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FROM KYIV TO FRANKFURT? UKRAINE'S MONETARY POLICY UNDER WAR AND INTEGRATION CONSTRAINTS

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From Kyiv to Frankfurt?
Ukraine's monetary policy under war and integration Constraints

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Abstract[§]

This paper examines whether the National Bank of Ukraine's policy remained rule-like through institutional reform, external constraints, and war. Using monthly data for 2009–2026, we estimate dynamic open-economy Taylor-type rules with inflation, economic activity, exchange-rate, and regime-interaction terms. Policy-rate persistence is strong, while the estimated inflation response changes across regimes and is largest during the full-scale war. The largest rule deviations occur during the 2015 currency crisis, the initial 2022 policy-rate freeze, and the June 2022 tightening. Descriptive event accounting links these episodes to institutional and geopolitical constraints. The evidence is consistent with state-contingent adaptation rather than a wholesale suspension of rules, with implications for monetary credibility and Ukraine's prospective European integration.

Résumé

Cette étude examine dans quelle mesure la politique monétaire de la Banque nationale d'Ukraine est demeurée fondée sur des règles malgré les réformes institutionnelles, les contraintes extérieures et la guerre. À partir de données mensuelles couvrant la période de 2009 à 2026, les auteurs estiment des règles de politique monétaire dynamiques de type Taylor, adaptées à une économie ouverte, qui intègrent l'inflation, l'activité économique, le taux de change ainsi que des termes d'interaction liés aux différents régimes.

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Les résultats révèlent une forte persistance du taux directeur, tandis que la réaction estimée de la politique monétaire à l'inflation varie selon les régimes et atteint son niveau le plus élevé durant la guerre à grande échelle. Les écarts les plus importants par rapport aux règles sont observés lors de la crise de change de 2015, du gel initial du taux directeur en 2022 et du resserrement monétaire de juin 2022.
Une analyse descriptive des événements permet de mettre ces épisodes en relation avec les contraintes institutionnelles et géopolitiques. Les résultats sont compatibles avec une adaptation de la politique monétaire aux circonstances plutôt qu'avec un abandon généralisé des règles, ce qui soulève des enjeux importants pour la crédibilité de la politique monétaire et les perspectives d'intégration européenne de l'Ukraine.

Mots-clés/Keywords : règles de type Taylor, Ukraine, stabilisation du taux de change, ciblage de l'inflation, risque géopolitique, politique monétaire en temps de guerre, Banque nationale d'Ukraine / Taylor-type rules, Ukraine, exchange-rate stabilization, inflation targeting, geopolitical risk, wartime monetary policy, National Bank of Ukraine.

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Contents

1 Introduction **1**

2 Related Literature **4**
2.1 War as a macroeconomic and productive-capacity shock 4
2.2 War finance and central-bank balance sheets 5
2.3 Wartime monetary and exchange-rate policy in Ukraine 6

3 Balance-sheet structure **7**
3.1 Evolution of assets and liabilities 7
3.2 Sterilization, inflation and quasi-fiscal exposure 12

4 Taylor-type rule analysis **13**

5 Policy-rate deviations from benchmark paths **24**

6 Descriptive event accounting for policy-rule deviations **29**

7 Conclusion **34**

A Appendix **A1**
A.1 Sample and frequency A1
A.2 Policy rate A1
A.3 Inflation and inflation gaps A1
A.4 Economic-activity gap A2
A.5 Exchange rates A2
A.6 Labor-market variables A3
A.7 Regime indicators A3
A.8 Second-stage shock dataset A4
A.9 Source URLs and retrieval notes A6
A.10 Residual and HAC-bandwidth diagnostics A7
A.11 Additional reaction-function robustness A8
A.12 Identification, timing, and instrument diagnostics A10
A.13 Exchange-rate measurement and the euro reference A12
A.14 Persistence and endogenous break dates A13
A.15 Capital controls and the wartime operating mix A15
A.16 Annual sterilization and profit-and-loss extension A16
A.17 Pandemic sensitivity and the pre-Covid frozen rule A17

List of Figures

1 NBU Balance-Sheet Components, % Shares 8
2 NBU Balance-Sheet Components, % of GDP 9
3 Excess Reserve-Money Growth 10
4 Inflation, the Policy Rate, and the Official Inflation Target, % per annum 13
5 Actual and Fitted NBU Policy Rate 22
6 Residuals from the Preferred Regime-Interaction Policy Rule 23
7 Actual Policy Rate and Reference Rule Paths 27
8 Policy-Rate Deviations from Estimated and Benchmark Rules 27
9 Taylor-Type Rule Residuals and Key Shock Episodes 32
10 Observed Residuals and Descriptive Event Accounting 33

List of Tables

1 Asset-Side Benchmark Shares, % of Total Assets 11
2 Liability and Equity Benchmark Shares, % of Total Liabilities plus Equity 11
3 First-Step Taylor-Type Rule Estimates 17
4 Implied Short- and Long-Run Responses from the Preferred Policy Rule . 17
5 Information-Set and IV/GMM Robustness of MPR4 21
6 Summary of Policy-Rate Deviations from Benchmark Paths 25
7 Policy-Rate Deviations by Regime 26
8 Largest Estimated-Rule Residual Episodes, in Chronological Order 26
9 Frozen pre-invasion coefficients: conditional wartime paths 28
10 Descriptive Event Accounting for Taylor-Type Rule Residuals 31
11 Conflict and Social Correlates of Policy-Rule Residuals 32
A1 Coverage for the dependent variable and the main second-stage shock proxies A4
A2 Public sources for second-stage shock dataset A5
A3 Public access points used to document the raw data sources A6
A4 MPR4 Residual diagnostics and HAC-bandwidth sensitivity A7
A5 MPR4 and the restricted MPR4″ specification A8
A6 Inflation responses across information-set and IV/GMM specifications . . A9
A7 Equation-specific first-stage diagnostics A11
A8 Exchange-rate reference and policy-rate aggregation A12
A9 Persistence and stationarity diagnostics A13
A10 Exploratory endogenous multiple-break selection A14
A11 Additional wartime operating-phase interactions A15
A12 Year-end CD stocks and subsequent December inflation A16
A13 Sterilization expense, consolidated earnings and distribution A16
A14 Sensitivity of MPR4 to the pandemic episode A18
A15 Frozen-rule gaps with and without pandemic training observations A18

1 Introduction

Ukraine offers an unusually demanding test of monetary policy credibility. Since the Global Financial Crisis (GFC), the country has experienced a balance-of-payments shock, banking stress, exchange-rate liberalization, the adoption of inflation targeting, the annexation of Crimea, the war in Donbas, the COVID-19 shock, and the full-scale Russian invasion of February 2022. In most economies, such a sequence would be sufficient to blur the distinction between rule-based policy and discretion. In Ukraine, it also raises a larger question: whether a central bank operating under existential geopolitical pressure can preserve a policy framework credible enough to support eventual European monetary integration, as required by the process of convergence and accession the country has recently began with the European (Monetary) Union (E(M)U).

This question is central to the paper. The path from Kyiv to Frankfurt referred to in our title is not meant here as a mechanical forecast of euro adoption. It refers to the institutional distance between a wartime emerging-market central bank and the monetary-policy standards implied by deeper integration with the EU and, ultimately, the euro area, that is, the EMU. Recent work on EU enlargement stresses that Ukraine's accession process is both merit-based and geopolitical: formal progress depends on *acquis* adoption and institutional capacity, while the war has made Ukraine's European trajectory strategically urgent (Dabrowski and Louro, 2026, pp. 21–22). Ukraine has nevertheless signaled its intention to move rapidly, with the government declaring a target of completing accession negotiations by the end of 2028 (Dabrowski and Louro, 2026, p. 21). Monetary policy is therefore part of a broader question of institutional preparedness, not merely a narrow macroeconomic stabilization problem.

That preparedness cannot be assessed from the policy rate alone. Under banking stress, external-financing shocks, and war, a central bank's balance sheet records how policy is actually implemented: which assets support foreign-exchange intervention or the banking system, which claims connect the central bank to the sovereign, and which liabilities create or absorb domestic liquidity. For the NBU, changes in foreign reserves, domestic securities, refinancing loans, bank reserves, certificates of deposit, and government deposits therefore reveal dimensions of monetary capacity and constraint that a reaction-function estimate cannot capture. Examining both the composition of the balance sheet and its scale relative to GDP also makes it possible to distinguish balance-sheet expansion from monetary expansion, and wartime liquidity creation from its subsequent sterilization.

The Ukrainian case also speaks directly to a growing literature on monetary policy under geopolitical instability. Ginn and Saadaoui (2025) show that geopolitical risk shocks may generate different monetary-policy responses over short and medium horizons: accommodation may help absorb confidence and economic-activity effects initially, while

later tightening may be needed to contain inflationary pressures. For Ukraine, this tension is more than a theoretical possibility. War affects inflation, output, capital flows, government financing needs, confidence, labor supply, and the exchange rate simultaneously. A conventional Taylor (Taylor, 1993) rule estimated without attention to these state contingencies risks misclassifying wartime stabilization as simple policy inconsistency.

Ukraine-specific studies provide our point of departure. Pifer et al. (2009) discuss the political and economic situation in Ukraine in the first decade of the century and evaluate the options and tensions of the country between the EU/NATO and Russia. Mantsurov et al. (2024) provide a longer-run view of the interrelated dynamics of economic development and inflation in Ukraine, focusing on the recent inflation targeting (IT) period. The NBU announced its transition to inflation targeting in August 2015 and began operating de facto under the framework during 2015–2016; the regime was formally entrenched by the NBU Council in December 2016 (National Bank of Ukraine, 2019, 2016b). Before this transition, Kozmenko et al. (2014) had already argued that the interest-rate policy of the National Bank of Ukraine (NBU) could be assessed through a monetary-policy rule, while emphasizing the importance of exchange-rate liberalization and institutional reform. Grui et al. (2022) later proposed a benchmark approach to Taylor-rule evaluation under limited data availability, a constraint especially relevant for emerging market economies (EMEs) with short and structurally unstable samples. Nikolaychuk (2025) presents the 2015 move toward inflation targeting as a decisive institutional break after a triple crisis of banking stress, macroeconomic instability, and balance-of-payments pressure.

At the same time, the open economy nature of Ukraine and its brief post-Soviet monetary history make the exchange-rate dimension of monetary policy unavoidable in the analysis. The hryvnia has often served as a visible barometer of confidence, external financing conditions, and policy credibility. Taylor-rule exchange-rate models link currency movements to monetary-policy fundamentals (Wang et al., 2019). More specifically for Ukraine, De Groot and Skok (2026) show that, after a shock on the magnitude of the full-scale invasion by Russia in February 2022, a flexible exchange rate and a conventional Taylor-type rule may fail to provide macroeconomic stability, making temporary exchange-rate stabilization and capital controls a reasonable wartime response. This insight is crucial for the interpretation of our estimates: deviations from a policy rule may be evidence of adaptation to a constrained version of the rule rather than a suspension of monetary discipline.

This paper contributes to the debate on the merits of monetary policy rules in anchoring macroeconomic expectations by combining three empirical layers. First, it constructs a harmonized mapping of the NBU's annual financial statements for 2008-2025 and uses it to trace the asset, liability, and equity structure of the central bank across pre-crisis,

reform, and wartime regimes. The analysis reports component shares and GDP-scaled stocks, and compares the growth of reserve money - with and without NBU certificates of deposit - with nominal GDP growth. This balance-sheet layer is a distinct contribution: it links the NBU's changing policy framework to the instruments, fiscal exposures, external buffers, and liquidity-management constraints through which policy was implemented. Second, the paper estimates a family of Taylor-type reaction functions for Ukraine using monthly data over 2009–2026. The economic activity gap measure is based on industrial production, as is common for monthly data, and estimated with the Hamilton (Hamilton, 2018) filter rather than the Hodrick-Prescott filter, in order to reduce endpoint distortions and artificial cycles in a sample marked by structural breaks and war. Third, it studies deviations between actual and rule-implied policy rates as episodes of state-contingent adjustment.

The empirical strategy, developed since at least Clarida et al. (2000), deliberately avoids two extremes. It does not impose canonical Taylor-rule coefficients as a universal benchmark for a country whose monetary regime changed substantially after 2015. But it also does not treat wartime monetary policy as pure discretion. Instead, the paper estimates Ukraine-specific reaction functions with interest-rate smoothing, exchange-rate pressure, labor-market conditions, and regime interactions. The residual policy component is then compared with institutional changes, conflict events, and war-related demographic and social disruption.

The balance-sheet and policy-rate evidence tell a coherent story. The NBU moved from the crisis exposures visible before 2014 toward reserve rebuilding, reduced refinancing of banks, and a more developed liquidity-absorption framework during the inflation-targeting period. The full-scale war produced an exceptional expansion of reserve money and bank liquidity in 2022, alongside greater reliance on external reserves and domestic securities. By 2023–2025, reserve-money growth had fallen back below nominal GDP growth, while the continuing importance of NBU certificates of deposit showed the scale of sterilization. The balance sheet thus documents both wartime intervention and the effort to contain the monetary overhang that it created.

Viewed together with the reaction-function estimates, these findings imply that Ukraine's monetary policy is better understood as adaptive rule modification than as a collapse of rules. This interpretation echoes the general characterization proposed by Arestis and Mihailov (2009) of 'flexible rules cum constrained discretion'. Although their analysis does not consider Ukraine, the distinction they draw between rule-like commitment and bounded policy flexibility provides a useful lens through which to interpret the NBU's experience. The NBU's policy rate remains systematically related to inflation, cyclical economic activity, exchange-rate pressure, and policy inertia. The largest deviations are concentrated around identifiable crisis moments, especially March 2015 and June 2022.

These are precisely the episodes in which monetary policy had to restore a nominal anchor under acute financial and geopolitical stress. The paper's central contribution is therefore to show rule-like behavior on both sides of the policy framework: in the rate-setting reaction function and in the changing balance-sheet instruments used to sustain it.

The remainder of the paper proceeds as follows. The next section relates our contribution to the literatures on the macroeconomics of war, wartime central-bank balance sheets, and monetary and exchange-rate policy under extreme stress. The following section documents the evolution of the NBU's balance sheet. The Taylor-rule section then describes the monthly dataset, estimates the baseline and extended reaction functions, and derives rule-implied policy rates. The subsequent sections compute and interpret policy-rate deviations from benchmark rule-based paths, then relate them to institutional, geopolitical, and social shocks. The conclusion returns to the implications for Ukraine's monetary credibility and its longer European integration trajectory.

2 Related Literature

This paper lies at the intersection of three literatures that are usually considered separately: the macroeconomic costs of war, wartime fiscal–monetary arrangements as reflected in central-bank balance sheets, and the conduct of monetary and exchange-rate policy under extreme stress. Bringing these strands together is important in the Ukrainian case. The invasion was simultaneously a shock to productive capacity, the public finances, the external balance, and monetary transmission. Consequently, neither a policy-rate equation nor the size of the NBU's balance sheet, considered in isolation, is sufficient to characterize the policy response.

2.1 War as a macroeconomic and productive-capacity shock

A growing empirical literature documents that wars cause large and persistent losses in economic activity. Using synthetic controls for almost 400 wars over two centuries, Chupilkin and Kóczán (2022a) show that wars fought on a country's territory reduce GDP per capita by more than seven percentage points relative to a synthetic counterfactual in the year after the war, with especially persistent effects following civil wars. The associated EBRD synthesis emphasizes that even where income flows recover, destruction of physical capital and losses of population can leave durable scars (Chupilkin and Kóczán, 2022b). Using a long panel of interstate wars, Federle et al. (2026) likewise find that a war of average intensity is associated with an output decline of close to 10 percent and a rise in consumer prices of about 20 percent in the war-site economy, together with losses in

capital, productivity, and equity values. They also identify adverse spillovers to economies connected to the war site through geography or trade.

Two recent studies sharpen mechanisms that are particularly relevant for Ukraine. Benmelech and Monteiro (2025), drawing on 115 conflicts in 145 countries, document persistent output and investment losses, shrinking domestic credit, wider primary deficits, shorter debt maturities, and substantial increases in money and prices. Their evidence connects the real damage from war to financial constraints and to governments' recourse to inflationary financing. Using firm-level data from Ukraine, Gorodnichenko et al. (2026) show that the full-scale invasion reduced output not only through the destruction of inputs but also through a collapse in allocative productivity, with war intensity, displacement, reallocation, and macroeconomic instability contributing to the loss.

This literature motivates two choices in our empirical design. First, the wartime coefficient on the economic-activity gap cannot be read as the response to an ordinary business-cycle fluctuation: industrial production during the invasion also reflects destroyed capacity, displacement, disrupted energy supply, and sectoral reallocation. Second, our regime interactions describe changes in the NBU's reaction function; they are not causal estimates of the war's macroeconomic effects. The contribution here is instead to study how monetary policy adapted when inflationary pressure and a contraction in economic activity occurred together.

2.2 War finance and central-bank balance sheets

The historical literature treats the central bank as part of the institutional machinery through which states finance and manage wars. Poast (2015) shows that central banks historically lowered sovereign borrowing costs, especially in wartime, by strengthening governments' access to debt markets. For the United States, Ohanian (1997) compares the macroeconomic consequences of the different tax, debt, and monetary arrangements used during World War II and the Korean War. Hall and Sargent (2022) place the Federal Reserve's balance sheet and Treasury financing within a consolidated government budget constraint and document the joint roles of taxes, interest-bearing debt, and money creation during the two world wars and the COVID-19 emergency. In the postwar period, Reinhart and Sbrancia (2015) show how regulated financial systems, capital controls, and negative real interest rates helped liquidate large public-debt burdens. Together, these studies imply that wartime monetary policy cannot be separated cleanly from debt management, fiscal capacity, and the structure of the financial system.

This perspective also cautions against equating a larger central-bank balance sheet mechanically with inflation. Comparing US balance-sheet expansions after World War II, the global financial crisis, and the pandemic, Reynard (2023) argues that the inflationary

outcome depends on the accompanying creation of broad money and on whether private intermediaries participate in financing the government. Composition therefore matters alongside scale. On the asset side, government securities, foreign reserves, and refinancing loans represent different policy functions and risks; on the liability side, currency, bank reserves, central-bank certificates of deposit, and government deposits have different implications for circulating money, bank liquidity, and sterilization.

Evidence from the former Yugoslavia illustrates the stakes for small, open transition economies facing war. Petrović et al. (1999) attribute the Yugoslav hyperinflation of 1992–1994 to money creation that monetized multiple deficits, with money growth feeding prices through currency depreciation as the central bank lost control of the supply process. Croatia provides a more contained comparison. Hedvall (1999) documents how the authorities secured scarce foreign currency for strategic imports during the 1991–1995 war, notably by building household confidence and mobilizing exporters' foreign-exchange earnings. Using monthly data for 1992–1999, Payne (2002) finds that Croatian inflation responded positively to wage growth and currency depreciation and identifies a structural break around the October 1993 stabilization programme. These cases do not supply a directly transferable policy rule for Ukraine, but they show why fiscal pressures, foreign-exchange scarcity, monetary expansion, and credibility must be examined jointly.

Our first contribution follows directly from this literature. We construct a harmonized mapping of the NBU's annual financial statements for 2008–2025 and distinguish foreign reserves, domestic securities, refinancing loans, bank reserves, certificates of deposit, government deposits, and other liabilities. This permits us to separate balance-sheet expansion from reserve-money growth, and reserve-money growth from liquidity subsequently absorbed through NBU certificates of deposit.

2.3 Wartime monetary and exchange-rate policy in Ukraine

The Ukraine-specific literature has developed alongside the war and is therefore partly prescriptive and partly institutional. In an early wartime policy report, Becker et al. (2022) argue that conventional inflation targeting may cease to provide a durable nominal anchor when interest-rate transmission is weak, capital controls alter the exchange-rate channel, and inflation expectations are highly sensitive to the currency. Their analysis supports a temporary exchange-rate anchor while recognizing the risks created by prolonged monetary financing and an increasingly misaligned peg. Using data on policy rates, refinancing, government bonds, foreign-exchange intervention, and reserves, Shapoval (2022) describes the initial shift away from inflation targeting and a floating exchange rate after the full-scale invasion, as well as the role of the fixed exchange rate and currency restrictions in limiting depreciation.

Later accounts make it possible to assess the subsequent normalization. Burban et al. (2024) interpret the NBU's response through domestic and external monetary autonomy. They stress the initially exceptional monetary financing and policy-rate freeze, followed by the June 2022 tightening, the end of direct monetary financing in 2023, stronger liquidity absorption, and the support that international assistance provided to reserves. Petryk and Chopa (2025) offer a broader institutional account covering monetary and exchange-rate policy, banking and financial regulation, payment-system continuity, and cooperation with the IMF and other international partners. Alongside research showing that geopolitical-risk shocks can call for accommodation at short horizons but tightening later as inflationary pressure materializes (Ginn and Saadaoui, 2025), this work suggests that the sequence of NBU decisions should be evaluated as state-contingent adaptation rather than against a single peacetime instrument rule. It is also consistent with model-based evidence that, after an invasion-sized shock, a conventional Taylor-type rule combined with a flexible exchange rate may fail to stabilize Ukraine, making temporary exchange-rate management and capital controls potentially welfare-improving (De Groot and Skok, 2026). Complementary cross-country evidence suggests that reserve adequacy also conditions monetary-policy autonomy, allowing economies with larger reserve buffers to absorb U.S. monetary tightening with smaller domestic interest-rate adjustments (Zhou et al., 2026).

Existing Ukraine studies thus explain particular instruments, episodes, or model-based policy choices, while the broader war literature quantifies macroeconomic destruction and the fiscal–monetary trade-offs of war finance. Our second contribution is to connect those perspectives empirically. We combine the long-run balance-sheet mapping with monthly Taylor-type reaction functions for 2009–2026, allowing the responses to inflation, economic activity, and exchange-rate pressure to vary across the pre-inflation-targeting, pre-full-scale-war inflation-targeting, and full-scale-war regimes. The balance-sheet evidence shows how policy was implemented; the reaction functions show whether policy-rate setting remained systematic; and the deviation analysis identifies episodes in which the observed rate departed most sharply from its estimated historical relationships.

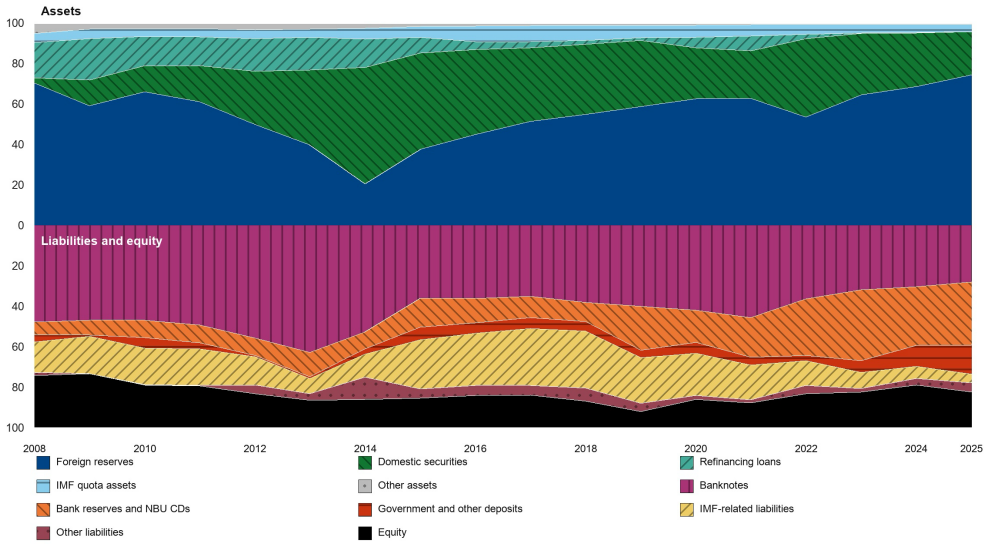
3 Balance-sheet structure

3.1 Evolution of assets and liabilities

Figures 1 and 2 point to a central bank balance sheet whose evolution is not only quantitative, but also institutional. Figure 1 shows the composition of assets and of liabilities plus equity, with other liabilities separated from equity. Figure 2 uses the same components but scales them by nominal GDP, making the macroeconomic size of the NBU's balance sheet visible. Before the 2014 crisis, the asset side was dominated

by foreign reserves, while refinancing loans still carried the trace of post-GFC banking support.

Figure 1: NBU Balance-Sheet Components, % Shares



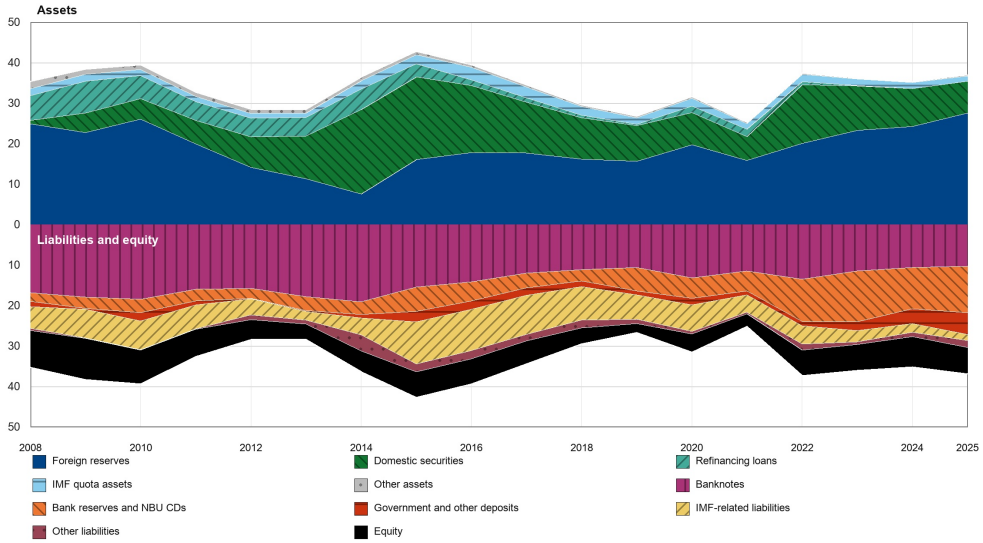
Notes: End-year asset components are reported as percentages of total assets. Liability and equity components are mirrored below zero and reported as percentages of total liabilities plus equity. Other liabilities and equity are shown separately. Source: NBU annual consolidated financial statements and management-report figures; authors' mapping.

From 2016 to 2021, the structure partly normalized. Foreign reserves were gradually rebuilt and loans to banks declined, consistent with the move toward inflation targeting and a less crisis-driven operating environment. This normalization was supported by the far-reaching banking-sector reforms of the 2010s, including bank diagnostics, recapitalization and resolution, tighter supervision, related-party lending restrictions, and stronger prudential requirements. The resulting capital and liquidity buffers were important in cushioning the banking system when the full-scale invasion began (National Bank of Ukraine, 2022). Yet the persistence of a large domestic-securities portfolio shows that the balance sheet retained a fiscal and legacy component. On the liability side, banknotes remained important, but bank accounts and NBU certificates of deposit gained weight, indicating the growing role of liquidity absorption and reserve management in the transmission framework.

The full-scale war opened a new regime. During its first months, foreign-currency demand, budget monetization, and delayed or insufficient external inflows put reserves under intense pressure. As international support subsequently became larger and more regular, official inflows increasingly replenished the NBU's foreign assets and help explain the renewed rise of reserves on its balance sheet (National Bank of Ukraine, 2023). Reserve

rebuilding also matters for the range of monetary-policy choices available to the NBU. Using cross-country evidence, Zhou et al. (2026) find that higher reserve adequacy is associated with weaker domestic interest-rate responses to U.S. monetary tightening, consistent with reserve sales providing an alternative means of absorbing exchange-rate pressure. They find no comparable insulation during U.S. easing. Although their analysis predates the full-scale invasion, it provides a useful perspective on how external support and reserve availability may shape Ukraine's combination of interest-rate policy and foreign-exchange intervention. Domestic securities remained substantial but declined in relative weight by 2025. Liabilities shifted toward bank liquidity and government deposits, whereas IMF-related liabilities became less dominant in relative terms and equity recovered. For euro-area integration, both scale and composition matter: the asset-to-GDP ratio rose markedly in 2022 and remained elevated thereafter, while reducing quasi-fiscal exposures, preserving high-quality reserve assets, and normalizing liquidity-absorption instruments remain key structural markers.

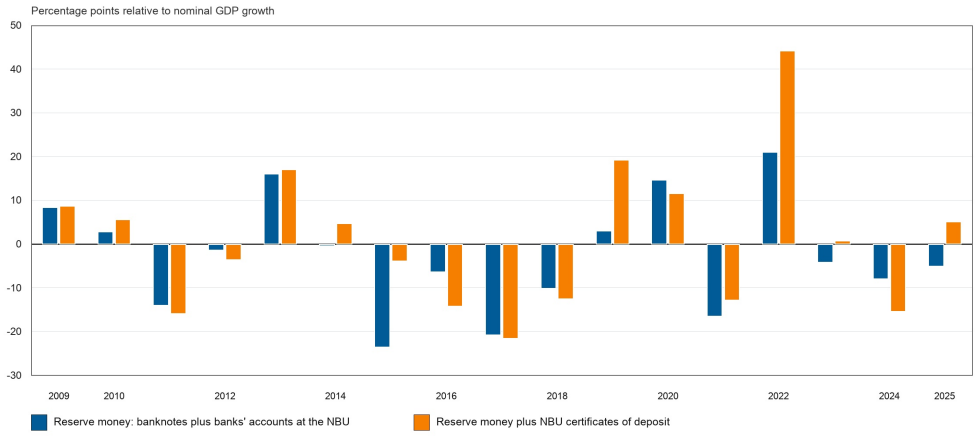
Figure 2: NBU Balance-Sheet Components, % of GDP



Notes: The figure uses the same balance-sheet mapping as Figure 1. End-year balance-sheet stocks are divided by annual nominal GDP at current prices, with asset components above zero and liability/equity components mirrored below zero. Sources: authors' calculations, from NBU annual reports.

Figure 2 also requires care in interpreting the denominator. NBU assets rose from about 25 percent of nominal GDP in 2021 to roughly 37 percent in 2022 and remained around the mid-30s thereafter. Moreover, nominal GDP is inflated by the wartime price level and therefore masks part of the contraction in real economic capacity. Even when the ratio changes only modestly after its initial wartime jump, the NBU can still represent

Figure 3: Excess Reserve-Money Growth



Notes: Excess growth is defined as annual growth in the monetary proxy minus annual nominal GDP growth. Reserve money is banknotes in circulation plus banks' accounts at the NBU. The broader liquidity measure adds NBU certificates of deposit, which are shown separately because they reflect sterilized liquidity rather than circulating money. Sources: NBU annual consolidated financial statements and management-report figures; nominal GDP from the annual GDP file; authors' calculations.

a larger operational presence relative to the economy's reduced real resource base. A broadly stable nominal-GDP share should therefore not be read as evidence that the central bank's economic footprint or policy importance was unchanged, but reveals a controlled expansion.

The GDP-scaled view in Figure 2 can be pushed one step further by asking whether the balance-sheet expansion generated excess monetary growth, as shown in Figure 3. Because the currently available dataset does not yet include a consistent broad-money aggregate, the exercise is deliberately framed as an analysis of reserve money rather than M2. Reserve money is measured as banknotes in circulation plus banks' accounts at the NBU. A second, broader liquidity measure adds NBU certificates of deposit, which are not money in circulation but capture the scale of sterilized liquidity absorbed by the central bank.

Reserve-money growth was not persistently excessive over the full period: after positive episodes in 2013 and 2020, it was generally below nominal GDP growth during much of the inflation-targeting period. The wartime break is sharper. In 2022, reserve money grew by about 21 percentage points more than nominal GDP, while the measure including NBU certificates of deposit exceeded nominal GDP growth by about 44 percentage points. These differentials partly reflect the contraction of nominal GDP: reserve money increased by 17.12 percent and reserve money plus NBU certificates of deposit by 40.29 percent, while

nominal GDP fell by 3.88 percent. Subtracting this negative GDP growth rate therefore adds 3.88 percentage points to each excess-growth measure. The large real contraction in the first invasion year should not be confused with this nominal-GDP component, which also incorporates price developments; the spike is not entirely attributable to monetary expansion. By 2023-2025, the narrower reserve-money measure had returned below nominal GDP growth, whereas the broader liquidity measure continued to show the importance of sterilization. The balance sheet therefore records both wartime liquidity creation and the subsequent effort to prevent it from becoming an unchecked monetary overhang.

Tables 1 and 2 summarize the same mapping used in the figures at four benchmark dates: the first year of the sample, the last pre-2014 year, the last pre-full-scale-war year, and the latest available observation. Asset items are reported as a percentage of total assets; liability-side items are reported as a percentage of total liabilities plus equity.

Table 1: Asset-Side Benchmark Shares, % of Total Assets

Balance-sheet item	2008	2013	2021	2025
Foreign reserves	70.4	40.0	62.8	74.6
Domestic securities	2.6	37.0	23.5	21.2
Refinancing loans	17.4	16.1	7.3	0.1
IMF quota assets	4.6	4.1	5.6	3.5
Other assets	4.9	2.9	0.8	0.6
Total	100.0	100.0	100.0	100.0

Source: NBU annual consolidated financial statements; authors' mapping.

Table 2: Liability and Equity Benchmark Shares, % of Total Liabilities plus Equity

Balance-sheet item	2008	2013	2021	2025
Banknotes	47.9	62.8	45.6	28.1
Bank reserves and NBU CDs	6.2	12.1	19.6	31.1
Government and other deposits	3.7	1.0	4.0	14.6
IMF-related liabilities	15.1	7.5	17.1	4.2
Other liabilities	1.4	3.2	1.5	4.5
Equity	25.7	13.5	12.1	17.6
Total	100.0	100.0	100.0	100.0

Source: NBU annual consolidated financial statements; authors' mapping.

3.2 Sterilization, inflation and quasi-fiscal exposure

An NBU certificate of deposit (CD) absorbs liquid bank reserves but remains an interest-bearing central-bank liability. The relevant distinction is between the composition of monetary liabilities, their remuneration, and the subsequent behavior of prices. We construct year-end CD stocks as reserve money including CDs minus reserve money excluding CDs, scale them by nominal GDP, and relate them to December inflation in the following year. This avoids mechanically repeating annual balance-sheet stocks in monthly estimates. Across the sixteen annual pairs for 2009–2024, the CD/GDP slope is negative but imprecisely estimated: it is -0.30 without controls, -0.62 controlling for current inflation, and -2.40 additionally controlling for whether the outcome year is wartime. None differs significantly from zero at conventional levels (Appendix Table A12).

The financial statements nevertheless reveal a material remuneration cost. Interest expense on CDs increased from UAH 10.7 billion in 2021 to 40.8 billion in 2022 and 91.6 billion in 2023, before falling to 76.8 billion in 2024 and rising to 82.0 billion in 2025 (Appendix Table A13). These are annual flows taken directly from the audited consolidated accounts, not approximations obtained by multiplying year-end stocks by the policy rate. They must be distinguished from net interest income, accounting profit and the amount legally distributable to the budget. For example, the 2024 accounts report consolidated profit of UAH 231.1 billion but distributable profit of UAH 102.7 billion; after allocating general reserves, UAH 84.2 billion was due to the budget. That entitlement is distinct from cash transfers executed during the year.

The quasi-fiscal channel operates through the consolidated public sector. Interest paid by the government to the NBU is largely internal to that sector; remuneration paid on CDs to banks is a cash expense outside the monetary-fiscal consolidation boundary, subject to further adjustments for public bank ownership, taxes and dividends. Its ultimate fiscal incidence depends on asset income, valuation adjustments, buffers and remittance rules. Gross CD interest expense is thus an exposure measure, not an estimate of the net fiscal cost of monetary policy or its welfare cost.

This distinction connects sterilization to the war-finance literature. The investigation of wartime FOMC debate by Farvaque et al. (2020) offers a complementary historical comparison. Negative ex-post real returns on outstanding nominal domestic debt can redistribute resources from creditors to the sovereign, as in debt-liquidation accounts (Reinhart and Sbrancia, 2015). A relevant return is approximately $(1 + j_t)/(1 + \pi_t) - 1$, using a debt yield matched to the holding period, not automatically the policy rate minus contemporaneous annual CPI inflation. Remunerating CDs may offset part of the fiscal advantage of monetary financing by replacing unremunerated reserves with interest-bearing liabilities. Quantifying net debt liquidation would require debt maturity, ownership, indexation and realized holding returns in addition to the central bank accounts.

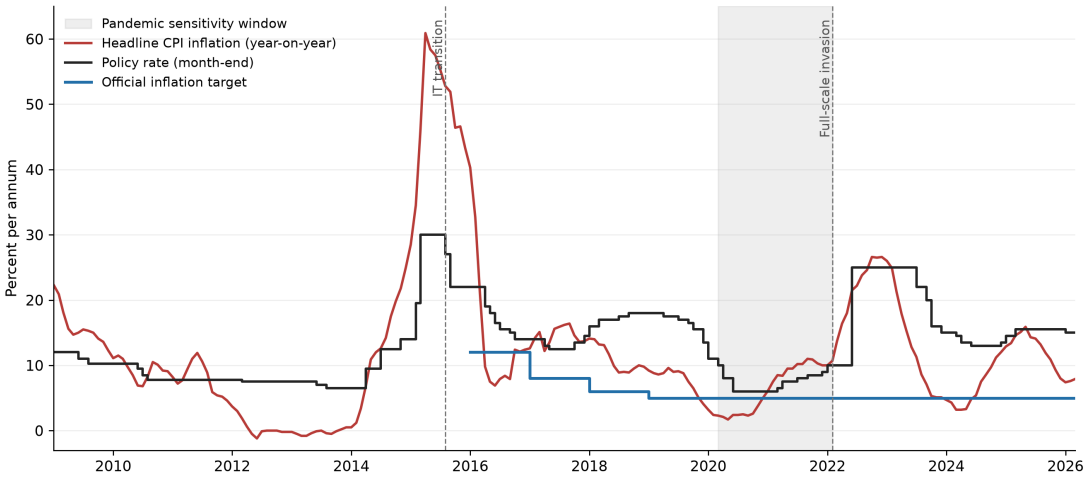
The present evidence identifies that channel without claiming to possibly measure its net size.

4 Taylor-type rule analysis

This section estimates a descriptive representation of the National Bank of Ukraine's monetary reaction function using monthly data. The purpose is not to impose a mechanical rule on a period marked by institutional reform and war, but to ask whether policy movements are consistent with a systematic, state-contingent response to inflation, economic activity, and exchange-rate conditions. The analysis therefore complements the balance-sheet evidence: where the previous section documents how the NBU's instruments and balance-sheet composition changed, the Taylor-type rule exercise evaluates whether the policy-rate reaction function changed in parallel.

Before estimating the reaction functions, Figure 4 compares inflation, the end-of-month policy rate, and the changing official inflation-target path. This matters for interpretation because the sample combines an initially high-inflation environment, the 2015 disinflation shock, the gradual reduction of official targets from 12 percent to 5 percent, and the renewed inflation surge after the full-scale invasion.

Figure 4: Inflation, the Policy Rate, and the Official Inflation Target, % per annum



Notes: The red line reports headline CPI inflation, year-on-year. The blue step line reports the official inflation target: 12 percent in 2016, 8 percent in 2017, 6 percent in 2018, and 5 percent from 2019 onward. The black step line reports the policy rate effective at month-end, carried forward between decisions; its monthly steps do not identify exact decision dates. All three series use the same percentage scale. The gray band marks March 2020–January 2022, the longer pandemic sensitivity window; the official target is left missing before 2016. Vertical markers indicate the August 2015 announcement and de facto transition toward inflation targeting and the start of the full-scale war. Source: NBU and State Statistics Service of Ukraine (SSSU); authors' calculations.

COVID-19 is treated as a temporary disturbance within inflation targeting rather than a fourth institutional regime. The NBU retained its inflation-targeting framework

while cutting the policy rate in 2020 (National Bank of Ukraine, 2020). This institutional distinction motivates the baseline periodization; it does not assume that the pandemic left the empirical reaction function unchanged.[1]

The estimation sample runs from December 2011 to March 2026. The starting point is dictated by the Hamilton-filtered industrial-production measure of the economic-activity gap, which requires lagged observations and a two-year forecasting horizon. Inflation is measured by headline CPI inflation relative to a 5 percent long-run anchor in the full-sample specifications. A post-2016 robustness specification uses the official inflation-target path: 12 percent in 2016, 8 percent in 2017, 6 percent in 2018, and 5 percent from 2019 onward. Economic activity is proxied by a Hamilton-filtered industrial-production gap rather than a GDP gap, because the policy rule is estimated at monthly frequency and industrial production is available as a timely measure of economic activity. Exchange-rate pressure is measured by year-on-year log depreciation of the Ukrainian hryvnia (UAH) against the US dollar (USD). We prefer the year-on-year measure for reasons of economic timing and measurement. The policy rate is highly persistent, while exchange-rate pass-through to prices and inflation expectations generally unfolds over several months. The twelve-month change therefore captures sustained currency pressure more closely aligned with the horizon over which monetary policy responds, and it is measured over the same horizon as headline inflation. This consideration is particularly relevant for Ukraine, where periods of exchange-rate stability or active management have been interrupted by discrete official adjustments. A month-on-month measure concentrates such an adjustment in a single observation and may make the estimated coefficient sensitive to the precise timing of the exchange-rate change and the policy decision within that month. The annual measure instead captures the cumulative depreciation that remains relevant while its effects pass through to prices and expectations. This choice involves a trade-off, since overlapping twelve-month changes are smoother and more persistent. We therefore report month-on-month depreciation as a robustness check. The appendix provides the supporting data documentation: Table A1 summarizes coverage of the residual and shock variables, Table A2 lists the raw public sources for the second-stage dataset, and Table A3 records the principal public access points and their use in constructing the database.

To distinguish the desired policy-rate setting from the observed instrument, let the former be

$$\widetilde{i}_t = \bar{i} + \beta_\pi \left(\pi_t - \pi_t^*\right) + \beta_y \left(y_t - y_t^*\right), \tag{1}$$

[1]Appendix A.17 adds a temporary pandemic indicator, varies its endpoint, excludes pandemic observations, and re-estimates the frozen-coefficient benchmark using training data ending in December 2019.

where $(\pi_t - \pi_t^*)$ is the inflation gap and $(y_t - y_t^*)$ is the deviation of industrial production from its time-varying Hamilton trend. The observed end-of-month policy rate follows a partial-adjustment equation,

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)\,\widetilde{i}_t + u_t, \tag{2}$$

where ρ_i measures policy-rate persistence. Substituting equation (1) into equation (2) gives the estimable reduced form

$$i_t = c + \rho_i i_{t-1} + \gamma_\pi\,(\pi_t - \pi_t^*) + \gamma_y\,(y_t - y_t^*) + \varepsilon_t, \tag{3}$$

where $c = (1-\rho_i)\bar{i}$, $\gamma_j = (1-\rho_i)\beta_j$, and ε_t collects the policy innovation and approximation error. Thus, the directly estimated γ_j are short-run responses, while the corresponding long-run responses are $\beta_j = \gamma_j/(1-\rho_i)$.

For an open economy, the reduced form is augmented with exchange-rate depreciation:

$$i_t = c + \rho_i i_{t-1} + \gamma_\pi\,(\pi_t - \pi_t^*) + \gamma_y\,(y_t - y_t^*) + \gamma_d d_t + \varepsilon_t, \tag{4}$$

where d_t^m is UAH depreciation against the USD. This extension is consistent with the importance of exchange-rate conditions in small open economies (Monacelli, 2005).

The preferred full-sample specification uses annual depreciation, d_t^a, and adds regime indicators and slope interactions:

$$i_t = c + \rho_i i_{t-1} + \gamma_\pi\,(\pi_t - \pi_t^*) + \gamma_y\,(y_t - y_t^*) + \gamma_d^a d_t^a + \delta' D_t + \theta' I_t + \varepsilon_t, \tag{5}$$

where D_t contains the inflation-targeting and full-scale-war indicators and I_t contains their interactions with the macroeconomic regressors. We refer to these as monetary-policy-rule (MPR) specifications. MPR1, the first such specification, is obtained by setting $\rho_i = 0$ and excluding exchange-rate and regime terms; the remaining specifications successively add the terms shown in Table 3.

Eight MPR specifications are reported. The first three build the conventional Taylor-type rule step by step: the baseline includes the inflation gap and the industrial-production measure of the economic-activity gap, the second adds interest-rate smoothing, and the third adds exchange-rate pressure. MPR4, which remains the preferred descriptive residual-generating model for continuity with the subsequent policy-rule deviation analysis, adds regime indicators and interactions for inflation targeting and the full-scale war. MPR4' repeats MPR4 using monthly exchange-rate depreciation instead of year-on-year depreciation. MPR5 restricts the sample to the official inflation-targeting period and uses the official target path. MPR6 adds wartime regime terms to MPR5, while MPR6' repeats MPR6 with monthly instead of annual exchange-rate depreciation.

Table 3 reports OLS point estimates with Newey–West heteroskedasticity and autocorrelation consistent (HAC) standard errors (Newey and West, 1987). The stated six monthly lags are the truncation bandwidth of the HAC covariance estimator, not six lags of the dependent variable or six additional regressors. Six months provides a transparent half-year bandwidth at monthly frequency; residual tests and bandwidths from zero to twelve months are reported below and in the appendix. HAC inference does not, however, resolve possible simultaneity or information-set problems in the contemporaneous macroeconomic regressors. We therefore supplement OLS with a lagged-information specification and the lag-instrument IV/GMM checks described after Table 4, following the moment-condition approach used in empirical reaction-function studies (Clarida et al., 1998, 2000).

The estimates reported in tables 3 and 4 should be read in light of the NBU's own stated hierarchy of objectives. In its annual reports, the Bank describes its main function as safeguarding the stability of the national currency, guided by the priority of price stability, while also emphasizing monetary and foreign-exchange (FX) market operations, liquidity management, and financial stability. Table 3 mirrors that hierarchy. The estimated policy-rate smoothing coefficient is high across all dynamic specifications, ranging from about 0.83 to 0.89. This persistence is consistent with a central bank that uses the policy rate as a signaling instrument and avoids excessive month-to-month volatility when credibility and financial stability are fragile.

Table 3: First-Step Taylor-Type Rule Estimates

Variable	MPR1 Baseline 5% anchor	MPR2 Smoothing 5% anchor	MPR3 FX y/y 5% anchor	MPR4 FX y/y	MPR4' FX m/m	MPR5 Official target FX y/y	MPR6 Official target war terms, FX y/y	MPR6' Official target war terms, FX m/m
Constant	12.019***	1.974***	1.793**	0.377	1.176*	1.351*	0.727	1.075
	(0.762)	(0.741)	(0.888)	(0.658)	(0.669)	(0.803)	(0.687)	(0.889)
Lagged policy rate		0.829***	0.841***	0.860***	0.834***	0.866***	0.889***	0.871***
		(0.058)	(0.066)	(0.049)	(0.062)	(0.057)	(0.045)	(0.061)
Inflation gap, 5% anchor	0.298***	0.067**	0.051	0.070***	0.113***			
	(0.037)	(0.029)	(0.039)	(0.025)	(0.025)			
Inflation gap, official target						0.124***	0.081***	0.090***
						(0.039)	(0.022)	(0.030)
Economic activity gap (industrial production)	-0.113***	-0.019	-0.017	0.054***	0.033*	-0.006	0.035*	0.024
	(0.043)	(0.014)	(0.017)	(0.021)	(0.017)	(0.014)	(0.020)	(0.022)
UAH/USD depreciation, y/y			0.011	0.035*		-0.008	0.014	
			(0.019)	(0.020)		(0.017)	(0.012)	
UAH/USD depreciation, m/m					0.060***			0.022
					(0.017)			(0.045)
Inflation-targeting regime				0.662	0.340			
				(0.463)	(0.322)			
Full-scale-war regime				0.425	0.243		0.354	0.182
				(0.379)	(0.355)		(0.367)	(0.326)
IT × inflation gap				-0.058***	-0.069***			
				(0.017)	(0.017)			
War × inflation gap, 5% anchor				0.170**	0.101**			
				(0.085)	(0.046)			
War × inflation gap, official target							0.103	0.045
							(0.087)	(0.047)
War × economic activity gap				-0.058***	-0.039**		-0.037*	-0.027
				(0.022)	(0.018)		(0.020)	(0.019)
War × FX depreciation, y/y				-0.080			-0.067	
				(0.051)			(0.053)	
War × FX depreciation, m/m					-0.104**			-0.070
					(0.048)			(0.064)
Observations	172	172	172	172	172	123	123	123
Adj. R-squared	0.658	0.935	0.935	0.943	0.942	0.927	0.928	0.926
RMSE	3.577	1.552	1.546	1.425	1.437	1.380	1.350	1.367

Notes: The dependent variable is the end-of-month NBU key policy rate. Parentheses report Newey–West standard errors with a six-month HAC truncation bandwidth; this is not a six-lag dynamic specification. *, **, and *** denote statistical significance of the estimated coefficients at the 10, 5, and 1 percent levels. MPR1 is the baseline Taylor rule with a 5 percent inflation anchor; MPR2 adds interest-rate smoothing; MPR3 adds year-on-year UAH/USD depreciation. MPR4 adds inflation-targeting and full-scale-war regime terms and interactions. MPR4' repeats MPR4 with month-on-month UAH/USD depreciation. MPR5 uses the official inflation-target path from 2016 onward. MPR6 adds wartime regime terms to MPR5; MPR6' repeats MPR6 with month-on-month UAH/USD depreciation. The post-IT dummy is not separately included in MPR6 and MPR6' because the official-target sample begins in 2016.

Table 4: Implied Short- and Long-Run Responses from the Preferred Policy Rule

	Pre-IT		IT before full-scale war		Full-scale war	
Variable	Short run	Long run	Short run	Long run	Short run	Long run
Inflation gap	0.070***	0.501***	0.012	0.084	0.182**	1.303**
	(0.025)	(0.151)	(0.029)	(0.203)	(0.091)	(0.554)
Economic activity gap (industrial production)	0.054***	0.389*	0.054***	0.389*	-0.004	-0.029
	(0.021)	(0.226)	(0.021)	(0.226)	(0.012)	(0.080)
UAH/USD depreciation, y/y	0.035*	0.251	0.035*	0.251	-0.044	-0.318
	(0.020)	(0.170)	(0.020)	(0.170)	(0.051)	(0.337)

Notes: Short-run responses are linear combinations of the MPR4 coefficients in Table 3. Long-run responses divide the short-run response by $1 - \widehat{\rho}_i$. Parentheses report HAC standard errors; long-run standard errors use the delta method and the full MPR4 covariance matrix. *, **, and *** denote significance against zero at the 10, 5, and 1 percent levels. The full-scale-war inflation point estimate exceeds one, but it is not significantly greater than one. Because inflation is contemporaneous and realized rather than expected, this comparison is descriptive and is not a formal test of determinacy.

The distinction between short- and long-run responses is material because $\widehat{\rho}_i = 0.860$. The implied long-run inflation response is about 0.50 before inflation targeting, 0.08 during inflation targeting before the full-scale war, and 1.30 during the full-scale war. Only the wartime point estimate exceeds one, but its delta-method standard error is 0.55, so the data do not establish a response significantly greater than one. The long-run economic-activity and exchange-rate responses are likewise imprecisely estimated in the wartime regime.

The conventional Taylor principle concerns the policy response to expected inflation within a structural equilibrium model. Our specification instead uses contemporaneous realized inflation, so these long-run coefficients cannot be interpreted as formal tests of determinacy. They remain useful as a descriptive benchmark for the historical strength of the policy-rate response to observed inflation. Provided $\rho_i < 1$, a regime-specific response greater than one is equivalent to the linear restriction $\rho_i + \gamma_\pi^{(r)} > 1$. The corresponding one-sided test gives $p = 0.289$ for the wartime MPR4 estimate. Appendix Table A6 shows that the wartime 2SLS point estimate also exceeds one but is similarly inconclusive ($p = 0.295$), while both GMM estimates are below one. Thus the estimates provide no statistically robust evidence that the policy-rate response satisfied this descriptive greater-than-one benchmark. Conversely, estimates below one do not by themselves establish indeterminacy, particularly where stabilization also relies on exchange-rate policy, intervention, capital controls, and balance-sheet instruments. Ukraine's price stabilization should therefore be understood as arising from a broader state-contingent policy mix rather than from an unambiguously active interest-rate rule alone.

The interaction coefficients in Table 3 are differences relative to the reference regime, not the responses within the named regime. Their economically meaningful interpretation therefore requires adding each interaction to the corresponding base coefficient, as done explicitly in Table 4. The negative coefficient on IT $\times$ inflation gap is an incremental slope change, not the total response to inflation under inflation targeting. In MPR4, the pre-IT short-run response is 0.070, while adding the IT interaction of -0.058 gives an IT-before-war response of 0.012. The latter is positive but statistically indistinguishable from zero, as is its long-run counterpart of 0.084 in Table 4. One possible interpretation is that, after the adoption of a forward-looking inflation-targeting framework, the contemporaneous realized inflation gap became a less complete measure of the information guiding rate decisions, particularly in a specification with strong interest-rate smoothing and a changing announced target. Limited within-regime variation and the disinflation path after 2015 may also contribute. The estimate should therefore be read as a change in the contemporaneous empirical reaction coefficient, not as evidence that the NBU attached less importance to price stability. Consistent with that caution, the official-target specifications MPR5 and

MPR6 retain positive and statistically significant inflation-gap coefficients; adding the wartime interaction improves fit only modestly.

A restricted specification, denoted MPR4″, removes both the IT regime intercept and the IT × inflation-gap interaction. As shown in Appendix Table A5, this restriction does not restore significance: it imposes a common pre-war inflation coefficient of 0.038, with a HAC standard error of 0.027. It also raises RMSE from 1.425 to 1.466, and a joint HAC Wald test rejects deletion of the two IT terms ($p = 0.002$). MPR4″ is therefore informative as a robustness check, but it is not preferred to MPR4 because it forces the pre-IT and IT-before-war regimes to share the same inflation slope.

The economic-activity interactions also need to be interpreted as sums. The positive MPR4 coefficient on the industrial-production measure of the economic-activity gap, 0.054, is offset during the full-scale war by the interaction of −0.058, leaving a wartime short-run response close to zero. This is consistent with the exceptional difficulty of reading industrial production as a conventional cyclical indicator during invasion, territorial disruption, and data breaks. It does not imply that economic conditions were irrelevant to policy; rather, the measured industrial-production gap did not enter the wartime reaction function in the same way as before the invasion.

Changing the depreciation horizon does not improve the overall fit of the reaction function. The annual specification performs slightly better: RMSE is 1.425 in MPR4, compared with 1.437 in MPR4', and 1.350 in MPR6, compared with 1.367 in MPR6'. Moreover, although the monthly measure produces a larger non-war coefficient, the implied total wartime responses are very similar under the two transformations. Using the rounded coefficients in Table 3, the wartime response is approximately −0.045 in MPR4 and −0.044 in MPR4'; the corresponding values are approximately −0.053 in MPR6 and −0.048 in MPR6'. The monthly measure therefore changes the estimated timing of the non-war exchange-rate response more than it changes the model's broad economic conclusions. We retain year-on-year depreciation in the preferred residual-generating specification because it captures sustained exchange-rate pressure, is less dependent on the timing of individual monthly adjustments, and yields marginally better fit. MPR4' and MPR6' remain important robustness checks for a more immediate exchange-rate response.

Several mechanisms can explain this weaker identification. Depreciation affects domestic prices, so part of the policy response to exchange-rate pressure may already be captured by the inflation gap. Moreover, the shorter sample provides less variation with which to distinguish the inflation and exchange-rate channels. Most importantly, the NBU did not rely exclusively on its policy rate to address exchange-rate pressure. Foreign-exchange intervention, exchange-rate management and, during the full-scale war, capital controls could substitute for an interest-rate response. A small or insignificant depreciation coefficient therefore does not imply that the NBU disregarded exchange-rate

developments. It indicates that the separate contribution of the policy rate is difficult to identify within this broader policy mix.

The monthly-depreciation specifications reinforce this interpretation. In MPR4', the non-war coefficient becomes larger and more precisely estimated, suggesting that policy-rate decisions were more closely associated with recent exchange-rate movements than with depreciation accumulated over an entire year. The negative wartime interaction indicates that this interest-rate response weakened during the full-scale war, when exchange-rate intervention, controls and direct management assumed a greater role. The interaction must, however, be added to the non-war coefficient before interpreting the total wartime response. Finally, the similar RMSE values of MPR4 and MPR4', and of MPR6 and MPR6', show that changing the depreciation horizon does not materially improve the model's overall fit. It mainly changes how the estimated rule allocates the policy response between inflation and exchange-rate pressure.

We next assess whether the MPR4 results depend on contemporaneous information or OLS exogeneity. The lagged-information column in Table 5 replaces the current inflation, economic-activity, and depreciation terms, and their slope interactions, with first lags, without claiming that these revised observations reconstruct the information available at the actual decision date. The remaining columns implement the lag-instrument protocol detailed in Appendix A.12. Set A uses the first lag of each macroeconomic variable and the corresponding regime interactions as excluded instruments and is estimated by just-identified 2SLS-HAC. Set B adds their second lags and is estimated by two-step HAC-GMM (Hansen, 1982). The conservative GMM specification additionally treats i_{t-1} as endogenous and instruments it with i_{t-2} and i_{t-3}. Regime indicators are maintained as exogenous in all specifications.

The lagged-information estimates preserve the signs and broad regime pattern of MPR4. The just-identified 2SLS estimates are also close to OLS, and their residuals correlate 0.989 with the OLS residuals. Set B and the conservative GMM specification do not reject the reported overidentifying restrictions and their residual correlations with OLS remain above 0.96. The control-function tests nevertheless reject joint exogeneity of the contemporaneous terms, supporting the decision to report IV/GMM rather than relying on HAC-OLS alone. Some magnitudes are estimator-sensitive: in particular, efficient GMM attenuates the wartime inflation interaction and the March–May 2022 freeze residuals, although March 2015 and June 2022 remain the two dominant positive deviations. We therefore retain MPR4-OLS as a transparent descriptive residual-generating benchmark, not as a uniquely identified structural rule.

Appendix Table A6 translates every estimator in Table 5 into regime-specific short- and long-run inflation responses. The pre-IT response is weaker under the lagged-information and 2SLS specifications, and the IT-before-war response remains close to

Table 5: Information-Set and IV/GMM Robustness of MPR4

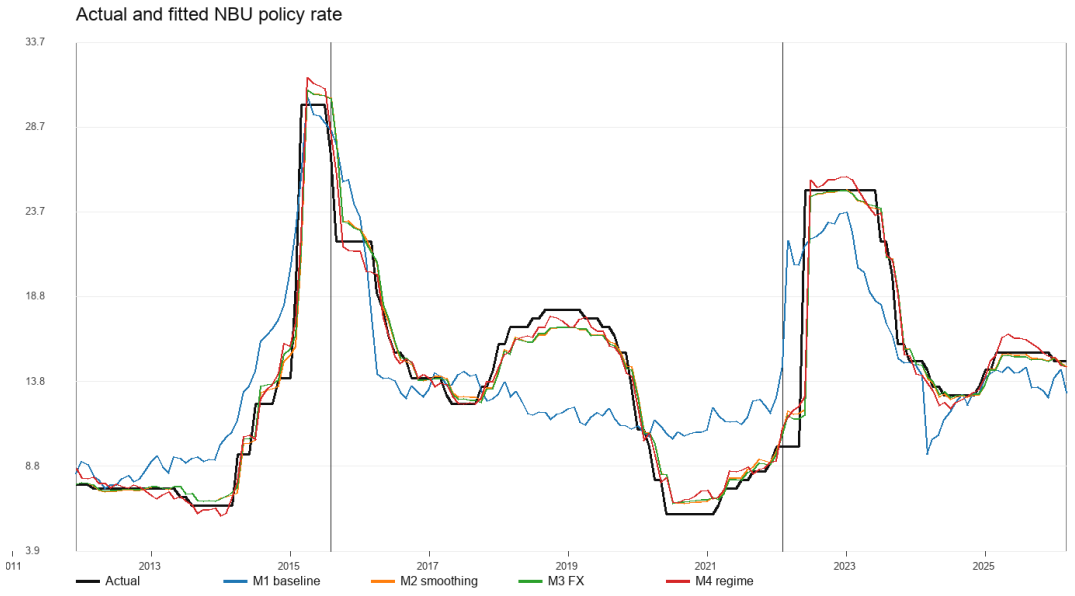
Variable	OLS-HAC MPR4	Lagged information OLS-HAC	2SLS-HAC Set A	GMM-HAC Set B	Conservative GMM Set B plus rate IVs
Constant	0.377	0.373	-0.359	-0.044	0.153
	(0.658)	(0.768)	(1.059)	(0.424)	(0.447)
Lagged policy rate	0.860***	0.850***	0.882***	0.905***	0.885***
	(0.049)	(0.062)	(0.055)	(0.028)	(0.032)
Inflation gap	0.070***	0.047	0.046	0.048***	0.057***
	(0.025)	(0.036)	(0.037)	(0.014)	(0.016)
Economic activity gap (industrial production)	0.054***	0.054***	0.083**	0.064***	0.064***
	(0.021)	(0.019)	(0.033)	(0.017)	(0.018)
UAH/USD depreciation, y/y	0.035*	0.051*	0.056	0.033**	0.034***
	(0.020)	(0.026)	(0.035)	(0.013)	(0.013)
Inflation-targeting regime	0.662	0.793	0.845	0.518	0.580
	(0.463)	(0.539)	(0.609)	(0.363)	(0.387)
Full-scale-war regime	0.425	0.510	0.774*	0.334	0.445*
	(0.379)	(0.359)	(0.407)	(0.228)	(0.259)
IT × inflation gap	-0.058***	-0.050***	-0.045**	-0.047***	-0.047***
	(0.017)	(0.016)	(0.018)	(0.013)	(0.013)
War × inflation gap	0.170**	0.154**	0.148**	0.085***	0.054*
	(0.085)	(0.062)	(0.067)	(0.029)	(0.030)
War × economic activity gap	-0.058***	-0.064***	-0.094***	-0.055***	-0.061***
	(0.022)	(0.022)	(0.035)	(0.017)	(0.019)
War × depreciation	-0.080	-0.085*	-0.102*	-0.017	-0.015
	(0.051)	(0.045)	(0.055)	(0.018)	(0.016)
Observations	172	171	171	170	170
RMSE	1.425	1.458	1.442	1.485	1.481
Number of instruments	—	—	11	18	19
Minimum conditional HAC F-type	—	—	41.72	36.08	57.60
Hansen J-test, p-value	—	—	—	0.539	0.322
Control-function endogeneity test, p-value	—	—	0.011	0.006	0.002

Notes: The dependent variable is the end-of-month NBU policy rate. The lagged-information column uses first lags of the macroeconomic variables and their interactions. Set A is just identified. Set B adds second lags of the same excluded instruments. The conservative column additionally instruments the lagged policy rate with its second and third lags. All covariance estimates use a six-month HAC bandwidth. The reported conditional HAC F-type statistic is the minimum across endogenous terms; it is a relevance diagnostic rather than a formal multiple-endogenous-regressor weak-IV-robust test. The Hansen test does not reject the overidentifying restrictions, but this does not establish instrument validity. *, **, and *** denote significance at the 10, 5, and 1 percent levels.

zero and insignificant under every estimator. By contrast, the full-scale-war response is positive and significant against zero throughout. That finding should not be confused with evidence that the response exceeds one: none of the appendix's linear one-sided tests rejects the null that the response is no greater than one.

Residual diagnostics are reassuring about the separate autocorrelation issue. The MPR4 Durbin–Watson statistic is 1.89, while Ljung–Box $Q(6) = 2.32$ ($p = 0.888$) and $Q(12) = 8.07$ ($p = 0.779$). Re-estimating the HAC covariance with bandwidths of 0, 3, 4, 6, 9, and 12 months leaves the principal inference intact. The non-war exchange-rate coefficient is the least robust inferential result: its positive point estimate suggests that the NBU tended to raise the policy rate when hryvnia depreciation intensified, consistent with concern about pass-through and exchange-rate expectations, but its significance varies with the covariance bandwidth. The evidence for a distinct interest-rate response to depreciation, after controlling for inflation and the other rule terms, is therefore suggestive rather than firm. Full bandwidth sensitivity is reported in Table A4 in the appendix.

Figure 5: Actual and Fitted NBU Policy Rate



Notes: The black line reports the actual end-of-month NBU key policy rate. The colored fitted paths are generated by the first-step Taylor-rule specifications reported in Table 3. The preferred fitted path is MPR4, the full-sample regime-interaction rule with year-on-year exchange-rate depreciation. Vertical markers indicate the August 2015 announcement and de facto transition toward inflation targeting and the beginning of the full-scale war. The figure is intended to show fit and timing, not to rank models as structural representations of monetary policy.

The fitted paths in Figure 5 confirm that a rule-based representation captures much of the broad movement in the NBU policy rate, but not the abrupt crisis decisions. As seen in Figure 6, the two largest residuals correspond to March 2015 and June 2022. The first occurred after the loss of Crimea, escalation of the Donbas war, a balance-of-payments and

Figure 6: Residuals from the Preferred Regime-Interaction Policy Rule

Notes: Residuals are actual policy rate minus the fitted rate from the preferred MPR4 regime-interaction rule, in percentage points. A positive residual indicates that actual policy was tighter than implied by the estimated reaction function; a negative residual indicates that actual policy was looser. The vertical markers identify the August 2015 announcement and de facto transition toward inflation targeting and the start of the full-scale war. These residuals are used in the descriptive event accounting.

confidence crisis, depletion of reserves, and the abandonment of the earlier exchange-rate anchor. As the hryvnia fell sharply and multiple exchange rates emerged, the NBU raised its key rate from 14.5 percent to 30 percent and tightened foreign-exchange restrictions to halt panic and restore an anchor (National Bank of Ukraine, 2016a). The June 2022 residual has a different chronology. The rate had been frozen at 10 percent during the first invasion months while budget monetization, foreign-currency demand, and reserve losses accumulated and external assistance had not yet arrived at sufficient scale or regularity. The NBU then raised the rate to 25 percent in June; the accumulated exchange-rate imbalance was addressed through a separate one-off 25 percent adjustment of the official hryvnia rate in July (National Bank of Ukraine, 2023). The residual pattern is therefore not a failure of the rule-based approach. It identifies episodes in which the implemented rule must be augmented by nonlinear financial constraints, institutional decisions, and geopolitical considerations.

These results support a qualified version of the paper's central claim. Wartime central banking in Ukraine need not be interpreted simply as a suspension of rules. The estimates are consistent with adaptive rule modification: policy remains associated with inflation, economic activity, smoothing, and exchange-rate conditions, while coefficients and residuals change across regimes. The event-accounting section uses the estimated MPR4 residuals to describe how the remaining deviations line up with institutional regime shifts and wartime conditions.

This interpretation also connects the monetary reaction function to the balance-sheet evidence. The balance sheet shows how the NBU's operating environment shifted from pre-2014 reserve management, to the transition toward inflation targeting and banking-system stabilization beginning in 2015, to wartime foreign-exchange stabilization and liquidity management. The Taylor-type rule estimates show the same sequence from the policy-rate side. Taken together, the two sets of evidence suggest that credibility and resilience were not substitutes: the NBU sought to preserve a nominal anchor while adapting its instruments to extraordinary geopolitical constraints.

The additional diagnostics qualify the interpretation of these estimates. Appendix A.12 makes the internal-instrument exclusions explicit and reports first-stage diagnostics without equating them to a system weak-identification test. A robustness check using the euro instead of the dollar exchange rate, also provided in the Appendix, reveals no substantial differences in the estimates. Endogenous least-squares segmentation selects April 2015 and June 2022 under all three reported trimming choices, rather than mechanically recovering the August 2015 and February 2022 institutional dates (Appendix A.14). The unit-root diagnostics remain inconclusive in levels. Together these results motivate treating MPR4 as a descriptive historical benchmark rather than a structurally invariant policy rule.

5 Policy-rate deviations from benchmark paths

The previous estimates reconstruct the systematic component of the NBU's reaction function. The next question is where actual policy departed from that fitted rule path, and whether those departures look like arbitrary discretion or state-contingent responses to exceptional constraints. To answer this, we compute two families of policy-rate deviations. The first is empirical: namely, the residual from the preferred regime-interaction rule, MPR4. The second is comparative: the gap between the actual NBU policy rate and benchmark Taylor-type reference rates – see Table 6. A positive deviation means that the actual policy rate is above, that is, tighter than, the fitted or benchmark-implied rate; a negative deviation means that actual policy is below, looser than, that reference path.

The estimated-rule residual is the main object for the later explanatory stage, because it measures departures from Ukraine's own estimated reaction function. The benchmark gaps serve a different purpose. They show how far Ukrainian policy was from simple policy rules, including a canonical Taylor rule, a balanced rule with a stronger economic-activity response, and an open-economy benchmark that adds exchange-rate depreciation pressure.

The contrast between the two types of deviations is central. The estimated-rule residual is centered near zero by construction and has a standard deviation of about 1.4 percentage points. Most months are therefore reasonably well described by the estimated reaction function once interest-rate smoothing, inflation gaps, economic-activity gaps,

Table 6: Summary of Policy-Rate Deviations from Benchmark Paths

Deviation measure	Mean	SD	Min	Max
Estimated-rule residual	-0.00	1.43	-3.85	12.07
Canonical Taylor gap	-3.77	14.47	-53.06	27.66
Balanced-rule gap	-3.77	19.37	-45.27	55.71
Open-economy benchmark gap	-4.93	15.56	-59.75	27.66

Notes: Deviations are actual NBU policy rate minus the fitted or benchmark-implied rate, in percentage points, over December 2011-March 2026. The estimated-rule residual is actual policy minus the fitted rate from the preferred MPR4 regime-interaction rule. The canonical Taylor gap compares actual policy with a Taylor-style benchmark equal to r* + inflation + 0.5 inflation gap + 0.5 economic-activity gap, with r* set to 2 percent. The balanced-rule gap uses the same inflation response but gives the economic-activity gap a coefficient of 1. The open-economy gap adds a modest exchange-rate-pressure term to the canonical benchmark. Positive values mean the actual policy rate is tighter, above the reference path; negative values mean it is looser, below the reference path.

exchange-rate pressure, and changing regimes are included. The large benchmark gaps tell a different story: canonical Taylor-type rules often prescribe substantially higher rates than those actually chosen by the NBU, particularly in periods when inflation and exchange-rate pressure were elevated. This does not imply policy failure. Rather, it shows that a simple rule is poorly suited to an economy facing institutional transition, exchange-rate constraints, and wartime financial controls.

The extrema in Table 6 make this distinction concrete. The preferred estimated rule misses the policy rate by only about 1.4 percentage points in a typical month, but its maximum residual of 12.1 percentage points is the June 2022 tightening discussed below. By contrast, the standard deviations of the benchmark gaps range from roughly 14 to 19 percentage points, and their very large minima and maxima reflect the unrealistic prescriptions produced when fixed textbook coefficients are applied mechanically to Ukraine's crisis observations. These summary statistics therefore compare descriptive fit, not policy welfare, and the benchmark extremes should not be interpreted as feasible rate recommendations.

The regime breakdown in Table 7 and Figure 7 reinforces this point. Estimated residual volatility is lowest during the inflation-targeting period before the full-scale invasion, and highest during the full-scale-war period. Benchmark gaps are negative on average before the invasion, meaning that benchmark rules generally called for tighter policy than the NBU actually implemented. During the full-scale war, however, the canonical benchmark gap turns positive on average, reflecting the exceptionally tight policy stance after the June 2022 policy-rate increase and the collapse in measured economic activity captured by the industrial-production gap.

The deviations reported in Table 8 and Figure 8 identify episodes in which inflation, economic activity, exchange-rate depreciation, and interest-rate smoothing do not fully account for policy-rate movements. These residuals describe departures from the fitted

Table 7: Policy-Rate Deviations by Regime

Regime	Residual mean	Residual SD	Taylor gap mean	Open-economy gap mean
IT before full-scale war	-0.00	0.93	-7.71	-8.37
Full-scale war	-0.00	1.96	7.01	5.97
Pre-IT	-0.00	1.48	-9.02	-11.21

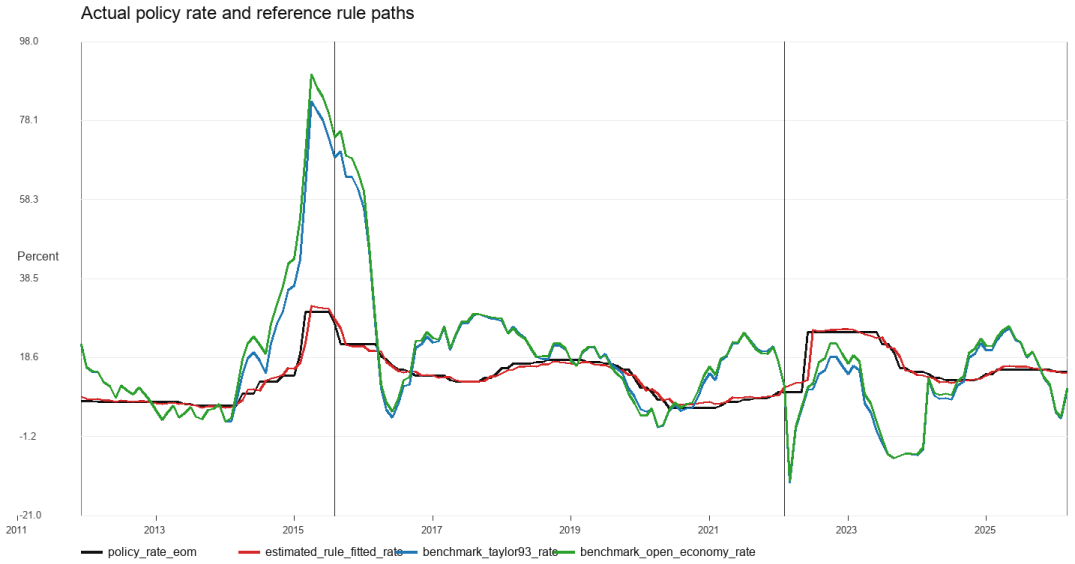
Notes: Deviations are measured as the actual NBU policy rate minus the fitted or benchmark-implied rate, in percentage points. The estimated-rule residual is taken from the preferred regime-interaction Taylor-rule specification. The Taylor gap is computed relative to the canonical Taylor-style benchmark, while the open-economy gap adds exchange-rate depreciation pressure. Regimes are defined as follows: pre-IT before August 2015; IT before full-scale war from the August 2015 announcement and de facto transition through January 2022; full-scale war from February 2022 onward. Formal entrenchment by the NBU Council occurred in December 2016.

Table 8: Largest Estimated-Rule Residual Episodes, in Chronological Order

Date	Regime	Actual policy rate	Fitted policy rate	Residual	Absolute residual
2015-02	Pre-IT	19.5	17.3	2.2	2.2
2015-03	Pre-IT	30.0	22.2	7.8	7.8
2015-09	IT before war	22.0	25.9	-3.9	3.9
2020-06	IT before war	6.0	8.2	-2.2	2.2
2022-04	Full-scale war	10.0	12.1	-2.1	2.1
2022-05	Full-scale war	10.0	12.3	-2.3	2.3
2022-06	Full-scale war	25.0	12.9	12.1	12.1
2023-10	Full-scale war	16.0	18.8	-2.8	2.8

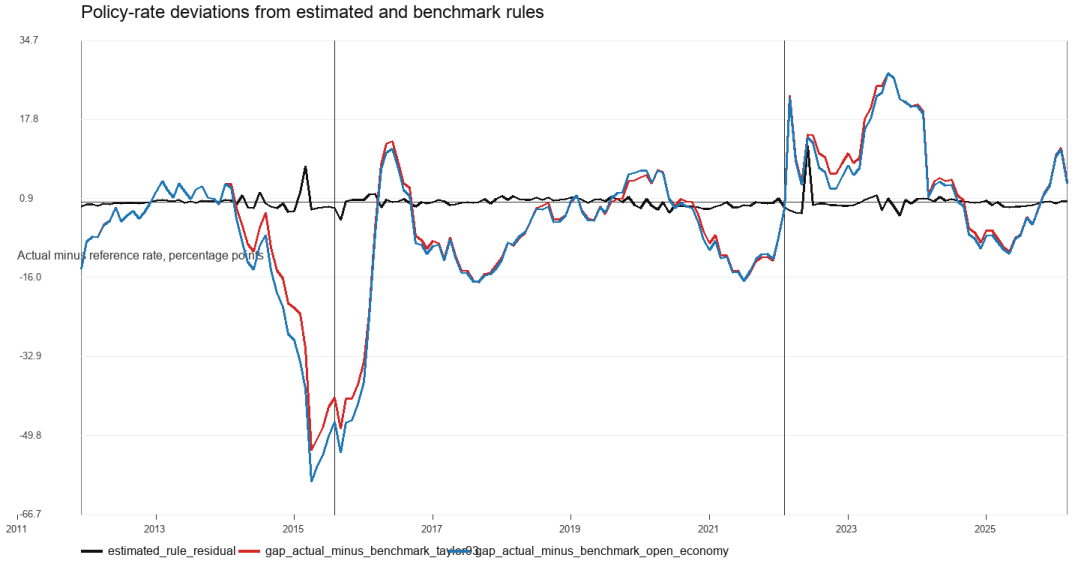
Notes: The table reports the largest absolute residuals from the preferred regime-interaction Taylor-type rule specification. The residual is defined as the actual NBU policy rate minus the fitted policy rate. A positive residual means that the actual rate was higher than implied by the estimated rule; a negative residual means that the actual rate was lower than implied by the estimated rule. Episodes were selected by absolute residual size and then reordered chronologically to show the sequence of crisis-related deviations.

Figure 7: Actual Policy Rate and Reference Rule Paths



Notes: The figure compares the actual NBU policy rate with three reference paths: the fitted rate from the preferred estimated rule, a canonical Taylor-style benchmark, and an open-economy benchmark that adds exchange-rate depreciation pressure. Benchmark paths are deliberately unconstrained: they do not impose wartime exchange-rate fixing, capital controls, financial-stability limits, or policy-rate lower/upper bounds. Large gaps should therefore be interpreted as diagnostic distances from simple rules, not as direct policy prescriptions.

Figure 8: Policy-Rate Deviations from Estimated and Benchmark Rules



Notes: Each series is actual policy rate minus the relevant fitted or benchmark rate, in percentage points. The zero line indicates equality between actual and reference policy. Positive (resp., negative) values mean that actual policy was tighter (resp., looser) than the reference path. The estimated-rule residual is centered near zero by construction.

reaction function, but do not establish their causes. A complementary question is whether wartime policy also departed from the relationship estimated before the full-scale invasion.

To address this question, Table 9 holds the coefficients estimated over August 2015–January 2022 fixed and applies them to realized wartime macroeconomic conditions. The one-step path uses the actual lagged policy rate, whereas the recursive path feeds each predicted rate into the following month's calculation. The former measures departures conditional on the observed policy history; the latter illustrates how those departures accumulate when the historical rule determines its own subsequent path.

Table 9: Frozen pre-invasion coefficients: conditional wartime paths

Period	N	Actual	One-step	Gap	Recursive	Gap
2022	11	19.55	14.47	5.07	-7.40	26.95
2023	12	21.75	19.02	2.73	-29.15	50.90
2024	12	13.58	13.03	0.55	-27.73	41.32
2025	12	15.33	14.58	0.75	-14.02	29.36
2026 Q1	3	15.00	13.60	1.40	-11.65	26.65
All wartime	50	17.36	15.19	2.17	-19.35	36.71

Notes: Period averages. Rates are expressed in percent per annum and gaps in percentage points. The 2022 row covers February–December. Coefficients are estimated over August 2015–January 2022. One-step predictions use the actual previous month's policy rate; recursive predictions use their own lagged rate, starting from the actual January 2022 rate. Both paths retain realized wartime macroeconomic covariates. Gap = actual minus counterfactual. These are conditional accounting exercises, not estimates of a no-war causal effect.

The actual policy rate exceeds the one-step benchmark by an average of 2.17 percentage points, with the largest annual mean gap occurring in 2022. This finding is not driven solely by the inclusion of pandemic observations in the estimation sample. Ending coefficient estimation in December 2019 reduces the average gap to 1.79 points, while leaving annual mean gaps positive throughout the wartime evaluation period (Appendix A.17). Recursive magnitudes are much more sensitive: the average gap falls from 36.71 to 14.67 points under the earlier endpoint. The economically implausible negative rates generated by recursive extrapolation highlight the limits of applying a fixed historical rule when wartime activity lies far outside the estimation sample.

A symmetric decomposition provides a further distinction between changes in economic conditions and changes in the estimated reaction function. It attributes 2.00 percentage points of the 3.49-point increase in mean policy rates to changed covariates and 1.50 points to changed coefficients, with the lagged policy rate accounting for much of the covariate contribution; the components differ from the total only because of rounding. These contributions are accounting quantities rather than separately identified causal effects. The balance-sheet evidence requires similar caution: annual CD remuneration expenses document a fiscal exposure, but the small-sample inflation regressions do not establish a causal disinflationary payoff from sterilization.

Together, these exercises distinguish historical fit, departures from a frozen pre-invasion rule, and changes in the estimated reaction function. They leave open why particular policy departures occurred. The next section therefore relates the MPR4 residuals to institutional, geopolitical, and social indicators. Because these residuals are estimated and several event windows correspond to conspicuous episodes in the data, the analysis provides descriptive event accounting rather than a causal second stage.

6 Descriptive event accounting for policy-rule deviations

This section describes how deviations from the estimated reaction function line up with institutional, geopolitical, and social events. The dependent variable is the estimated MPR4 residual: the actual NBU policy rate minus the fitted policy rate. A positive residual means that the actual rate was tighter than the estimated rule; a negative residual means that it was looser. Neither sign establishes that policy was normatively excessive in either direction.

The analysis is deliberately parsimonious. The residual sample is monthly but short, many war-related variables move together, and first-stage estimation uncertainty is not yet propagated through these regressions. We therefore report two families of descriptive associations. The first uses externally dated event and regime indicators to account for the timing of notable residuals. The second adds conflict-intensity and social variables, including ACLED[2] event counts, civilian-targeting indicators, IOM[3] displacement measures, and registered-unemployment changes. These regressions characterize the episodes; they do not identify causal effects of war-related shocks on the policy rate.

We consider both signed and absolute residuals. Table 10 reports the event coefficients for each measure, while Figure 9 plots the observed signed residual against the fitted values from the signed-residual column of that table. Signed residuals indicate whether policy was tighter or looser than the estimated rule; absolute residuals measure the size of the deviation regardless of direction.

The event accounting in Table 10 and its fitted series in Figure 9 show that residual variation is concentrated around a small number of crisis episodes. Figure 10 complements that model-based comparison by displaying the raw residual against shaded crisis periods and the two largest positive episodes. The February–March 2015 exchange-rate and policy-tightening peak is associated with a large positive residual. The June 2022 indicator accounts for about 12 percentage points in the signed-residual regression. Because this is

[2]ACLED stands for Armed Conflict Location & Event Data: `https://acleddata.com/about-acled.`

[3]IOM stands for the International Organization for Migration at the United Nations (UN): `https://www.iom.int.`

a one-month indicator for the largest observed residual, its coefficient largely restates the episode rather than providing an independent hypothesis test. Its value is to document that the move to 25 percent lay far outside the fitted MPR4 path.

The early full-scale-invasion period points in the opposite direction. The March–May 2022 rate-freeze dummy is negative in the signed-residual model and positive in the absolute-residual model. This means that, during the first invasion months, the actual rate was below the fitted rule, but the magnitude of the deviation was still large. During that freeze, monetary budget financing and foreign-currency demand accumulated while official external support was not yet sufficiently large or regular to relieve reserve pressure. The 15-percentage-point June rate increase was therefore a discrete attempt to improve the attractiveness of hryvnia assets and arrest those imbalances. It preceded, rather than coincided with, the one-off official exchange-rate adjustment in July. Later, the opposite external-financing configuration - larger and more regular partner inflows - helped rebuild international reserves and raised the foreign-asset component of the NBU balance sheet (National Bank of Ukraine, 2023).

The conflict and social variables in Table 11 add context but should be interpreted cautiously. Because the continuous regressors are standardized, the coefficients are percentage-point changes in the policy-rule residual associated with a one-standard-deviation increase in the corresponding variable. In the 2018-onward model, a one-standard-deviation increase in ACLED civilian-targeting events is associated with a residual about 0.67 percentage points lower: policy was somewhat looser relative to the fitted rule in months when attacks on civilians were unusually numerous. The political-violence fatality term is positive but too imprecise to support an economic conclusion. A one-standard-deviation increase in month-on-month registered-unemployment growth is associated with a residual about 0.36 percentage points higher, suggesting that acute labor-market disruption coincided with policy rates above the fitted rule.[4] In the much shorter full-scale-war sample, the signs of several continuous variables change and none is precisely estimated once the freeze and June-jump indicators are included. Wartime registered unemployment also reflects changes in the composition of those registering, including a growing predominance of women (**?**). Mobilization, migration, displacement, and caring responsibilities may affect male and female labor-force participation and registration differently. Aggregate registered unemployment may consequently diverge from overall

[4]Robustness checks confirm that the unemployment result is sensitive to the periodicity used for registered unemployment. Replacing the month-on-month change with a three-month change preserves the positive association with signed full-war residuals, while the year-on-year change is not significant in the signed-residual model but becomes negative and significant in the absolute-residual model. This suggests that high-frequency unemployment changes capture short-run wartime labor-market stress, whereas year-on-year changes partly reflect administrative registration dynamics and base effects. The unemployment coefficients should therefore be interpreted as social-disruption proxies rather than standard labor-market-slack responses.

labor-market slack; we interpret it as a proxy for social and administrative disruption rather than a comprehensive unemployment measure. The event dummies, rather than the continuous conflict measures, account for most of the fitted residual variation. These coefficients should therefore be read as conditional descriptive associations, not as estimates of the monetary response to an additional conflict event.

The absolute-residual models focus on the scale of adjustment rather than direction and again show that June 2022 dominates the accounting exercise. With month-on-month registered-unemployment growth, the labor-market term is not significant in the absolute-residual model. Labor-market variables should therefore be treated as social-disruption proxies rather than standard slack indicators.

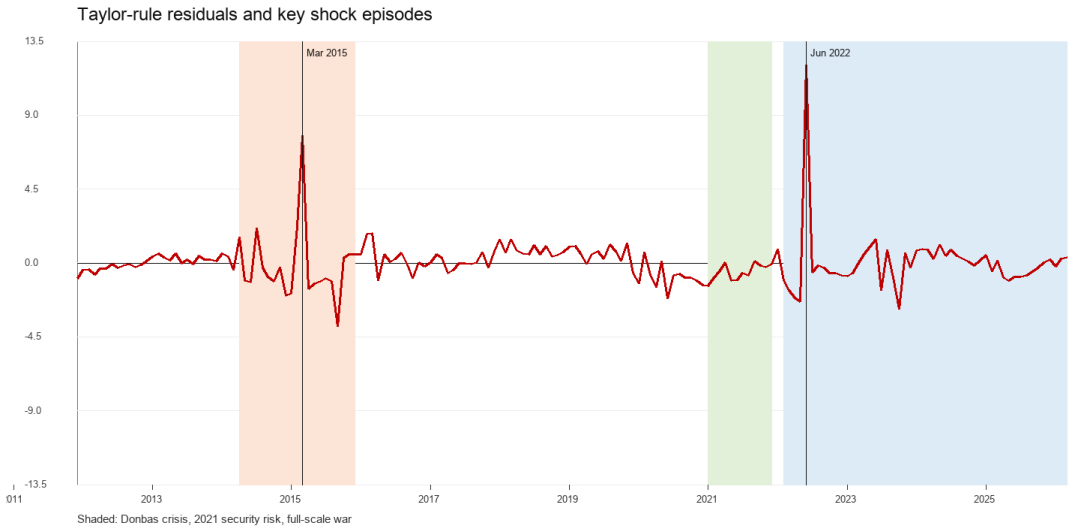
Table 10: Descriptive Event Accounting for Taylor-Type Rule Residuals

Variable	Signed residual	Absolute residual
Constant	0.043 (0.109)	0.591*** (0.064)
Crimea annexation, Mar. 2014	-0.501*** (0.109)	-0.134** (0.064)
Donbas crisis, 2014-2015	-0.748** (0.324)	0.646*** (0.127)
FX/policy peak, Feb.-Mar. 2015	5.701*** (0.845)	3.759*** (0.694)
Security-risk period, 2021	-0.599*** (0.176)	-0.015 (0.155)
Full-scale invasion, Feb. 2022	-1.100*** (0.109)	0.465*** (0.064)
Policy-rate freeze, Mar.-May 2022	-2.099*** (0.132)	1.464*** (0.107)
Policy-rate jump, Jun. 2022	12.028*** (0.109)	11.480*** (0.064)
Observations	172	172
R-squared	0.639	0.747
RMSE	0.856	0.590

Notes: Newey–West standard errors with a six-month HAC bandwidth are in parentheses. The signed residual is actual minus fitted policy rate; the absolute residual removes its sign. The event coefficients provide in-sample accounting and should not be interpreted as causal effects. In particular, the June 2022 singleton indicator mechanically absorbs the largest residual. First-stage estimation uncertainty is not included. *, **, and *** denote approximate significance at the 10, 5, and 1 percent levels.

The event accounting is consistent with the interpretation developed in the previous sections, but it is not an independent causal test of it. The NBU's largest deviations from the estimated reaction function occur around the post-Crimea/Donbas currency crisis, the initial full-scale-invasion freeze, and the June 2022 policy-rate jump. Conflict and social variables help characterize the wartime environment, while the strongest descriptive pattern comes from the timing of the policy episodes themselves.

Figure 9: Taylor-Type Rule Residuals and Key Shock Episodes



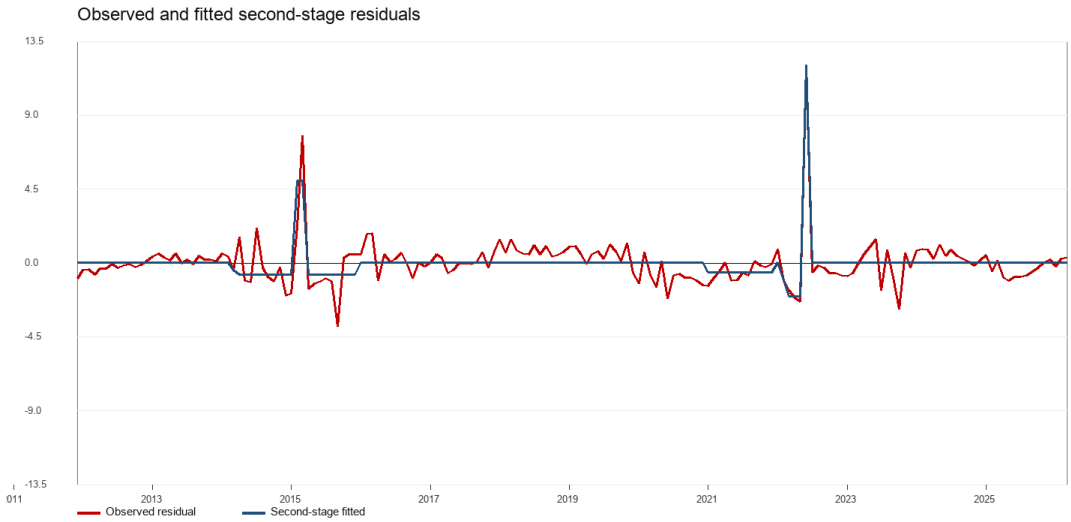
Notes: The observed series is the signed first-stage Taylor-rule residual. The fitted series is generated by the descriptive event-accounting regression using institutional and geopolitical indicators. The figure summarizes in-sample timing and direction; it is neither a causal nor a forecasting exercise.

Table 11: Conflict and Social Correlates of Policy-Rule Residuals

Variable	Signed, 2018-	Signed, full war	Absolute, full war
Constant	-0.077 (0.143)	-1.387 (1.283)	1.126*** (0.397)
Policy-rate freeze, Mar.-May 2022	-1.676*** (0.243)	-2.407*** (0.785)	1.483*** (0.461)
Policy-rate jump, Jun. 2022	12.305*** (0.171)	11.867*** (0.489)	11.662*** (0.166)
ACLED political violence events	0.215 (0.271)	-0.435 (0.761)	0.019 (0.457)
ACLED civilian-targeting events	-0.668* (0.369)	0.079 (0.774)	0.012 (0.704)
ACLED political violence fatalities	0.487 (0.551)		
IOM IDP stock	1.064 (1.115)	-0.432 (0.348)	
Registered unemployment, m/m	0.357** (0.150)	-0.053 (0.086)	
Observations	99	50	50
R-squared	0.714	0.863	0.929
RMSE	0.809	0.717	0.451

Notes: Continuous shock variables are log-transformed where appropriate and standardized. Registered unemployment is measured as month-on-month growth in the stock of registered unemployed persons, standardized over the estimation sample. Signed 2018- uses the ACLED coverage period; full-war models begin in February 2022. Newey-West standard errors with six monthly lags in parentheses. Robustness checks using three-month and year-on-year registered-unemployment changes are discussed in the text.

Figure 10: Observed Residuals and Descriptive Event Accounting



Notes: The red line is the signed residual from the preferred first-stage Taylor rule. Shaded areas identify the Donbas crisis period, the 2021 security-risk period, and the full-scale-war period. The vertical markers highlight March 2015 and June 2022, the two largest positive residual episodes. The figure is descriptive and does not identify the causal effects of the marked events.

7 Conclusion

This paper examined whether Ukraine's wartime monetary policy should be read as a departure from rule-based central banking or, alternatively, as an adaptation of the prescribed and implemented rules to exceptional state contingencies. The evidence supports the second interpretation. Across 2009-2026, the NBU's policy rate remains meaningfully connected to inflation gaps, cyclical conditions, exchange-rate pressure, and monetary policy inertia. The wartime period does not erase this systematic component. It rather changes the constraints under which the adopted rule is implemented, with appropriate adaptations.

This evidence does not, however, establish that the NBU satisfied the conventional Taylor principle. The wartime long-run response to observed inflation exceeds one in the OLS and 2SLS point estimates, but not significantly, and it falls below one in the GMM specifications. The longer pandemic sensitivity window also lowers estimated persistence enough to bring the OLS wartime long-run inflation response below one, despite a stable short-run inflation slope. Because the rule uses contemporaneous realized rather than expected inflation, these estimates are descriptive and cannot determine equilibrium determinacy. Price stabilization is therefore better understood as arising from the NBU's broader state-contingent mix of interest-rate, exchange-rate, intervention, and balance-sheet instruments than from an unambiguously active interest-rate rule alone.

The estimated Taylor-type rules and the deviation analysis point to a central bank operating with both rule-like discipline and state-contingent discretion. The largest departures from fitted rule prescriptions are concentrated in identifiable episodes: the 2014–2015 exchange-rate and banking crisis, the initial freeze after the full-scale invasion, and the June 2022 policy-rate jump that re-established a nominal anchor. Their timing is consistent with institutional regime changes, war-related financial stress, and the need to stabilize expectations when conventional Taylor-rule equilibria may be fragile, as also emphasized by De Groot and Skok (2026). The descriptive event accounting does not, however, establish that those events causally generated the residuals.

The broader implication is important for the paper's title, and for Ukraine's European accession trajectory. The path from Kyiv to Frankfurt is not only a question of eventual euro adoption, nor only a question of satisfying formal nominal convergence criteria. Before reaching there, it is also essentially a question of whether Ukraine can sustain credible, rules-oriented monetary institutions while rebuilding after war. In that respect, the NBU's experience since the announced and de facto transition toward inflation targeting beginning in 2015, followed by its formal entrenchment in December 2016, is best understood as part of a longer institutional convergence process rather than as a sequence of isolated crisis measures (Grui et al., 2022; Nikolaychuk, 2025; National Bank of Ukraine, 2016b).

The accession perspective developed by Dabrowski and Louro (2026) provides a useful benchmark for this interpretation. Their quantification of European Commission assessments shows that Ukraine remains behind the Western Balkan front-runners in *acquis* adoption, with weighted overall preparedness scores of 31 in 2023, 31 in 2024, and 33 in 2025 (Dabrowski and Louro, 2026, p. 10). At the same time, Ukraine's accession process has been accelerated by geopolitical circumstances: candidate status was granted in June 2022, accession negotiations opened in December 2023, the first intergovernmental conference was held in June 2024, screening was completed in September 2025, and Cluster 1 negotiations were opened in June 2026 after Hungary lifted its block. Despite remaining at an early stage of the process, the Ukrainian government has declared the goal of completing negotiations by the end of 2028. This mixture of merit-based conditionality, an ambitious timetable, and geopolitical urgency is precisely the environment in which monetary credibility becomes strategically valuable.

Our results add a monetary-policy dimension to that accession debate. They suggest that Ukraine's central bank has preserved a rule-like reaction function under conditions that would normally threaten fiscal dominance, orderly exchange-rate functioning, and institutional credibility. This does not mean that the road to EU membership, let alone to the euro, is short. War complicates *acquis* implementation, raises questions about the timing of capital-account normalization, and makes the future exchange-rate regime unusually consequential. But it does mean that resilience itself should be treated as part of the evidence on institutional capacity.

For policy, the conclusion is therefore two-sided. Ukraine should preserve the operational independence and transparency of the NBU, rebuild monetary transmission, and sequence the exit from wartime controls in a way that protects the nominal anchor. The European Union, for its part, should recognize that wartime stabilization is not a substitute for *acquis* adoption, but neither is it irrelevant to accession readiness. A central bank able to combine rules, flexibility, and credibility under invasion offers an unusually strong test of European monetary integration in extreme conditions.

The conceptual contribution of the paper follows from this point. Wartime central banking is often described as the suspension of normal policy. Ukraine's case shows a different possibility: rules can survive by becoming explicitly state-contingent. The relevant comparison is not between rule and discretion, but between ad hoc discretion and disciplined adaptation. That distinction may matter well beyond Ukraine, for emerging market economies whose monetary regimes must remain credible while exposed to geopolitical shocks.

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A Appendix

to "From Kyiv to Frankfurt: Ukraine's monetary policy under war and integration constraints"

Sources and construction of the database

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This appendix describes the construction of the monthly database used to estimate Taylor-type monetary policy rules for Ukraine, as analyzed in the main text.

A.1 Sample and frequency

The database is monthly and covers January 2009 to March 2026. Monthly frequency is retained throughout. This is important because the National Bank of Ukraine's (NBU) key policy rate changes on decision dates, CPI and exchange-rate indicators are available monthly, and industrial production provides the most suitable monthly measure of real economic activity for Ukraine over the sample.

A.2 Policy rate

The policy instrument is the NBU key policy rate. The source is the NBU policy-rate, which lists effective decision dates and annualized policy rates. The event-date observations are converted into two monthly measures:

- `policy_rate_eom`: the rate in force on the final calendar day of each month;
- `policy_rate_monthly_avg`: the calendar-day-weighted average rate in force during the month.

The end-of-month policy rate is used as the preferred dependent variable in the first-stage Taylor-type rule estimates in the main text.

A.3 Inflation and inflation gaps

Inflation is headline CPI inflation relative to the corresponding month of the previous year:

- `inflation_yoy`: headline CPI, year-on-year percentage change.

Or monthly CPI inflation, retained as:

- `inflation_mom`: headline CPI, month-on-month percentage change.

Two target concepts are constructed. First, `inflation_target_official` follows the formal inflation-targeting period: 12% in 2016, 8% in 2017, 6% in 2018, and 5% from 2019 onward. This variable is left missing before 2016, because the pre-inflation-targeting period should not be treated as if it had a fully comparable numerical target. Second, `inflation_target_longrun_5` is set equal to 5% throughout the sample. This provides a continuous long-run anchor for specifications that require a full-sample inflation gap.

The resulting inflation-gap variables are:

- `inflation_gap_official` = `inflation_yoy` − `inflation_target_official`;
- `inflation_gap_longrun_5` = `inflation_yoy` − 5.

The preferred full-sample specifications use the 5% long-run anchor, while post-2016 robustness specifications use the official target path.

A.4 Economic-activity gap

The real economic-activity measure is based on monthly industrial production. The source contains monthly industrial-production indices relative to the previous month. Two methodological vintages are combined:

- the 2010-method series is used through December 2014;
- the 2016-method series is used from January 2015 onward.

The combined monthly growth series is stored as `ipi_mom_used`. A chained log industrial-production index, `log_ipi_chained`, is obtained by cumulating monthly log changes.

Potential economic activity is estimated using a Hamilton-style filter adapted to monthly data. Specifically, the log industrial-production index at month t + 24 is projected on a constant and 12 monthly lags observed at month t. The economic-activity gap is the forecast residual dated at t + 24 and expressed in percentage log points:

- `industrial_activity_gap_hamilton_pct`.

Because the procedure requires both lagged observations and a two-year forecast horizon, the economic-activity gap begins in December 2011.

A.5 Exchange rates

Exchange-rate data are average monthly official exchange rates:

- `uah_per_usd`: hryvnia per US dollar;

- `uah_per_eur`: hryvnia per euro.

Bilateral official-rate depreciation is represented by log changes (these are not exchange-market-pressure indices):

- `uah_per_usd_mom_pct`, `uah_per_eur_mom_pct`: monthly log changes;
- `uah_per_usd_yoy_pct`, `uah_per_eur_yoy_pct`: year-on-year log changes.

An increase in these variables denotes hryvnia depreciation.

A.6 Labor-market variables

Labor-market data come from the State Statistics Service of Ukraine (SSSU). Its unemployment rate is available only through December 2018. The full-sample labor-market proxy is registered unemployment:

- `registered_unemployed_thsd`: registered unemployed persons, thousands;
- `registered_unemployed_mom_pct`: month-on-month log change in registered unemployment;
- `registered_unemployed_3m_pct`: three-month log change in registered unemployment;
- `registered_unemployed_yoy_pct`: year-on-year log change in registered unemployment.

Additional labor-market indicators are also retained where available:

- `benefit_recipients_thsd`;
- `registered_unemployed_per_vacancy`;
- `unemployed_status_during_period_thsd`.

These variables are useful for robustness checks and for the later residual-decomposition stage.

A.7 Regime indicators

The database includes regime indicators designed for interacted Taylor-type rule specifications. August 2015 is used as the empirical breakpoint because it marks the NBU's announcement and de facto transition toward inflation targeting; it should not be confused with the NBU Council's formal entrenchment of the framework in December 2016:

- `pre_it`: months before August 2015;
- `post_it_aug2015`: August 2015 onward;
- `it_pre_fullscale_war`: August 2015 through January 2022;
- `fullscale_war`: February 2022 onward;
- `crimea_donbas_2014_2015`: March 2014 through December 2015;
- `security_risk_2021`: January 2021 through December 2021.

These indicators are intended to avoid fragile subsample regressions while still allowing the reaction function to differ across monetary-policy regimes and wartime conditions.

A.8 Second-stage shock dataset

The event-accounting dataset is constructed to describe correlates of the estimated-rule residuals. Several humanitarian variables are irregular snapshots rather than strictly monthly observations. For those series, the dataset preserves both the observed monthly value and a latest-available version carried forward from the most recent observation.

Table A1 summarizes coverage for the dependent variable and the main second-stage shock proxies. ACLED (Armed Conflict Location & Event Data: `https://acleddata.com/about-acled`) starts in 2018, UCDP (Uppsala Conflict Data Program: `https://ucdp.uu.se`) currently covers 2014-2024, and humanitarian stock variables are strongest after the full-scale invasion. The latest-available humanitarian stocks are set to zero before February 2022 for regressions that interpret them as post-2022 full-scale-war shock variables.

Table A1: Coverage for the dependent variable and the main second-stage shock proxies

Variable	Non-missing	First	Last
Estimated-rule residual	172	2011-12-01	2026-03-01
ACLED political-violence events	99	2018-01-01	2026-03-01
UCDP best fatalities	132	2014-01-01	2024-12-01
Refugee stock, latest available	172	2011-12-01	2026-03-01
IOM DTM IDP stock, latest available	172	2011-12-01	2026-03-01
Civilian killed stock, latest available	172	2011-12-01	2026-03-01
Registered unemployment, m/m	172	2011-12-01	2026-03-01

Table A2 lists the raw public sources that were used for the second-stage shock dataset.

Table A2: Public sources for second-stage shock dataset

Raw file	Source
unhcr_ukraine_refugee_situation.csv	https://docs.google.com/spreadsheets/d/e/2PACX-1vRzvb2ZKLS95aToa_SBYfsZIFhcL_0rvfir5kSUNzl7KNY8UIAVH9AyBZ2I-d5yAZly4l6S15bCVM_d/pub?gid=2043074349&single=true&output=csv
unhcr_situations_monthly.csv	https://data.humdata.org/dataset/e6320d49-1944-4c80-ad9c-ab83e4239267/resource/a1dc9602-b522-4966-bb59-f4a44d238dd1/download/unhcr-situations.csv
iom_dtm_admin_0_to_1.csv	https://data.humdata.org/dataset/fd8bf6f7-cb5e-4dde-8037-19b5d57ce6ec/resource/820e7059-e484-414b-9ccf-b9ed8b118bb0/download/ukr-iom-dtm-from-api-admin-0-to-1.csv
ucdp_conflict_data_ukr.csv	https://data.humdata.org/dataset/bb30eaae-306d-4d53-8978-998eb8b9a06e/resource/d4c483d4-e8dc-4246-9b6c-3aef8a7b16c6/download/conflict_data_ukr.csv
acled_political_violence_monthly.xlsx	https://data.humdata.org/dataset/7b36830b-c033-4a06-b812-9940baec603b/resource/e122ca1c-9463-4e3a-8731-8a85fab2a15e/download/ukraine_hrp_political_violence_events_and_fatalities_by_month-year_as-of-09jul2026.xlsx
acled_civilian_targeting_monthly.xlsx	https://data.humdata.org/dataset/7b36830b-c033-4a06-b812-9940baec603b/resource/23755ad0-1d81-4b10-9e66-23b784ccd429/download/ukraine_hrp_civilian_targeting_events_and_fatalities_by_month-year_as-of-09jul2026.xlsx
ukraine_key_figures.csv	https://docs.google.com/spreadsheets/d/e/2PACX-1vQIdedbZz0ehRC0b4fsWiP14R7MdtU1mpmwAkuXUPElSah2AWCURKGALFDuHjvyJUL8vzZAt3R1B5qg/pub?output=csv

A.9 Source URLs and retrieval notes

Table A3 records the principal public access points used to document the raw data sources. For the Taylor-rule variables, the local workbooks preserve the downloaded source series; for the second-stage shock variables, the exact download URLs are also stored in the raw-data manifest. Because several institutional websites update files in place, the local archived files should be treated as the analysis vintage.

Table A3: Public access points used to document the raw data sources

Data block	Series or file	URL or access point	Use in the database
NBU monetary policy	Key policy rate decisions	https://bank.gov.ua/en/monetary/archive-rish	Event-date policy-rate series converted to end-of-month and calendar-day-weighted monthly measures.
NBU monetary policy	Inflation target and monetary-policy regime information	https://bank.gov.ua/en/monetary	Official inflation-target path and interpretation of the NBU policy regime.
NBU exchange rates	Official hryvnia exchange rates	https://bank.gov.ua/en/markets/exchangerates	Monthly average official UAH/USD and UAH/EUR exchange rates.
NBU open data	Exchange-rate and interest-rate API documentation	https://bank.gov.ua/en/open-data/api-dev	Reference access point for programmatic retrieval of NBU rates and official exchange-rate data.
State Statistics Service of Ukraine	CPI, industrial production, GDP, employment and unemployment indicators	https://stat.gov.ua/en/economic_and_financial_data_for_ukraine	Macroeconomic and labor-market source for CPI, the industrial-production measure of economic activity, GDP diagnostics, and unemployment variables.
State Statistics Service of Ukraine	Dataset catalogue and metadata	https://stat.gov.ua/en/datasets	Metadata and alternative access point for individual statistical indicators.
NBU balance-sheet data	Consolidated financial statements and management reports	https://data.gov.ua/dataset/f7620976-74c5-4efb-82be-53513df2b9b4/resource/a01b108d-7206-445e-b6c6-146d61334c82?filter=for_month	Annual consolidated statement-of-financial-position items used for balance-sheet decomposition.
UNHCR / OCHA	Ukraine refugee situation	https://docs.google.com/spreadsheets/d/e/2PACX-1vRzvb2ZKLS95aToa_SBYfsZIFhcL_0rvfir5kSUNzl7KNY8UIAVH9AyBZ2I-d5yAZly4l6S15bCVM_d/pub?gid=2043074349&single=true&output=csv	Refugee stock and related humanitarian indicators.
UNHCR via HDX	UNHCR situations monthly file	https://data.humdata.org/dataset/e6320d49-1944-4c80-ad9c-ab83e4239267/resource/a1dc9602-b522-4966-bb59-f4a44d238dd1/download/unhcr-situations.csv	Monthly humanitarian situation data used in the second-stage shock dataset.
IOM DTM via HDX	Ukraine displacement tracking, admin 0 to 1	https://data.humdata.org/dataset/fd8bf6f7-cb5e-4dde-8037-19b5d57ce6ec/resource/820e7059-e484-414b-9ccf-b9ed8b118bb0/download/ukr-iom-dtm-from-api-admin-0-to-1.csv	IDP stock variables and latest-available displacement measures.
UCDP via HDX	Ukraine conflict events and fatalities	https://data.humdata.org/dataset/bb30eaae-306d-4d53-8978-998eb8b9a06e/resource/d4c483d4-e8dc-4246-9b6c-3aef8a7b16c6/download/conflict_data_ukr.csv	Conflict-event and fatality indicators.
ACLED via HDX	Political violence events and fatalities by month-year	https://data.humdata.org/dataset/7b36830b-c033-4a06-b812-9940baec603b/resource/e122ca1c-9463-4e3a-8731-8a85fab2a15e/download/ukraine_hrp_political_violence_events_and_fatalities_by_month-year_as-of-09jul2026.xlsx	Monthly political-violence event and fatality variables.
ACLED via HDX	Civilian-targeting events and fatalities by month-year	https://data.humdata.org/dataset/7b36830b-c033-4a06-b812-9940baec603b/resource/23755ad0-1d81-4b10-9e66-23b784ccd429/download/ukraine_hrp_civilian_targeting_events_and_fatalities_by_month-year_as-of-09jul2026.xlsx	Monthly civilian-targeting event and fatality variables.
OCHA / humanitarian key figures	Ukraine key figures	https://docs.google.com/spreadsheets/d/e/2PACX-1vQIdedbZz0ehRC0b4fsWiP14R7MdtU1mpmwAkuXUPElSah2AWCURKGALFDuHjvyJUL8vzZAt3R1B5qg/pub?output=csv	Civilian casualties, refugee, IDP, and other humanitarian stock indicators.

Notes: URLs were checked for accessibility during the July 2026 revision. The HDX and Google-sheet links reproduce the source files stored locally under Data/Second-stage shocks/raw. The NBU and State Statistics Service entries identify the public source pages or API documentation from which the stored macroeconomic series are drawn.

A.10 Residual and HAC-bandwidth diagnostics

Table A4: MPR4 Residual diagnostics and HAC-bandwidth sensitivity

Panel A: residual diagnostics

Diagnostic	Lag	Statistic	p-value
Durbin–Watson	—	1.888	—
Ljung–Box Q	1	0.516	0.473
Ljung–Box Q	3	0.938	0.816
Ljung–Box Q	6	2.317	0.888
Ljung–Box Q	12	8.073	0.779

Panel B: HAC standard errors by truncation bandwidth

Coefficient	HAC(0)	HAC(3)	HAC(4)	HAC(6)	HAC(9)	HAC(12)
Lagged policy rate	0.057	0.051	0.049	0.049	0.050	0.051
Inflation gap	0.032	0.028	0.026	0.025	0.023	0.021
Economic activity gap (industrial production)	0.016	0.019	0.019	0.021	0.022	0.022
UAH/USD depreciation, y/y	0.016	0.020	0.020	0.020	0.019	0.018
IT × inflation gap	0.027	0.024	0.020	0.017	0.018	0.017
War × inflation gap	0.085	0.084	0.085	0.085	0.084	0.082
War × economic activity gap	0.018	0.021	0.021	0.022	0.023	0.024
War × depreciation	0.053	0.050	0.050	0.051	0.052	0.052

Notes: Panel A uses residuals from MPR4. Panel B holds the OLS coefficients fixed and changes only the Newey–West truncation bandwidth. HAC(0) is heteroskedasticity-robust with no autocovariance terms. The main conclusions are stable over the reported bandwidths. The non-war exchange-rate estimate is positive, consistent with rate increases in response to depreciation pressure, but its statistical significance varies across bandwidths; evidence for a distinct exchange-rate response is therefore suggestive rather than firm.

A.11 Additional reaction-function robustness

Table A5 reports the suggested restricted specification, MPR4″, which removes the IT regime intercept and the IT × inflation-gap interaction from MPR4 while retaining the full-scale-war intercept and slope interactions.

Table A5: MPR4 and the restricted MPR4″ specification

Variable	MPR4	MPR4″
Constant	0.377	0.636
	(0.658)	(0.617)
Lagged policy rate	0.860***	0.874***
	(0.049)	(0.047)
Inflation gap, 5% anchor	0.070***	0.038
	(0.025)	(0.027)
Economic activity gap (industrial production)	0.054***	0.045**
	(0.021)	(0.020)
UAH/USD depreciation, y/y	0.035*	0.035**
	(0.020)	(0.017)
Inflation-targeting regime	0.662	—
	(0.463)	
Full-scale-war regime	0.425	0.642*
	(0.379)	(0.368)
IT × inflation gap	-0.058***	—
	(0.017)	
War × inflation gap	0.170**	0.145*
	(0.085)	(0.084)
War × economic activity gap	-0.058***	-0.048**
	(0.022)	(0.020)
War × UAH/USD depreciation, y/y	-0.080	-0.084
	(0.051)	(0.052)
Observations	172	172
Adjusted R-squared	0.943	0.941
RMSE	1.425	1.466
Joint deletion of IT terms, HAC Wald p-value	0.002	—

Notes: MPR4″ removes both the inflation-targeting regime intercept and the IT × inflation-gap interaction. It therefore imposes a common inflation slope before the full-scale war. Parentheses report Newey–West HAC standard errors with a six-month bandwidth. The joint Wald test is computed in unrestricted MPR4 for deletion of the two IT terms. *, **, and *** denote significance at the 10, 5, and 1 percent levels. Source: authors' calculations.

Table A6 converts the coefficient estimates in Table 5 into total regime-specific inflation responses. Short-run standard errors use the full covariance matrix of the relevant linear combination; long-run responses and standard errors additionally account for estimated policy-rate persistence. The final column reports a one-sided test of the descriptive benchmark that the long-run response exceeds one. Provided $\rho_i < 1$, this is computed from the equivalent linear restriction $\rho_i + \gamma_\pi^{(r)} > 1$ rather than from the ratio itself.

Table A6: Inflation responses across information-set and IV/GMM specifications

Estimator	Regime	Short run	SE	p-value	Long run	SE	p-value	p: LR> 1
OLS-HAC MPR4	Pre-IT	0.070	0.025	0.005	0.501	0.151	0.001	0.966
OLS-HAC MPR4	IT before full-scale war	0.012	0.029	0.692	0.084	0.203	0.681	0.996
OLS-HAC MPR4	Full-scale war	0.182	0.091	0.045	1.303	0.554	0.019	0.289
Lagged-information OLS-HAC	Pre-IT	0.047	0.036	0.194	0.316	0.192	0.100	0.982
Lagged-information OLS-HAC	IT before full-scale war	-0.003	0.037	0.940	-0.019	0.252	0.940	0.996
Lagged-information OLS-HAC	Full-scale war	0.152	0.067	0.024	1.012	0.330	0.002	0.485
2SLS-HAC Set A	Pre-IT	0.046	0.037	0.214	0.387	0.220	0.079	0.971
2SLS-HAC Set A	IT before full-scale war	0.001	0.041	0.988	0.005	0.349	0.988	0.993
2SLS-HAC Set A	Full-scale war	0.149	0.067	0.028	1.257	0.524	0.016	0.295
GMM-HAC Set B	Pre-IT	0.048	0.014	0.001	0.499	0.155	0.001	0.972
GMM-HAC Set B	IT before full-scale war	0.000	0.018	0.997	0.001	0.185	0.997	0.999
GMM-HAC Set B	Full-scale war	0.085	0.027	0.001	0.898	0.271	0.001	0.640
Conservative GMM	Pre-IT	0.057	0.016	< 0.001	0.499	0.145	0.001	0.977
Conservative GMM	IT before full-scale war	0.010	0.018	0.582	0.086	0.153	0.575	0.999
Conservative GMM	Full-scale war	0.064	0.030	0.031	0.561	0.249	0.024	0.926

Notes: Each response is the sum of the relevant baseline and regime-interaction coefficients. Long-run responses divide the short-run response by one minus the estimated coefficient on the lagged policy rate. Standard errors use the full estimator-specific covariance matrix and the delta method. The final column gives the one-sided upper-tail p-value for $\rho_i + \gamma_\pi^{(r)} > 1$; it is a descriptive comparison, not a formal determinacy test. The lagged-information model uses first-lagged macroeconomic terms. Source: authors' calculations.

A.12 Identification, timing, and instrument diagnostics

The contemporaneous inflation gap, industrial-activity gap and depreciation rate are jointly determined with monetary policy. Their interactions with regime indicators inherit this endogeneity. Writing the estimated rule as $i_t = X_t'\beta + u_t$, internal-instrument estimation imposes $E[Z_t u_t] = 0$. Set A contains the constant, i_{t-1}, the IT and war indicators, and seven excluded instruments: $\pi_{t-1} - 5$, y_{t-1}, $\Delta_{12} \log e_{t-1}$, and their four interactions with the *current* regime indicators. Set B adds second lags of these seven macroeconomic terms. The conservative specification removes i_{t-1} from the included exogenous block, treats it as endogenous, and adds i_{t-2} and i_{t-3} as excluded instruments. There are respectively 7, 7 and 8 endogenous regressors, with 11, 18 and 19 instruments including the constant and included exogenous variables.

These exclusions require lagged macroeconomic conditions not to affect current rate setting except through the included regressors, and not to be correlated with current unobserved policy shocks. They can fail under persistent omitted expectations, delayed policy responses, serially correlated shocks or errors in the activity gap. Treating war timing as external does not make its interactions with inflation or depreciation exogenous. HAC covariance estimation addresses dependence in sampling errors; it does not validate moment conditions. The lagged-information specification also uses revised data and a Hamilton projection estimated over the available sample. Its first lags are not a reconstructed real-time information set, and industrial-production releases may arrive more than one month after the reference period.

Table A7 reports ordinary equation-specific first-stage F statistics and partial R^2, supplementing the existing HAC relevance diagnostics. Neither an ordinary first-stage F nor the earlier conditional HAC Wald statistic is the Kleibergen–Paap rk F. In particular, conditioning a first-stage regression on the other observed endogenous regressors is not a Sanderson–Windmeijer conditional weak-instrument test. A large value cannot certify joint identification of all endogenous slopes. A validated HAC Kleibergen–Paap diagnostic and weak-identification-robust confidence sets are not available in this revision; the internal-instrument results therefore remain sensitivity checks.

For Set B the two-step HAC-GMM Hansen statistic is $J = 6.007$ with seven degrees of freedom ($p = 0.539$); the conservative specification gives $J = 9.247$ with eight degrees of freedom ($p = 0.322$). Set A is exactly identified and has no overidentification test. Failure to reject does not establish valid exclusions, particularly with many correlated lag instruments and a short wartime subsample. Agreement between OLS and IV residual rankings supports descriptive episode selection, not a causal interpretation of the estimated policy responses.

The dependent variable is the annualized rate *effective on the final calendar day* of month t. Source entries marked "from" are effective dates, not necessarily announcement

Table A7: Equation-specific first-stage diagnostics

Set	Endogenous term	Partial R^2	Ordinary F
A	Inflation	0.952	454.88
A	Activity	0.730	61.77
A	Depreciation	0.874	158.16
A	IT × inflation	0.960	548.95
A	War × inflation	0.955	483.64
A	War × activity	0.749	68.16
A	War × depreciation	0.859	138.80
B	Inflation	0.966	306.51
B	Activity	0.738	30.60
B	Depreciation	0.883	81.80
B	IT × inflation	0.973	396.54
B	War × inflation	0.980	541.24
B	War × activity	0.755	33.50
B	War × depreciation	0.908	107.61
Conservative	Lagged rate	0.943	155.73
Conservative	Inflation	0.986	643.07
Conservative	Activity	0.815	41.64
Conservative	Depreciation	0.923	112.96
Conservative	IT × inflation	0.980	456.11
Conservative	War × inflation	0.982	508.73
Conservative	War × activity	0.773	32.22
Conservative	War × depreciation	0.930	125.01

Excluded-instrument joint F against the included exogenous controls, with ordinary homoskedastic finite-sample scaling. These are not HAC-robust weak-identification statistics; the $F > 10$ rule is not applicable to establish system identification here. Instrument ranks equal 11, 18 and 19 for A, B and conservative sets, respectively. No Kleibergen–Paap rk F has been computed.

dates. A rate is carried forward between changes; a month with no new decision is still observed. A decision announced in t but effective in $t+1$ first changes the latter month's series. Thus i_t is a policy stance, not a count or average of decisions taken in t. The alternative calendar-day-weighted series uses the same daily effective-rate step function. Table A8 checks whether this aggregation choice matters for the FX response.

A.13 Exchange-rate measurement and the euro reference

Let e_t^{USD} denote the monthly average official number of hryvnias per US dollar. The baseline regressor is $100[\log(e_t^{USD}) - \log(e_{t-12}^{USD})]$, in annual log-percentage points; positive values mean depreciation. It is neither an exchange-market-pressure index nor a nominal or real effective exchange-rate index. In particular, it omits reserve sales, administrative rationing and deviations between official and market rates. A fixed official rate can conceal substantial excess demand for foreign currency, while a discrete parity adjustment can generate persistent year-on-year depreciation without continuing monthly depreciation.

The dollar benchmark reflects the wartime operating anchor, rather than a presumption about the currency of eventual integration: the NBU fixed the official UAH/USD rate in February 2022 and subsequently moved to managed flexibility in October 2023 (National Bank of Ukraine, 2026). The euro is an economically relevant alternative for the integration question. We replace both the depreciation regressor and its war interaction by $100\Delta_{12}\log e_t^{EUR}$ and re-estimate on exactly the same months as the dollar model. Movements in EUR/USD can alter this alternative even when the official dollar parity is fixed. A NEER/REER or exchange-market-pressure extension would answer a different question and requires weights, price indices or intervention data not included in the present monthly database.

Table A8: Exchange-rate reference and policy-rate aggregation

Model	N	FX slope	SE	War slope	SE	RMSE
USD	75	-0.016	0.023	-0.002	0.029	1.570
EUR	75	-0.012	0.013	-0.007	0.023	1.569
Monthly average	172	0.024	0.018	-0.036	0.054	1.309

USD and EUR use January 2020–March 2026 (75 months); redundant IT terms are removed because the entire sample is post-IT. The monthly-average specification uses full-sample MPR4 with USD and replaces both the dependent policy rate and its lag by calendar-day-weighted averages. War slope includes the baseline and interaction. Standard errors: HAC(6).

The archived EUR series begins in January 2019, so annual euro depreciation becomes available only in January 2020. Both currency comparisons consequently use 75 observations through March 2026. Since all these observations are post-IT, the redundant IT intercept and IT–inflation interaction are absorbed into the constant and inflation slope. The total wartime depreciation slopes are close to zero for both currencies and

imprecisely estimated. This is a limited recent-sample robustness check, not confirmation of reference-currency invariance over the full historical sample.

A.14 Persistence and endogenous break dates

An estimated smoothing coefficient below one does not establish stationarity of each underlying series or validate all long-run multipliers. Table A9 tests the policy rate and the three macroeconomic regressors in levels and first differences over the common estimation sample. The two tests have opposite null hypotheses. Year-on-year overlapping observations, administered rate plateaus and structural breaks complicate their interpretation. The activity gap is generated by an estimated filter; conventional test probabilities do not account for that preliminary estimation. Consequently, the long-run ratios remain descriptive and conditional on within-regime stability, rather than evidence of a cointegrating relation.

Table A9: Persistence and stationarity diagnostics

Series	ADF statistic	ADF p	Lags	KPSS statistic	KPSS p
Policy rate	-2.37	0.150	1	0.20	0.100
Policy rate (diff.)	-10.62	0.000	0	0.06	0.100
Inflation gap	-2.11	0.239	12	0.12	0.100
Inflation gap (diff.)	-4.00	0.001	12	0.05	0.100
Activity gap	-2.76	0.064	0	0.44	0.060
Activity gap (diff.)	-13.41	0.000	0	0.08	0.100
USD depreciation	-2.45	0.128	12	0.24	0.100
USD depreciation (diff.)	-4.58	0.000	12	0.07	0.100

Constant, no trend. ADF lag selection: AIC, maximum 12; KPSS: automatic bandwidth. KPSS probabilities are bounded at 0.01 and 0.10. ADF null: unit root; KPSS null: level stationarity. Breaks and short samples limit power. Source: archived monthly data; authors' calculations.

The level ADF probabilities are 0.150 for the policy rate, 0.239 for the inflation gap, 0.064 for the activity gap and 0.128 for depreciation; none rejects a unit root at 5%. KPSS does not reject level stationarity at 5% either. This combination is inconclusive rather than evidence that all variables are integrated. First differences reject the ADF null, but that result alone cannot establish their integration order. Long-run response comparisons are therefore reported with this qualification.

The institutional dates used in MPR4 are not estimates of unknown break dates. To assess their sensitivity, we globally minimize the sum of squared residuals over partitions of a common rule containing the intercept, lagged rate, inflation gap, activity gap and dollar depreciation. All five coefficients may differ across segments. The dynamic-programming partition follows the least-squares approach of Bai and Perron (2003); Table A10 reports zero to three breaks and minimum segment lengths of 24, 30 and 36 months. BIC includes

both segment coefficients and break dates. This exercise supplies endogenous candidate dates, not formal HAC sup-F inference, break-date confidence sets, or proof of causal regime changes. The trimming sensitivity is particularly relevant because a short crisis episode can move the selected partition.

Table A10: Exploratory endogenous multiple-break selection

Minimum months	Breaks	BIC	First month of new segment
24	0	175.57	None
24	1	125.41	2022-06
24	2	107.17	2015-04; 2022-06
24	3	121.37	2015-03; 2017-10; 2022-06
30	0	175.57	None
30	1	125.41	2022-06
30	2	107.17	2015-04; 2022-06
30	3	121.37	2015-03; 2017-10; 2022-06
36	0	175.57	None
36	1	125.41	2022-06
36	2	107.17	2015-04; 2022-06
36	3	124.81	2015-04; 2018-10; 2022-06

Global least-squares partition of a rule with intercept, lagged rate, inflation, activity and USD depreciation; all five coefficients may change. BIC = N log(SSR/N) + [5(m+1)+m] log N, with m breaks. At most three breaks. This is exploratory Bai–Perron-style segmentation, not a HAC sup-F test or a confidence interval for break dates.

BIC selects two breaks, with new segments beginning in April 2015 and June 2022, for each trimming choice. The second date coincides with the large wartime rate increase, while the first follows the March 2015 crisis tightening. The institutional IT date of August 2015 and invasion date of February 2022 need not equal the timing of the largest estimated change in the reaction function. The detected dates describe conditional fit and do not identify the events causing each break.

Markov-switching rules would instead allow recurrent latent regimes and estimate transition probabilities; TVP specifications would permit gradual coefficient drift. These alternatives need not recover the same object as a small number of permanent breaks. With 172 observations, strong policy persistence and occasional large policy-rate jumps, adding regime-specific variances and unrestricted switching slopes risks weakly distinguished regimes. We therefore report the parsimonious endogenous partition as an additional check and do not claim to have estimated Markov-switching or TVP rules. The related literature provides a motivation for this caution: e.g., Byrne et al. (2018) examine coefficient and model uncertainty in exchange-rate forecasting, while Hauzenberger and Huber (2018) allow Markov transitions between structural exchange-rate representations, including Taylor-rule fundamentals.

A.15 Capital controls and the wartime operating mix

A dummy equal to one from February 2022 for the introduction of comprehensive wartime FX restrictions is identical to the full-scale-war dummy. Its interaction with depreciation is likewise identical to an existing war interaction. Adding both would not separately identify capital controls. Nor should the subsequent managed-flexibility regime be labelled an absence of controls: liberalization was gradual (National Bank of Ukraine, 2026).

We instead add an indicator for March 2022–September 2023, the complete months of the initial fixed-rate operating phase, together with its inflation and depreciation interactions (Table A11). February 2022 is treated as a transition month. The July 2022 parity reset remains inside this phase. These terms distinguish an observable policy bundle within wartime; they do not measure control stringency or FX-operation intensity and are themselves potentially endogenous responses to stress. A separate intensity analysis requires dated restrictions or net intervention sales scaled by lagged reserves. Annual balance-sheet FX valuation changes cannot substitute for those monthly transactions.

Table A11: Additional wartime operating-phase interactions

Term	Estimate	HAC SE	p
peg phase	0.521	1.206	0.666
peg x fx	-0.174	0.104	0.093
peg x pi	0.364	0.233	0.119

MPR4 augmented with a March 2022–September 2023 fixed-rate-phase intercept and interactions with depreciation and inflation; February 2022 is a transition month. This proxy describes a policy bundle, not measured capital-control or intervention intensity. A February 2022-onward capital-controls indicator is exactly collinear with the war indicator.

The additional fixed-rate-phase depreciation interaction is negative (-0.174, HAC $p = 0.093$), while its inflation interaction and intercept are not individually significant at 10%. These imprecise estimates provide, at most, suggestive evidence of a different policy mix during the initial operating phase. They do not identify an effect of controls separate from wartime conditions.

A.16 Annual sterilization and profit-and-loss extension

The annual association estimated here is $\pi_{t+1}^{Dec} = a + b(CD_t/GDP_t) + c\pi_t^{Dec} + dW_{t+1} + v_{t+1}$, with nested versions omitting c and d. GDP is the annual nominal flow, and CD_t is the year-end stock. Sixteen observations remain because December CPI begins in 2009 and full-year 2026 inflation is not available. HC3 standard errors and finite-sample t reference probabilities are reported; they do not eliminate the risks of serial dependence, omitted variables or low power.

Table A12: Year-end CD stocks and subsequent December inflation

Specification	N	CD/GDP slope	HC3 SE	p
Lagged CDs	16	-0.297	0.844	0.730
Inflation controlled	16	-0.617	1.214	0.620
War controlled	16	-2.399	2.156	0.288

Annual observations, 2009–2024; dependent variable is December year-on-year inflation in t+1. CD stocks/GDP are measured at end t, in percentage points. Controls as indicated; finite-sample t reference with residual degrees of freedom. A lagged stock is not an exogenous sterilization shock. Very small sample; no causal interpretation.

Table A13: Sterilization expense, consolidated earnings and distribution

UAH billions	2021	2022	2023	2024	2025
CD interest expense	10.656	40.766	91.560	76.831	81.975
Net interest income	28.836	63.245	27.553	17.649	18.128
Consolidated profit	1.343	232.298	130.641	231.062	152.897
Distributable profit	31.584	91.054	76.609	102.666	155.045
Due to State Budget	18.786	71.868	38.643	84.158	146.111

Source: archived NBU consolidated financial statements for 2022, 2024 and 2025, notes 17 (interest), 29 (profit reconciliation and distribution), including prior-year comparative columns. Amounts converted from UAH millions to billions. CD expense is shown as a positive cost. Consolidated profit includes consolidation adjustments; distributable profit is calculated under the NBU's statutory rules. The final row is the entitlement arising from that year's earnings, not cash remitted in that calendar year.

A.17 Pandemic sensitivity and the pre-Covid frozen rule

The baseline regime dates identify changes in the monetary-policy framework rather than every large macroeconomic shock. During COVID-19, the NBU continued inflation targeting and lowered the policy rate from 13.5 percent at the beginning of 2020 to 6 percent in June (National Bank of Ukraine, 2020). We nevertheless test whether pooling this episode with the earlier inflation-targeting observations affects the wartime estimates.

The longer pandemic indicator equals one from March 2020, when lockdown disrupted financial markets, through January 2022, the last pre-invasion month, and zero otherwise. This window includes the prolonged pandemic episode without overlapping the full-scale-war indicator. An alternative endpoint of December 2020 isolates the initial pandemic calendar year. Neither endpoint is a claim about the epidemiological end of COVID-19; the windows are transparent sensitivity choices, not dates selected to optimize statistical significance. We add each indicator separately as a temporary intercept to MPR4, and then re-estimate MPR4 after removing observations in each window. Lagged rates are formed on the original calendar before observations are removed, so February 2022 retains its actual January 2022 lag. The omission exercises remove pandemic outcome observations, not every subsequent regressor with exposure to that period; year-on-year changes can retain such exposure. Newey–West covariance calculations preserve calendar distances across the resulting gaps.

The wartime inflation interaction ranges from 0.158 to 0.185, compared with 0.170 in baseline MPR4. The total short-run wartime inflation response stays between 0.175 and 0.182, and the total activity and depreciation responses remain imprecise. These results support stability of the short-run inflation association, but not of every parameter. With the longer window, persistence falls from 0.860 to about 0.75 and the war intercept changes sign. Consequently, the implied long-run wartime inflation response falls from 1.30 to about 0.70; the shorter window yields about 1.07. The pandemic intercept is negative in both windows.

For the frozen-coefficient exercise, we retain the same five-regressor rule (including the constant), the August 2015 start date, and the same 50 wartime evaluation months. We move the training endpoint from January 2022 to December 2019, reducing training observations from 78 to 53. Both one-step paths use the actual lagged policy rate. Both recursive paths start from the actual January 2022 policy rate, which isolates the change in estimated coefficients rather than introducing a simulation of 2020–2021. The archived industrial-production gap is held fixed and was constructed using the full sample: ending coefficient estimation in 2019 does not turn this exercise into a real-time forecast.

The mean one-step gap falls by 0.38 percentage points, from 2.17 to 1.79, and remains positive on average in every wartime year. Its largest annual value remains in February–December 2022 (4.41 points with pre-Covid training, versus 5.07). Thus the positive

Table A14: Sensitivity of MPR4 to the pandemic episode

	Baseline	Dummy L	Dummy S	Omit L	Omit S
Lagged rate	0.860	0.748	0.831	0.751	0.831
	(0.049)	(0.065)	(0.053)	(0.066)	(0.054)
War intercept	0.425	-0.288	0.003	-0.316	0.015
	(0.379)	(0.352)	(0.324)	(0.352)	(0.325)
War × inflation	0.170	0.158	0.185	0.170	0.185
	(0.085)	(0.073)	(0.084)	(0.074)	(0.084)
War × activity	-0.058	-0.058	-0.047	-0.061	-0.048
	(0.022)	(0.019)	(0.018)	(0.020)	(0.019)
War × depreciation	-0.080	-0.041	-0.073	-0.050	-0.074
	(0.051)	(0.037)	(0.047)	(0.037)	(0.048)
Total wartime inflation	0.182	0.175	0.180	0.176	0.180
	(0.091)	(0.078)	(0.087)	(0.078)	(0.087)
Total wartime activity	-0.004	-0.012	-0.006	-0.012	-0.006
	(0.012)	(0.015)	(0.012)	(0.015)	(0.012)
Total wartime depreciation	-0.044	-0.009	-0.035	-0.010	-0.035
	(0.051)	(0.038)	(0.048)	(0.038)	(0.048)
Long-run wartime inflation	1.303	0.697	1.066	0.705	1.068
	(0.554)	(0.271)	(0.453)	(0.272)	(0.455)
Pandemic intercept	–	-1.971	-1.592	–	–
		(0.664)	(0.470)		
Observations	172	172	172	149	162

L: March 2020–January 2022; S: March–December 2020. Dummy specifications add one temporary intercept to MPR4; omission specifications remove observations in the indicated window. Parentheses: Newey–West standard errors with six calendar-month lags, without treating observations across an omitted interval as consecutive. Total responses sum the applicable base and interaction coefficients; the long-run response divides by one minus persistence (delta-method SE). Lags are constructed before exclusions. All models retain the same 50 wartime observations. Changes across specifications are descriptive, not formal tests of coefficient equality.

Table A15: Frozen-rule gaps with and without pandemic training observations

Period	N	One-step PI	One-step PC	Recursive PI	Recursive PC
2022	11	5.07	4.41	26.95	18.55
2023	12	2.73	2.47	50.90	26.76
2024	12	0.55	0.18	41.32	11.22
2025	12	0.75	0.50	29.36	4.81
2026 Q1	3	1.40	0.98	26.65	5.39
All wartime	50	2.17	1.79	36.71	14.67

Mean actual rate minus conditional counterfactual, percentage points. PI: August 2015–January 2022 training (78 observations). PC: August 2015–December 2019 training (53 observations). Evaluation: February 2022–March 2026 (50 observations). Both rules include an intercept, the lagged rate, inflation gap, activity gap and annual USD depreciation. One-step paths use the actual lagged rate; both recursive paths start from the actual January 2022 rate. Wartime covariates and the archived full-sample activity-gap construction are held fixed. These are conditional extrapolations, not real-time forecasts or causal no-war paths.

average conditional gap is not generated solely by including the pandemic in training. Recursive gaps are substantially less stable: the full-period mean falls from 36.71 to 14.67 points. The estimated pre-invasion smoothing coefficient falls from 0.955 to 0.885 when training ends in 2019, reducing the persistence of extrapolated deviations; the intercept and other slopes also change. Even with pre-Covid training, the recursive path has a negative annual mean in 2023. The shorter training window also changes sample size, so differences cannot be attributed exclusively to COVID-19.