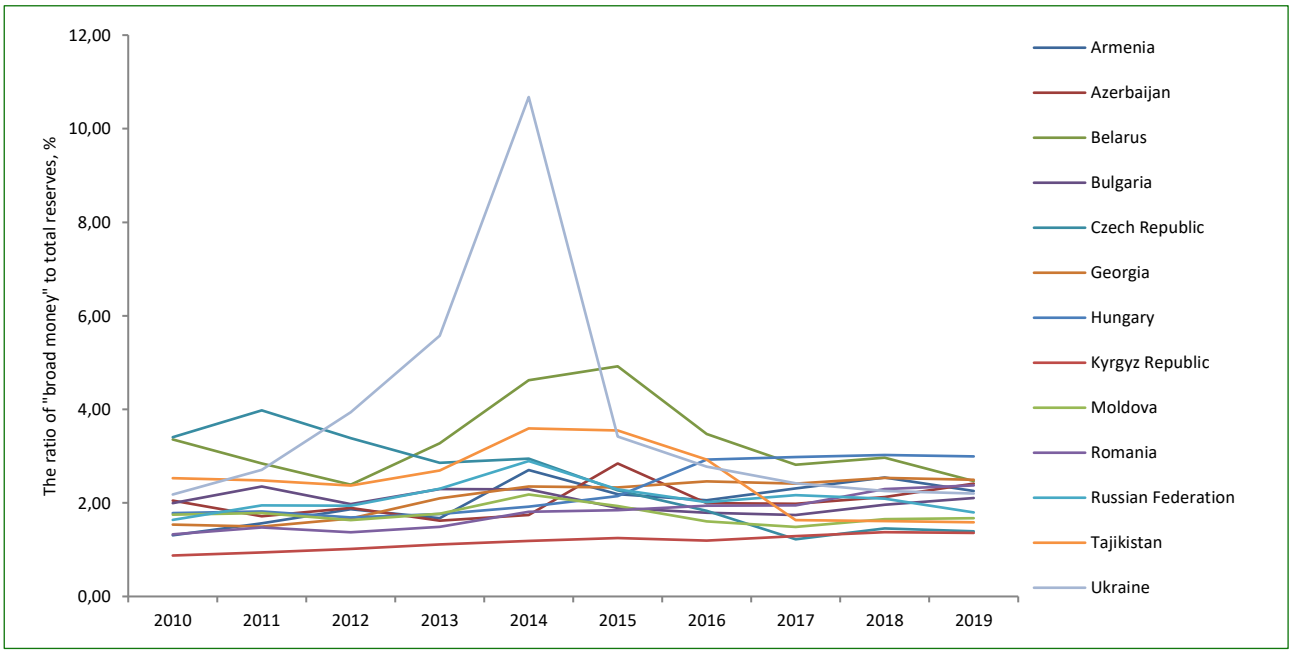

Figure 4. Dynamics of change in the ratio of "broad money" to total reserves in Ukraine and other countries in 2010-2019.

On this chart, Ukraine stands out the most, where in 2013-2015 there were sharp changes in this indicator. Sharp jumps are also observed in Belarus, Tajikistan, Hungary, and the Czech Republic, while in other studied countries the ratio of "broad money" to total reserves is relatively stable compared to other sample countries.

Another important indicator of monetary policy is inflation targeting (Table 5), for the study of which the Dummy-indicator is introduced: when introducing the inflation targeting regime – 1 point, if inflation targeting is not applied – 0 points.

Table 5. Dummy inflation targeting indicator (1 – introduced inflation targeting mode, 0 – inflation targeting is not applied) for 2010–2019. *(Source: compiled by the authors according to the Centralbanknews, Jahan, National Bank of the Republic of Belarus, Interfax Azerbaijan [32-35])*

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Armenia	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Azerbaijan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belarus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech Republic	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Georgia	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Hungary	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Kyrgyz Republic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Moldova	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Romania	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Russian Federation	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
Tajikistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ukraine	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0

In Ukraine, the transition to inflation targeting took place in 2015, while in many countries in Europe and the world it has been successfully applied for a relatively long time. The goal of inflation targeting is to achieve a consistently low level that will ultimately have a positive impact on long-term price stability, economic growth and sustainable development of the country.

Let's investigate how the above indicators affect the share of $R\&D$ expenditures in the country's GDP and its dynamics. Accordingly, data on the share of gross expenditure on $R\&D$ in the GDP of Ukraine and other sample countries are shown in Table 6.

Table 6. The share of gross $R\&D$ expenditures in GDP for 2010–2019, %. Note: * - in the absence of statistics the level of 2018 was taken. *(Source: compiled by the authors according to the World Bank [36])*

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019*
Armenia	0.24	0.27	0.24	0.22	0.24	0.25	0.23	0.23	0.19	0.19
Azerbaijan	0.22	0.21	0.21	0.21	0.21	0.22	0.21	0.18	0.18	0.18
Belarus	0.65	0.68	0.65	0.65	0.51	0.50	0.50	0.58	0.61	0.61
Bulgaria	0.56	0.53	0.60	0.64	0.79	0.96	0.78	0.75	0.77	0.77
Czech Republic	1.34	1.56	1.78	1.90	1.97	1.93	1.68	1.79	1.93	1.93
Georgia	0.08	0.08	0.08	0.08	0.18	0.32	0.30	0.29	0.30	0.30
Hungary	1.14	1.19	1.26	1.39	1.35	1.36	1.20	1.35	1.55	1.55
Kyrgyz Republic	0.16	0.16	0.17	0.15	0.13	0.12	0.11	0.11	0.11	0.11
Moldova	0.37	0.34	0.35	0.30	0.31	0.31	0.28	0.25	0.25	0.25
Romania	0.46	0.50	0.48	0.39	0.38	0.49	0.48	0.50	0.51	0.51
Russian Federation	1.13	1.01	1.03	1.03	1.07	1.10	1.10	1.11	0.99	0.99
Tajikistan	0.09	0.12	0.11	0.12	0.12	0.11	0.11	0.12	0.10	0.10
Ukraine	0.83	0.74	0.75	0.76	0.65	0.61	0.48	0.45	0.47	0.47

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The analysis of the dynamics of changes in the share of R&D expenditures in the GDP of these countries is graphically presented in Figure 5.

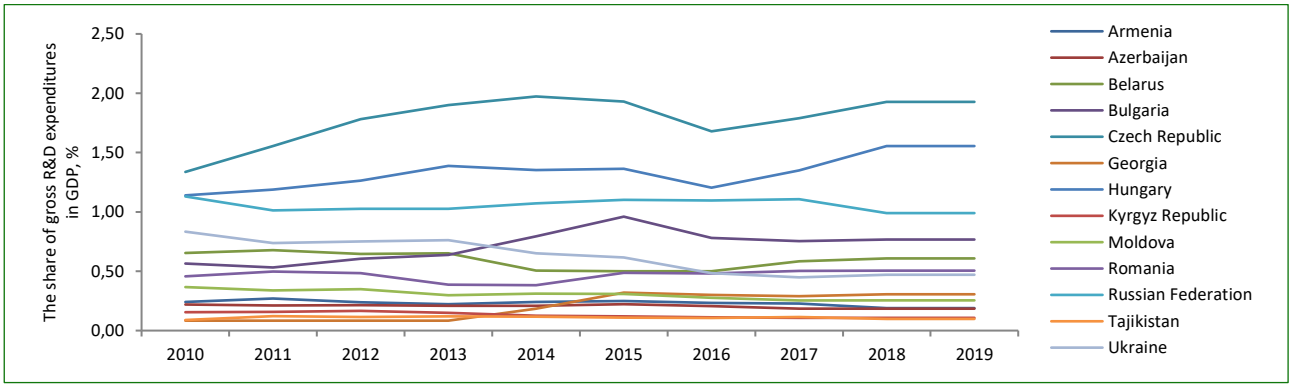

Figure 5. Dynamics of change in the share of gross expenditures on R&D in the GDP of Ukraine and other countries in 2010-2019.

Ukraine is at the average level of the share of $R\&D$ expenditures in GDP in this sample of countries. Since 2013, there has been a decrease in this indicator.

To determine the significance, strength and nature of the relationship between the discount rate, real interest rate, the ratio of "broad money" to total reserves, the ratio of liquid reserves to bank assets, the introduction of inflation targeting and the share of gross $R\&D$ expenditures in GDP, the subordination of variables to the law of normal distribution was previously checked according to the Shapiro-Wilk test (Table 7).

Table 7. Testing the subordination of monetary policy indicators to the law of normal distribution (the Shapiro-Wilk test). Note: * - not subject to normal distribution; DR - discount rate; RR - real interest rate; R1 - the ratio of "broad money" to total reserves; R2 - the ratio of liquid reserves to bank assets.

	W	V	z	Prob > z		W	V	z	Prob > z
Armenia					***Azerbaijan***				
DR	0.92249	1.194	0.310	0.37823	**DR**	0.86562	2.071	1.348	0.08884
RR	0.91372	1.330	0.503	0.30755	**RR**	0.94919	0.783	-0.409	0.65888
R1	0.97785	0.341	-1.671	0.95264	**R1**	0.89670	1.592	0.836	0.20148
R2	0.96897	0.478	-1.181	0.88113	**R2**	0.86389	2.098	1.374	0.08480
Belarus					***Bulgaria***				
DR	0.88179	1.822	1.095	0.13681	**DR**	0.58018	6.470	3.997	0.00003*
RR	0.67755	4.969	3.307	0.00047*	**RR**	0.92501	1.156	0.252	0.40063
R1	0.87205	1.972	1.250	0.10560	**R1**	0.91748	1.272	0.422	0.33642
R2	0.85095	2.297	1.558	0.05962	**R2**	0.85972	2.162	1.434	0.07573
Czech Republic					***Georgia***				
DR	0.83995	2.466	1.705	0.04407*	**DR**	0.93711	0.969	-0.053	0.52130
RR	0.95260	0.730	-0.522	0.69930	**RR**	0.95991	0.618	-0.789	0.78490
R1	0.92738	1.119	0.195	0.42261	**R1**	0.81357	2.873	2.030	0.02119*
R2	0.81680	2.823	1.992	0.02318*	**R2**	0.94181	0.897	-0.185	0.57334
Hungary					***Kyrgyz Republic***				
DR	0.79831	3.108	2.202	0.01383*	**DR**	0.83734	2.507	1.739	0.04100*
RR	0.90654	1.440	0.649	0.25804	**RR**	0.87240	1.966	1.245	0.10660
R1	0.77188	3.516	2.479	0.00659*	**R1**	0.93987	0.927	-0.130	0.55154
R2	0.91514	1.308	0.473	0.31820	**R2**	0.92163	1.208	0.330	0.37078
Moldova					***Romania***				
DR	0.75582	3.763	2.635	0.00420*	**DR**	0.82910	2.634	1.843	0.03264*
RR	0.64433	5.481	3.557	0.00019*	**RR**	0.91999	1.233	0.367	0.35687
R1	0.90382	1.482	0.702	0.24120	**R1**	0.92280	1.190	0.303	0.38089
R2	0.93001	1.079	0.131	0.44798	**R2**	0.89788	1.574	0.815	0.20764
Russian Federation					***Tajikistan***				
DR	0.81234	2.892	2.044	0.02047*	**DR**	0.94689	0.818	-0.337	0.63191
RR	0.90532	1.459	0.673	0.25036	**RR**	0.83286	2.576	1.796	0.03622*
R1	0.91675	1.283	0.438	0.33062	**R1**	0.90386	1.482	0.702	0.24143
R2	0.95364	0.714	-0.558	0.71167	**R2**	0.92845	1.103	0.169	0.43278
Ukraine									
DR	0.88792	1.727	0.992	0.16066					
RR	0.90329	1.490	0.713	0.23800					
R1	0.67192	5.056	3.351	0.00040*					
R2	0.77415	3.481	2.456	0.00703*					

Based on the test results, the method of calculating the Pearson or Spearman correlation coefficient on the allowable calculation interval was chosen, taking into account time lags from 0 years to 3 years (Table 8).

Table 8. The results of correlation analysis and determination of the nature of the relationship (d, i), the strength of influence (h, a, l) and the duration of time lags (years), when the impact of individual monetary policy indicators on the share of gross R&D. Note: * - in the allowable calculation interval with a lag of 0–3 years, the impact remains statistically insignificant; d - direct connection; i - inverse relationship; h - high level of influence; a - average level of influence; l - low level of influence; DR - discount rate; RR - real interest rate; R1 - the ratio of "broad money" to total reserves; R2 - the ratio of liquid reserves to bank assets.

	Armenia	Azerbaijan	Belarus	Bulgaria	Czech Republic	Georgia	Hungary	Kyrgyz Republic	Moldova	Romania	Russian Federation	Tajikistan	Ukraine
DR	0.74	-0.93	-0.73	0.22	0.32	-0.48	-0.51	-0.52	-0.66	-0.93	0.66	-0.71	-0.84
	d h 0	i h 1	i h 3	* l *	* l *	i a 3	i a 3	i a 1	i h 2	i h 3	d h 1	i h 1	i h 1
RR	-0.81	0.56	-0.60	-0.45	-0.85	0.82	-0.79	-0.70	0.46	-0.81	0.55	-0.77	0.54
	i h 3	d a 1	i a 0	i a 0	i h 0	d h 3	i h 0	i h 1	d a 2	i h 3	d a 1	i h 1	d a 1
R1	-0.55	-0.66	-0.76	-0.46	-0.50	0.59	0.54	-0.91	-0.49	0.68	0.55	0.45	0.85
	i a 1	i a 2	i h 1	i a 0	i a 0	d a 2	d a 2	i h 0	i a 3	d h 3	d a 2	d a 1	d h 0
R2	-0.46	-0.80	-0.52	0.83	0.45	0.67	-0.71	0.33	-0.65	-0.76	-0.78	-0.61	-0.81
	i a 3	i h 2	i a 3	d h 0	i a 0	d h 3	i h 2	* l *	i h 0	i h 3	i h 1	i a 2	i h 2

To substantiate and assess the impact of the discount rate, real interest rate, the ratio of "broad money" to total reserves, the ratio of liquid reserves to bank assets, and the application of inflation targeting on the share of gross $R\&D$ expenditures in the country's GDP a linear regression with panel-corrected standard errors was built [25]. It is based on the estimation of coefficients by the usual least-squares method (OLS) in the absence of autocorrelation and assumptions that disturbances are not independent of each observation, but are heteroskedastic and correlated between panels. The panel data estimation model with panel adjustment of standard error estimates is also considered an alternative to estimating linear cross-sector time series models [23].

The results of the formalization of the impact of individual monetary instruments and indicators on the share of R&D expenditures in the country's GDP are given in Table 9.

Table 9. Results of the impact of formalization of individual monetary instruments and indicators on the share of R&D expenditures in the country's GDP. Note: $R\&D$ - the share of gross R&D expenditures in the country's GDP; *DR* - discount rate; *RR* - real interest rate; *R1* - the ratio of "broad money" to total reserves; *R2* - the ratio of liquid reserves to bank assets; *IT* - dummy-inflation targeting; $Coef$ - estimates of β coefficients; $Panel-corrected\ Std.Err.$ - standard deviations of estimates, adjusted by the panel; z - z - statistics; P - the level of significance of the z -criterion; $Conf.Interval$ - confidence interval; *Const.* - constant.

$R\&D$	$Coef.$	$Panel-corrected\ Std.Err.$	z	$P>\|z\|$	$[95\%\ Conf.Interval]$
DR	-.0355993	.0048324	-7.37	0.000	-.0450706 -.026128
RR	-.0248446	.0044562	-6.70	0.000	-.0385786 -.0211105
R1	.1147248	.0316637	3.69	0.000	.0546651 .1787845
R2	.0070715	.0027749	2.55	0.011	.0016328 .0125101
IT	.195753	.0459042	4.26	0.000	.1057825 .2857235
Const.	.521945	.1001261	5.21	0.000	.3257014 .7181886
Prob > F = 0.0000, R-squared = 0.4523, Wald chi2(5) = 120.84					

In the constructed model, the coefficient of determination (*R*-squared) and the Wald coefficient (Wald chi2 (5)) are not high enough (0.4523 and 120.84, respectively). It can be explained by the specific features of the estimated model parameters. At the same time, the level of significance of the model *Prob> F* = 0.0000 indicates its adequacy. The coefficients for all studied indicators are also statistically significant, as the level of significance of the *z*-criterion ($P>|z|$) does not exceed the allowable value of 0.5.

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Thus, the model of formalization of the impact of individual monetary instruments and indicators on the share of $R\&D$ expenditures in the country's GDP is as follows:

$$R\&D = -0.04DR - 0.02RR + 0.11R1 + 0.21T + 0.52 \quad (1)$$

It is empirically confirmed that if the discount rate increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will decrease by 0.04% on average (excluding time lag). If the real interest rate increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will decrease by 0.02% on average (without time lag). If the ratio of "broad money" to total reserves increases by 1%, the share of gross R&D expenditures in the country's GDP will increase by 0.11% on average (without time lag). If the ratio of liquid reserves to bank assets increases by 1%, the share of gross R&D expenditures in the country's GDP will increase by 0.007% on average (without time lag). The introduction of an inflation-targeting regime contributes to an increase in the share of gross expenditure on $R\&D$ in GDP by 0.2% on average.

To strengthen the country's innovation development, it is proved the expediency of lowering the discount rate and real interest rate, increasing "broad money" on general reserves, and increasing liquid reserves on bank assets, as well as the transition to inflation targeting.

To assess the impact of monetary instruments and indicators on the share of $R\&D$ expenditures in the country's GDP in Ukraine, a lag model of linear regression was constructed (Table 10).

Table 10. Results of estimating the impact of monetary instruments and indicators on the share of R&D expenditures in Ukraine's GDP.
Note: $Coef.$ - estimates of β coefficients; $Std.Err$ - standard deviations of estimates; t - t-statistics; P - the level of significance of the t-test; $Conf.Interval$ - confidence interval; Const. – constant; $R\&D$ - the share of gross R&D expenditures in the country's GDP; DR - discount rate; RR - real interest rate; R1 - the ratio of "broad money" to total reserves; R2 - the ratio of liquid reserves to bank assets; IT - dummy-inflation targeting.

$R\&D$	$Coef.$	$Std.Err.$	t	$P > \|t\|$	$[95\% \ Conf.Interval]$
L1.DR	-.0088851	.0007602	-11.69	0.007	-.0121561 -.0056141
L1.RR	.0043146	.0006708	6.43	0.023	.0014282 .0072009
R1	-.0253309	.0016241	-15.60	0.004	-.0323191 -.0183428
L2.R2	-.025578	.0014955	-17.10	0.003	-.0320129 -.0191432
IT	-.1176133	.0098581	-11.93	0.007	-.1600292 -.0751974
Const.	1.073539	.0156587	68.56	0.000	1.006165 1.140913
Prob > F = 0.0017, R-squared = 0.9993					

In the constructed model, the coefficient of determination (R-squared) has a very high value (0.9993). The significance level of the model Prob> F = 0.0017, which does not exceed the allowable level of 0.5 and indicates the adequacy of the model. The coefficients for all studied indicators are also statistically significant, as the level of significance of the t-criterion $(P > |t|)$ does not exceed the allowable value of 0.5.

Thus, in Ukraine the lag model of the impact of formalizing certain monetary instruments and indicators on the share of $R\&D$ expenditures in the country's GDP is as follows:

$$R\&D = -0.00DR_{t-1} + 0.004R1 - 0.03R2_{t-2} - 0.12IT + 1.07 \quad (2)$$

It is empirically confirmed that if the discount rate in Ukraine increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will decrease by an average of 0.009% with a lag of 1 year. If the real interest rate in Ukraine increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will increase by 0.004% with a lag of 1 year. The share of gross R&D expenditures in Ukraine's GDP will decrease by 0.03% (excluding time lag) with an increase in the ratio of "broad money" to total reserves by 1%. The share of gross $R\&D$ expenditures in Ukraine's GDP will decrease by 0.03% with a lag of 2 years with an increase in the ratio of liquid reserves to bank assets by 1%. It is also empirically confirmed that the introduction of the inflation targeting regime in Ukraine in 2015 leads to a decrease in the share of gross $R\&D$ expenditures in GDP by an average of 0.12%.

CONCLUSIONS

So, the results of the calculations both for the panel of countries and for Ukraine, in particular, are the basis of the following conclusions.

It is empirically confirmed that if the discount rate increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will decrease by 0.04% on average (excluding time lag). If the real interest rate increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will decrease by 0.02% on average (without time lag). If the ratio of "broad money" to total reserves increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will increase by 0.11% on average (without time lag). If the ratio of liquid reserves to bank assets increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will increase by 0.007% on average (without time lag). The introduction of an inflation-targeting regime contributes to an increase in the share of gross expenditure on $R\&D$ in GDP by 0.2% on average.

To strengthen the country's innovation development, it is proved the expediency of lowering the discount rate and real interest rate, increasing "broad money" on general reserves and increasing liquid reserves on bank assets, as well as the transition to inflation targeting.

As for Ukraine, it is empirically confirmed that if the discount rate in Ukraine increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will decrease by an average of 0.009% with a lag of 1 year. If the real interest rate in Ukraine increases by 1%, the share of gross $R\&D$ expenditures in the country's GDP will increase by 0.004% with a lag of 1 year. The share of gross $R\&D$ expenditures in Ukraine's GDP will decrease by 0.03% (excluding time lag) with an increase in the ratio of "broad money" to total reserves by 1%. The share of gross $R\&D$ expenditures in Ukraine's GDP will decrease by 0.03% with a lag of 2 years with an increase in the ratio of liquid reserves to bank assets by 1%. It is also empirically confirmed that the introduction of the inflation targeting regime in Ukraine in 2015 leads to a decrease in the share of gross R&D expenditures in GDP by an average of 0.12%.

According to the calculations, for all monetary instruments and indicators, except the discount rate, the directions of influence in Ukraine and the panel from 12 other countries were opposite. This once again confirms that monetary instruments in Ukraine are not fully performing their regulatory function, in particular in the context of stimulating innovation development.

ADDITIONAL INFORMATION

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ВПЛИВ ІНСТРУМЕНТІВ І ПОКАЗНИКІВ МОНЕТАРНОЇ ПОЛІТИКИ НА ДИНАМІКУ ФІНАНСУВАННЯ ІННОВАЦІЙ: ЕМПІРИЧНЕ ПІДТВЕРДЖЕННЯ

Сьогодні інновації є драйвером економічного зростання, конкурентоспроможності, безпеки та сталого розвитку країн світу. Фінансова політика та її інструменти відіграють значну роль в управлінні інноваціями, а монетарні інструменти є однією з найважливіших складових фінансової політики. Тому необхідність підвищення ефективності фінансової підтримки інноваційного розвитку актуалізує вивчення впливу інструментів і показників монетарної політики на рівень фінансування інновацій. Метою статті є удосконалення наукової бази дослідження впливу інструментів та індикаторів монетарної політики на динаміку фінансування інновацій на основі емпіричного підтвердження. Інформаційну базу дослідження було сформовано на основі даних для України та 12 пострадянських та інших країн із подібними стартовими економічними умовами за 2010-2019 роки з урахуванням наявності статистичних даних Міжнародного валютного фонду, Світового банку та центральних банків для всього масиву досліджуваних показників на момент дослідження. Під час розрахунків використовувалося програмне забезпечення Excel і STATA. Методи регресії (модель лінійної регресії з панеллю виправлених стандартних помилок) та кореляційного аналізу (розрахунок коефіцієнтів Пірсона та Спірмена) були застосовані для виявлення зв'язку між монетарними інструментами й показниками та індикатором фінансування інновацій, підтвердження гіпотези щодо впливу інструментів та індикаторів монетарної політики на динаміку фінансування інновацій і формалізації цього ефекту. Для посилення інноваційного розвитку країни доведено доцільність зниження облікової ставки та реальної процентної ставки, збільшення відношення «широких грошей» до загальних резервів, збільшення ліквідних резервів за активами банків, а також перехід до таргетування інфляції. Згідно з розрахунками, для всіх монетарних інструментів та індикаторів, крім облікової ставки, напрями впливу в Україні та для панелі з 12 інших країн були протилежними. Це підтверджує, що монетарні інструменти в Україні не в повній мірі виконують свою регуляторну функцію щодо стимулювання інноваційного розвитку.

Ключові слова: витрати на НДДКР, інноваційний розвиток, монетарна політика, облікова ставка, реальна процентна ставка, таргетування інфляції, фінансове забезпечення, фінансування інновацій

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