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ON THE EFFECTIVENESS OF THE INTEREST RATE CHANNEL WITHIN INFLATION TARGETING IN UKRAINE: A VAR APPROACH

Abstract

Assessing the effectiveness of the inflation targeting framework via the interest rate channel remains crucial in the current monetary policy debate. For Ukraine, the relevance of this discussion is enhanced by the adoption by the National Bank of a rigid inflation targeting policy since 2016, as well as by the challenges of price stability during war. The aim of the study is to identify how the discount rate affects the money market rates and how this affects inflation in Ukraine. Employing a VAR model on monthly data spanning 2016 – Q1 2022, the analysis demonstrates weak empirical evidence for the interest rate channel effectiveness. The impulse response indicates that the discount rate's initial effect does not provide long-term inflation dynamics control. Variance decomposition analysis highlights the minimal influence of the NBU's discount rate, primarily evident in the refinancing rate, followed by its impact on the rate of term deposits made by individuals, followed by the inflation, followed by the rate of new loans granted to residents, and finally the rate of government bond yields. Addressing the limitations of a rigid inflation targeting approach, the study recommends adopting a balanced approach, considering both price stability supported by exchange rate control measures and fostering economic growth. Additionally, a viable strategy for deepening the financial sector should be developed.

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INTRODUCTION

The National Bank of Ukraine (NBU) began implementing strict inflation targeting (IT) in its monetary policy in early 2016, aiming to reduce inflation to 5% within a predetermined timeline. Central to this strategy is the utilization of the key policy tool – the discount rate, with all other levers being considered auxiliary, even though the Law does not distinguish between primary and secondary monetary instruments or limit the NBU's practical use of them. This regime has advantages, including setting clear objectives and procedures for the NBU to communicate regularly with businesses and the public.

During 2016–2021, the NBU's monetary policy was not only focused on achieving a single goal but also placed deliberate emphasis on using a primary tool – the discount rate. At first glance, the dynamics of changes in the CPI and the discount rate during 2015–2023 were quite related. However, inflation levels were not solely determined by the latter factor. External factors and structural as well as functional parameters of the financial market also had a significant impact. Nevertheless, while the discount rate was a common NBU's instrument, it was essential to consider its effectiveness in varying conditions, as it mostly depends on the financial market development level.

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The crux of the scientific problem lies in evaluating the efficacy of the discount rate as a primary tool under varying conditions, particularly contingent upon the developmental stage of the financial market. The deeper financial sector leads to a higher effectiveness of the interest rate, while a less developed financial system renders it less responsive to changes in the central bank rate. While achieving a certain level of inflation is important, it should also support economic growth, primarily through the expansion of credit supply.

1. LITERATURE REVIEW

The debate about the role of the discount rate policy tool has a long history (Bonomo & Sorensen, 1970; Aftalion & White, 1977; McNees, 1993). Since the late 1990s, there has been a shift in monetary policy from a discretionary regime and then from controlling monetary aggregates to controlling interest rates. After the GFC, there has been another shift towards targeting GDP alongside the widely accepted IT. An effective implementation of IT requires that central bank pursued a low inflation (Goodfriend, 2007), independence in its decision-making and fiscal dominance. According to rigid IT, its successful implementation should not come at the expense of other economic factors, such as exchange rates or wages. The central bank should solely focus on maintaining inflation levels. It is crucial to minimize or eliminate the public sector's direct borrowing from the central bank. It is also necessary to guarantee a substantial domestic financial market that can absorb public debt and prevent uncontrolled surges of public debt (Scarlata, 2002). Unlike rigid IT, flexible IT acknowledges the presence of multiple objectives, such as the stabilization of inflation and the real economy simultaneously. Furthermore, monetary policy requires a reasonable balance between inflation stability and resource utilization in the event of conflicting objectives. The Swedish central bank defines such a policy as well-balanced, allowing the achievement of the inflation target while ensuring the normal use of available resources (Khatat, 2016).

Central banks implementing IT commit to achieving a specific inflation rate for a defined period. They usually declare the target and use institutional mechanism and communication policy to commit accountability in achieving the target. However, for a long time some central banks in developed economies, like the Fed before 2012, followed a more simplified approach to IT, focusing on achieving low inflation without announcing specific numerical targets and having other objectives like the Fed's emphasis on promoting full employment (Jahan, 2012). In response to minor fluctuations in demand, central banks often resort to loosening monetary policies to inject more liquidity and spur economic activity. This approach has proven to be effective in achieving inflation targets even in the presence of large demand shocks. However, central banks struggle to fully restore economic activity and GDP to levels consistent with full employment (Beckworth, 2014).

In particular, central banks with IT adoption in pre-2000 have achieved their medium-term inflation targets, but since then the success of IT adopters can be seen in only about half the cases (Bhalla et al., 2023). Meanwhile, it is uncertain whether IT offers any additional benefits beyond the obligation to maintain stable prices. For instance, the Fed has managed to achieve low and stable inflation without necessarily relying on IT. In addition, the effectiveness of IT in maintaining price stability can be influenced by the relatively mild economic shocks that have occurred during that period (Rasche & Williams, 2005). In this regard, global inflation was already declining in the 1980s, well before the advent of IT in the 1990s. Furthermore, financial globalization in the last few decades has "improved the effectiveness of monetary policy in both developed and emerging economies" (Jäger & Grigoriadis, 2017). The integration of China into the global economy has been the primary driver of the reduction of inflationary pressures worldwide since the 1990s (Weber, 2015).

The linkage between inflation and interest rates can be weak due to the high liquidity in the financial system. In a low-interest-rate environment, monetary transmission is less effective due to headwinds or inherent nonlinearity (Borio & Hofmann, 2017). The potency of monetary policy

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considerably weakens in the face of low interest rates (Ahmed et al., 2021). With low real interest rates and an effective lower bound, conventional monetary policy loses its effectiveness in stabilizing the macroeconomy (Coenen et al., 2021).

Structural features of the economy and financial markets, as well as the level of openness, significantly affect the impact of monetary policy through various channels. Interest rate changes can have a weak transmission effect in small open economies (Primus, 2016; Arsić et al., 2022). This is partly since keeping inflation low is easier in low-inflation conditions, whereas emerging markets are more accustomed to high-inflation conditions where the money supply is more effective than interest rates (Taylor, 2019). In the context of IT adoption, the exchange rate plays a crucial role in providing the consequences of interest rates changes and market conditions (Kandil, 2015; Agénor & da Silva, 2019).

Notably, IT can be effective in reducing inflation only after a certain threshold level of financial depth has been reached (Ouyang & Rajan, 2019). An underdeveloped domestic financial market can hinder monetary policy transmission (Cevik & Teksoz, 2012), and financial structure affects the interest rate cycle asymmetry (Mojon, 2000). Furthermore, a weak institutional framework can impede the effectiveness of capital markets and monetary mechanism, delaying rates and price responses on market (Hussain & Bashir, 2019; Mishra et al., 2023). In case of Ukraine, the link between economic growth and new corporate lending is subject to the proportion of government bonds and deposit certificates in total assets of corporate lending (Hlazunov, 2023). Moreover, the public debt accumulation may cause the push-out effect (Becker & Ivashina, 2018; Pinardon-Touati, 2021). In case of Ukraine, this effect causes a decrease in private demand for credit by raising borrowing costs in Ukraine (Shvets, 2023).

Thus, although IT is a popular monetary policy regime, it may only sometimes be effective, as it could interfere with achieving financial stability. Central banks nowadays adopt a more inclusive approach to monetary policy (Guerini et. al., 2018), which considers a variety of economic indicators beyond inflation (Pérez-Moreno et. al., 2022). While inflation targets serve as a valuable metric for evaluating central bank actions, they do not guarantee the success of monetary policy.

Before IT implementation, the Ukrainian economy was not noticeably sensitive to the NBU's discount rate due to certain factors. First, the significance of the exchange rate as a price rising factor has been elevated, altering the transmission mechanism. Second, the characteristic feature of the Ukrainian financial sector is a low depth amidst bank-based (Shapoval, 2022). The level of bank credits granted to the economy of Ukraine fell in 2019 to 22.8% of GDP against 59.8% in 2015, and the monetization indicator (the ratio of broad money to GDP) – from 60% to 36.2% of GDP and that was primarily the consequence of the currency crisis (Korablin, 2021). Third, the introduction of IT coincided with the banks crisis that resulted in a significant reduction of financial institutions. The loss of over half of the banks from 2014 to 2016 led to direct fiscal losses of 14% of GDP and total losses of 38% of GDP (Danylyshyn, 2017). These losses are comparable to those Ukraine suffered in 2022 due to the intentional destruction of its production, infrastructure, and demography since the full-scale war. As rigid inflation targeting is a more restrictive policy, whether it is appropriate to implement under Ukraine's post-war recovery conditions remains open.

The aim of this paper is to explore the efficiency of the NBU's discount rate in applying the inflation targeting. According to the hypothesis, adjustments in the discount rate should cause changes in the rates of the money market, such as refinancing rates and government securities yields, which affect the rates of loans and deposits. The effect cascades through changes in consumer behaviour, investment decisions, and economic savings patterns, that ultimately impact inflation.

2. METHODS

The paper uses the Vector Autoregression (VAR) modelling approach, following Sims's methodology (1980), because, in VAR, each variable has linear dependence by past lags of itself and other variables. The VAR model utilizes monthly data sourced from the NBU and the State Statistics

Service of Ukraine. The dataset encompassed observations from 2016 to Q1 2022, comprising variables (indices, month to the previous month) such as: DR – discount rate; RR – rate of refinancing; DEP_R – rate of term deposits obtained by banks from individuals in national currency; LEN_R – rate of issued loans (to the non-financial sector) in national currency; GOV_BO_R – yield of issued government bonds in national currency; and CPI – consumer price index.

3. RESULTS

After the official declaration of the inflation targeting policy, the NBU took persistent measures to bring the inflation rate to the target level of 5%. Until in 2020 this happened, the discount rate was kept at a relevant high level of 15-20% (Figure 1).

Even though the discount rate was a familiar tool of the NBU and at first glance, as a result of its increase, the inflation level was reduced to the target, confirmation of this requires quantitative calculation, since inflation could have decreased for other reasons as well.

To build a VAR model, the time series of variables are analyzed for stationarity using the Augmented Dickey-Fuller (ADF) test (as not all the data was stationary at the level since the value of the statistic was greater than the 0.1) (Appendix Table A1). Once the data for constructing the VAR model has been proven to be stationary, the lag order selection criteria are performed to ascertain the maximum lag length. The Schwarz information criterion (SC) suggests using the 0 lag, the Hannan and Quinn information criterion (HQ) – 2 lags, the final prediction error (FPE) and Likelihood-Ratio test statistics (LR) –5 lags, and the Akaike's information criterion (AIC) – 8 lags (Appendix, Table A2). The discrepancy in the results of choosing the optimal number of lags does not indicate the system's inconsistency but requires the additional Lag Exclusion Wald Test (Appendix, Table A3). To assess the correct specification of the VAR model, the residuals are analyzed using the LM test for 5 lags to determine whether the residuals are autocorrelated (Appendix, Table A4). The results show that the null hypothesis can be rejected for 3 lags (as P-value is lower than 0.05). Since there is no autocorrelation at the lag 5, LR and AIC criteria suggest the 5 lags, and the Wald test indicated the significance of the lag 5, the VAR model should be estimated using 5 lags. The VAR model, tested for stability condition, is considered stable since all roots are less than 1 due to the inverse root of the autoregressive (AR) parameters polynomial (Appendix, Figure A1). Further, a statistically significant relationship between the factor and outcome variables of the VAR model is performed using the Granger causality test, according to which (Appendix, Table A5) only GOV_BO_R is endogenous. CPI, DR, DEP_R, LEN_R, and RR are exogenous (P-value is greater than 0.1 in the last line); that is, they do not have a significant impact on the total.

Source: Calculated according to the State Statistics Service of Ukraine (2023) and the NBU (2023).

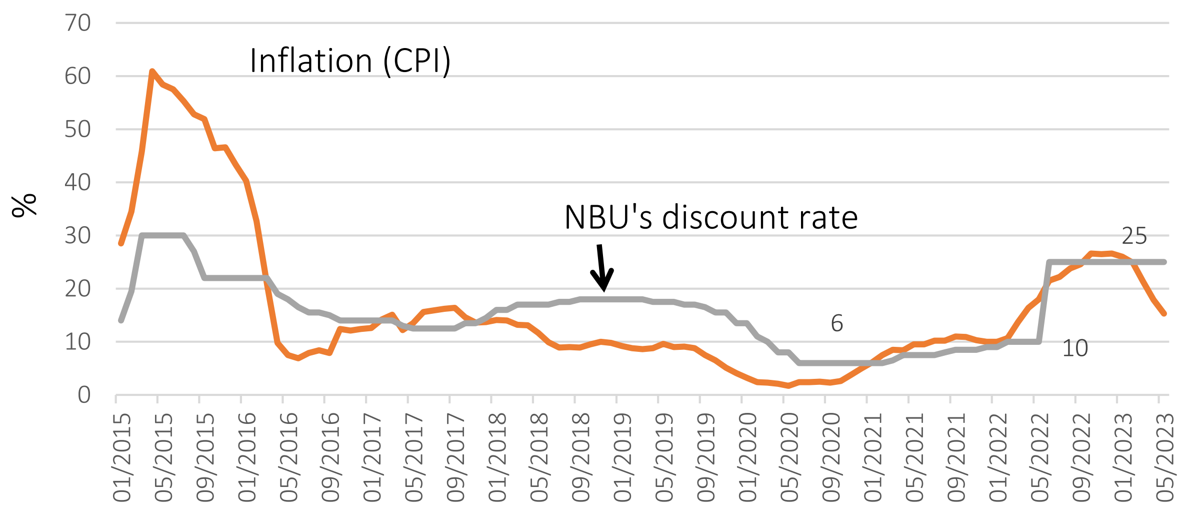

Figure. 1. CPI and the NBU's discount rate, 2015–2023

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Based on the statistical evaluation results, one can conclude that the VAR model has been constructed accurately (Appendix, Table A6) and begin calculating the impulse responses and dispersion decomposition.

The analysis of displaying confidence intervals for the impulse response function for 30 periods (months) (Figure 2) demonstrates that when NBU increase its discount rate:

a) there is no reduction in inflation in the short term; an increase in the discount rate even provokes some increase in inflation;

b) the rate of term hryvnia deposits of individuals exhibits an immediate and drastic increase, followed by a subsequent decrease; such a reaction may be associated with an increase in banks' demand for still cheap deposit resources for their further placement as loans and certificates of deposit at higher rates in the future;

c) the government bond yields initially increase and then have multidirectional volatility changes in the long run, that is, without any clear regulatory influence;

d) the rate for new loans to households decreases with a hold, which may be due to the availabil-

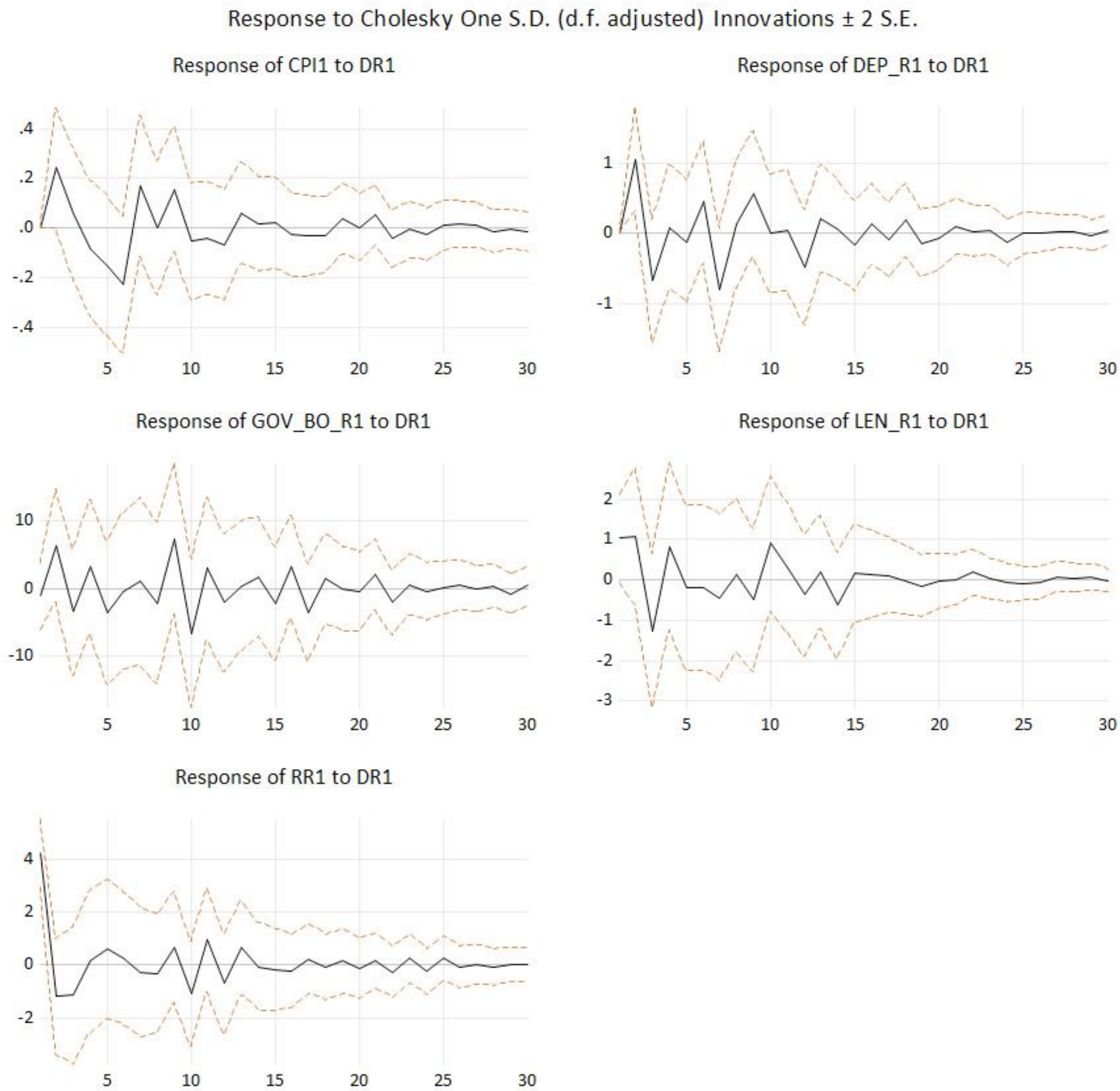

Figure 2. Impulse responses of money market rates and inflation to the change in the discount rate

ity of more profitable substitute instruments, such as certificates of deposit and government bonds;

e) the refinancing rate initially sharply decreases, followed by a slow increase and decay in the long run.

Overall, the functions of impulse responses confirm that changes in the discount rate cannot restrain inflation volatility, and the reaction of government bond yields primarily depend on the need in fiscal financing, but not on the discount rate shock.

The variance decomposition analysis (Appendix Table A7) shows that variations in:

a) the inflation changes are primarily caused by factors mostly beyond the NBU's discount rate policy (due to itself in the 2nd period by 87% and in the 30th period by 63%) and due to the change of the discount rate (in the 2nd period only by 8% and in the 30th period by 17%);

b) the rate of term hryvnia deposits of individuals are explained by its past values (due to itself in the 2nd period by 82% and in the 30th period by 52%) and the variations in the discount rate (in the 2nd period by 14% and in the 30th period by 22%);

c) the government bond yields are explained by historical performance (due to itself in the 2nd period by 93% and in the 30th period by 50%) and the variations in the discount rate (in the 2nd period by 5% and in the 30th period by 10%) and in the increasing role of the rate of new loans to residents (in the 2nd period by 0.3% and in the 30th period by 24%);

d) the rate of new loans to residents are explained by its past values (due to itself in the 2nd period by 81 % and in the 30th period by 55%) and the changes in the inflation (in the 2nd period by 7% and in the 30th period by 18%), and the changes in the discount rate (in the 2nd period by 6% and in the 30th period by 11%);

e) the refinancing rate are explained by its past values (due to itself in the 2nd period by 49% and in the 30th period by 37%) and the change in the discount rate (in the 2nd period by 28% and in the 30th period by 25%).

According to this, by the level of significance, the NBU's discount rate has the most significant effect on the refinancing rate, then on the rate of term deposits made by individuals, then on inflation, then on the rate of new loans granted to residents and then on government bond yields. This suggests complexities within the interest rate channel, challenging the conventional notion of interest rate adjustments as a panacea for inflation control.

4. DISCUSSION

The discount rate is positioned as a crucial management tool, if not the most significant, in the context of inflation targeting. However, in Ukraine, the discount rate has a limited effect on economic processes. The paper's findings do not confirm the results of previous research (Zholud et al., 2019), which states that "the central bank has sufficient control over short-term interest rates in the interbank market". This can be explained by the important caveat to the VAR modelling, that it is fraught with disagreements on identifying monetary policy shocks (Iddrisu & Alagidede, 2020).

As the analysis showed, the effectiveness of using the key interest rate as a tool for achieving the inflation target remains uncertain. This outcome supports the findings of Bhalla et al. (2023) and Primus (2016), who noted that implementing the IT regime through interest rate adjustments does not necessarily guarantee successful inflation management. Among the reasons, as noted by Taylor's (2019), the money supply is more influential than interest rates in the context of high inflation among emerging economies. Meanwhile, the factor of financial depth, as highlighted by Ouyang and Rajan (2019), is even more crucial. While interest rates may be significant in competitive markets, monopolistic supply rules apply in concentrated markets.

Ukraine's economy experienced a serious crisis in 2014–2015, which led to a decline in its financial depth. The country's economic indicators reached the levels of HIPC countries. Ukraine's

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debt burden was so high that it would have taken almost four decades for the country to pay off its debts. Till now, the Ukrainian banking sector has accounted for 85% of the country's financial sector. The bank-centric and state-bank-owned structure determines its coverage (Anufriieva et al., 2021). In addition, weak institutional frameworks coupled with imperfect competition in the banking sector increase the cost of lending to private firms, resulting in a high rate of reserves and investment on domestic or foreign bond markets. Furthermore, the prevalence of certificates of deposit and government bonds in Ukraine has a disturbing effect on the mechanism of money transmission by acting as substitutes for the credit market. That confirms the results of Hlazunov (2023) and Shvets (2023) about the role of government bonds and deposit certificates in Ukraine.

Notably, small open economies, such as Ukraine, are susceptible to significant fluctuations in the money supply by inherent volatility of exchange rates (Korablin, 2021). The monetary policies of major countries around the world have an impact on Ukraine's monetary mechanism, causing either positive or negative effects, depending on changes in the commodity markets and the global trends in economic development (Shumska, 2019). As a result, effective IT becomes challenging to attain amidst the absence of exchange rate stability. Against this backdrop, the proposed integrated IT approach, as stated by Agénor and da Silva (2019), presents a promising solution to this challenge.

Thus, it is impossible to continue implementing monetary policy using the same instruments during and after the war. To gain a comprehensive understanding of the transmission mechanism in the macroeconomic landscape, it is crucial to consider the role of fiscal policy and the currency channel on the macroeconomy. The attainment of price stability necessitates a two-pronged approach that involves targeting inflation and exchange rates through the monetary policy framework, as well as promoting financial deepening within the financial market development strategy.

Future research could consider including the effect of currency volatility and the role of other financial instruments such as certificates of deposit and government bonds, along with financial depth, in monetary transmission modeling.

CONCLUSION

The estimated effect of the NBU's discount rate on money market rates and inflation underscores its minimal impact. In essence, fluctuations in the discount rate do not have the power to subdue inflation-related uncertainty. Regarding its significance, the NBU's discount rate has a very weak influence, which is the most notable on the refinancing rate, followed by its impact on the rate of term deposits made by individuals, followed by the inflation, followed by the rate of new loans granted to residents, and finally the rate of government bond yields. Insufficient financial depth, underdeveloped institutional structures, and high exchange rate risks have collectively contributed to the discount rate's limited effectiveness. The prevalence of financial instruments such as government bonds and certificates of deposit has further complicated the monetary transmission mechanism, disrupting the credit market. To address the insufficiency in the discount rate's impact, policymakers are advised to veer away from a rigid inflation targeting approach. Instead, a balanced approach should be adopted, considering both price stability, supported by measures for exchange rate control, and economic growth. This aligns with the evolving trend toward flexible inflation targeting.

AUTHOR CONTRIBUTIONS

Conceptualization: Sergiy Korablin.
Data curation: Yuliia Shapoval.
Formal analysis: Yevhen Bublyk.
Investigation: Yevhen Bublyk, Yuliia Shapoval.
Methodology: Yuliia Shapoval.

Project administration: Yevhen Bublyk.
Supervision: Sergiy Korablin.
Validation: Yevhen Bublyk.
Visualization: Sergiy Korablin.
Writing – original draft: Yevhen Bublyk, Sergiy Korablin.
Writing – reviewing & editing: Yuliia Shapoval.

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APPENDIX A

Table A1. ADF unit root test

Null Hypothesis: Unit root (individual unit root process)
Series: CPI1, DEP_R1, GOV_BO_R1, LEN_R1, RR1, DR1
Sample: 2016M01, 2022M03
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 5
Total number of observations: 429
Cross-sections included: 6

Method	Statistic	Prob.**
ADF – Fisher Chi-square	153.272	0.0000
ADF – Choi Z-stat	–11.0316	0.0000

Series	Prob.	Lag	Max Lag	Obs.
CPI1	0	0	11	73
DEP_R1	0	2	11	71
GOV_BO_R1	0	5	11	68
LEN_R1	0	1	11	72
RR1	0.0001	0	11	73
DR1	0.0001	1	11	72

Note: ** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. Intermediate ADF test results UNTITLED.

Table A2. Lag order selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: CPI1 DEP_R1, DR1, GOV_BO_R1, LEN_R1, RR1
Exogenous variables: C
Sample: 2016M01, 2022M03
Included observations: 66

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–1,219.71	NA	5.45E+08	37.14267	37.34173*	37.22133
1	–1,155.71	114.4162	2.34E+08	36.29432	37.68774	36.84493
2	–1,093.17	100.446	1.08E+08	35.49002	38.0778	36.51258*
3	–1,054.9	54.50869	1.08E+08	35.42117	39.20331	36.91567
4	–1,022.12	40.72696	1.36E+08	35.51874	40.49523	37.48519
5	–968.819	56.52953*	1.03e+08*	34.99452	41.16537	37.43292
6	–925.39	38.16515	1.22E+08	34.76939	42.1346	37.67973
7	–863.799	42.92694	1.06E+08	33.99391	42.55347	37.3762
8	–822.047	21.50879	2.54E+08	33.81960*	43.57352	37.67384

Note: * Indicates lag order selected by the criterion. *LR*: sequential modified LR test statistic (each test at 5% level); *FPE*: Final prediction error; *AIC*: Akaike information criterion; *SC*: Schwarz information criterion; *HQ*: Hannan-Quinn information criterion.

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Table A3. Lag exclusion Wald test

VAR Lag Exclusion Wald Tests
Sample (adjusted): 2016M07, 2022M03
Included observations: 69 after adjustments
Chi-squared test statistics for lag exclusion
Numbers in [] are p-values

Lag	CPI1	DEP_R1	DR1	GOV_BO_R1	LEN_R1	RR1	Joint
Lag 1	10.2539	26.49971	26.24068	64.43929	28.29168	34.4023	239.5626
	[0.1144]	[0.0002]	[0.0002]	[0.0000]	[0.0001]	[0.0000]	[0.0000]
Lag 2	8.067144	11.8564	9.32583	39.17164	10.39082	5.942691	109.8302
	[0.2332]	[0.0653]	[0.1561]	[0.0000]	[0.1091]	[0.4296]	[0.0000]
Lag 3	12.08443	5.474064	4.255575	12.91415	9.135974	5.928565	54.96493
	[0.0601]	[0.4846]	[0.6421]	[0.0444]	[0.1661]	[0.4312]	[0.0224]
Lag 4	3.845831	7.073267	3.492079	7.720264	4.741652	3.586388	37.89185
	[0.6975]	[0.3141]	[0.7450]	[0.2593]	[0.5773]	[0.7324]	[0.3830]
Lag 5	10.18233	17.91191	1.911403	21.6237	8.024729	4.28761	76.44633
	[0.1172]	[0.0065]	[0.9277]	[0.0014]	[0.2363]	[0.6378]	[0.0001]
df	6	6	6	6	6	6	36

Table A4. Residual serial correlation LM tests

VAR Residual Serial Correlation LM Tests
Sample: 2016M01 2022M03
Included observations: 69

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
Null hypothesis: No serial correlation at lag h						
1	45.57482	36	0.1317	1.315163	(36, 121.3)	0.1378
2	43.12319	36	0.1929	1.232853	(36, 121.3)	0.2004
3	58.80476	36	0.0096	1.785412	(36, 121.3)	0.0106
4	36.12834	36	0.4627	1.005876	(36, 121.3)	0.4719
5	38.38892	36	0.3617	1.077978	(36, 121.3)	0.371
Null hypothesis: No serial correlation at lags 1 to h						
Lag	**LRE* stat**	**df**	**Prob.**	**Rao F-stat**	**df**	**Prob.**
1	45.57482	36	0.1317	1.315163	(36, 121.3)	0.1378
2	73.15721	72	0.4398	1.005295	(72, 120.1)	0.483
3	123.2614	108	0.1496	1.142145	(108, 93.1)	0.2557
4	185.3966	144	0.0114	1.300475	(144, 60.5)	0.1236
5	276.7497	180	0	1.458849	(180, 26.0)	0.1279

Note: * Likelihood ratio statistic adjusted for Edgeworth expansion.

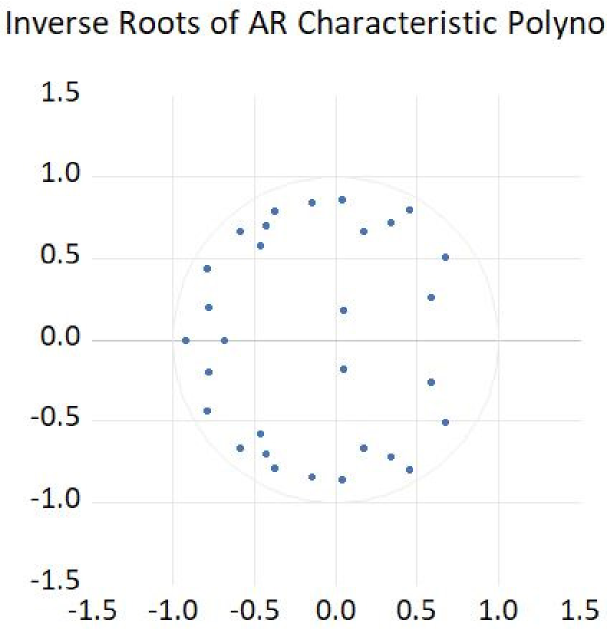

Figure A1. Stability test

Table A5. Granger causality test

"VAR Granger Causality/Block Exogeneity" Wald Tests Sample: 2016M01, 2022M03 Included observations: 69			
Dependent variable: CPI1			
Excluded	Chi-sq	df	Prob.
DEP_R1	4.675772	5	0.4567
DR1	8.786177	5	0.1179
GOV_BO_R1	3.729742	5	0.5889
LEN_R1	1.373709	5	0.9272
RR1	2.949051	5	0.7078
All	25.4162	25	0.4393
Dependent variable: DEP_R1			
Excluded	Chi-sq	df	Prob.
CPI1	7.949298	5	0.1591
DR1	7.05397	5	0.2167
GOV_BO_R1	5.993721	5	0.3068
LEN_R1	8.955035	5	0.1109
RR1	3.833332	5	0.5737
All	42.94577	25	0.0142
Dependent variable: DR1			
Excluded	Chi-sq	df	Prob.
CPI1	0.696098	5	0.9832
DEP_R1	3.921629	5	0.5608
GOV_BO_R1	4.284331	5	0.5092
LEN_R1	1.848167	5	0.8697
RR1	3.870988	5	0.5681
All	14.33152	25	0.9556

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Table A5 (cont.). Granger causality test

Dependent variable: GOV_BO_R1			
Excluded	Chi-sq	df	Prob.
CPI1	14.89304	5	0.0108
DEP_R1	6.065138	5	0.2999
DR1	7.076777	5	0.215
LEN_R1	13.14036	5	0.0221
RR1	2.114684	5	0.8331
All	51.31145	25	0.0015
Dependent variable: LEN_R1			
Excluded	Chi-sq	df	Prob.
CPI1	12.04946	5	0.0341
DEP_R1	2.612201	5	0.7595
DR1	6.483649	5	0.262
GOV_BO_R1	15.32188	5	0.0091
RR1	1.405354	5	0.9237
All	39.66789	25	0.0315
Dependent variable: RR1			
Excluded	Chi-sq	df	Prob.
CPI1	4.540815	5	0.4744
DEP_R1	3.484869	5	0.6257
DR1	6.932623	5	0.2257
GOV_BO_R1	0.607523	5	0.9877
LEN_R1	0.125434	5	0.9997
All	18.38607	25	0.8256

Table A6. Vector autoregression estimates

Vector Autoregression Estimates
Sample (adjusted): 2016M076 2022M03
Included observations: 69 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Variable	CPI1	DEP_R1	DR1	GOV_BO_R1	LEN_R1	RR1
R-squared	0.519837	0.667639	0.614433	0.851957	0.657597	0.587448
Adj. R-squared	0.14076	0.405249	0.310038	0.735081	0.387279	0.261748
Sum sq. residuals	21.16073	186.5189	1458.321	15701.15	830.8902	1447.634
S.E. equation	0.746231	2.215489	6.194907	20.32703	4.676059	6.172166
F-statistic	1.371325	2.544451	2.018537	7.289398	2.432678	1.80365
Log likelihood	–57.1292	–132.215	–203.164	-285.152	-183.756	-202.91
Akaike AIC	2.554468	4.730854	6.787363	9.16381	6.224819	6.780007
Schwarz SC	3.558197	5.734583	7.791092	10.16754	7.228548	7.783736
Mean dependent	0.068116	–0.02939	0.120773	-0.02772	0.004667	0.069013
S.D. dependent	0.805038	2.872777	7.457996	39.49272	5.973771	7.183488
Determinant resid covariance (dof adj.)		14,307,711	–			
Determinant resid covariance		399,187.8	–			
Log likelihood		–1,032.39	–			
Akaike information criterion		35.31575	–			
Schwarz criterion		41.33813	–			
Number of coefficients		186	–			

Table A7. Variance decomposition analysis

Variance Decomposition of CPI1							
Period	**S.E.**	**CPI1**	**DEP_R1**	**DR1**	**GOV_BO_R1**	**LEN_R1**	**RR1**
1	0.746231	100	0	0	0	0	0
2	0.848353	86.45739	3.5945	8.191017	1.093786	0.555735	0.107573
10	1.084697	65.15159	7.190173	16.98889	4.898737	2.096004	3.674608
20	1.131851	62.99945	7.025973	16.77206	5.486221	3.4435	4.272796
30	1.140734	62.65339	7.00971	17.0059	5.453439	3.505108	4.372454
Variance Decomposition of DEP_R1							
Period	**S.E.**	**CPI1**	**DEP_R1**	**DR1**	**GOV_BO_R1**	**LEN_R1**	**RR1**
1	2.215489	0.869692	99.13031	0	0	0	0
2	2.775751	1.507919	81.78465	14.42805	0.041356	2.193402	0.044615
10	3.701481	10.99636	55.41462	20.09347	3.33665	7.16116	2.997737
20	3.832579	11.32406	52.61155	21.39002	3.614017	7.317027	3.743332
30	3.846776	11.35755	52.32232	21.46659	3.622791	7.451642	3.779107
Variance Decomposition of GOV_BO_R1							
Period	**S.E.**	**CPI1**	**DEP_R1**	**DR1**	**GOV_BO_R1**	**LEN_R1**	**RR1**
1	6.194907	0.005294	0.65796	0.285908	99.05084	0	0
2	7.943229	1.550528	0.470995	4.571802	92.95933	0.255797	0.191546
10	9.923238	9.101735	1.81942	8.667135	54.0832	25.47015	0.85836
20	10.26228	11.15586	2.148449	10.03554	49.99664	24.0151	2.648403
30	10.2895	11.18656	2.160172	10.36421	49.66878	23.92467	2.695602
Variance Decomposition of LEN_R1:							
Period	**S.E.**	**CPI1**	**DEP_R1**	**DR1**	**GOV_BO_R1**	**LEN_R1**	**RR1**
1	20.32703	2.174773	1.83882	4.941926	1.90365	89.14083	0
2	29.97854	6.656939	1.240716	6.232727	4.055175	81.42789	0.386556
10	45.27036	17.2713	5.327707	9.7285	7.193745	56.70453	3.774224
20	47.2396	17.55377	5.392451	10.56667	7.058268	55.25812	4.170728
30	47.48106	17.63717	5.401517	10.62648	7.063545	55.09488	4.17641
Variance Decomposition of RR1							
Period	**S.E.**	**CPI1**	**DEP_R1**	**DR1**	**GOV_BO_R1**	**LEN_R1**	**RR1**
1	4.676059	1.115731	0.038445	46.82424	0.27804	4.516912	47.22663
2	6.012312	16.53695	0.960302	28.18061	0.234686	4.995662	49.09179
10	7.782934	26.74347	2.638619	24.20031	1.98485	5.385466	39.04729
20	7.92216	27.49439	3.016441	24.50903	2.283058	5.317275	37.3798
30	7.939251	27.68333	3.011186	24.53367	2.356158	5.286394	37.12927
Cholesky Ordering: CPI1 DEP_R1 DR1 GOV_BO_R1 LEN_R1 RR1							

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