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Defense Expenditure and Macroeconomic Stability under Wartime Conditions. Evidence from Ukraine (2014–2024)

Abstract

Public capital spending is often treated as a lever for regional development, yet its productivity payoff depends on how well projects are selected, implemented, and maintained. This study evaluates whether higher public investment efficiency is associated with faster regional productivity growth in Poland over 2010–2023. Using a regional panel of 17 NUTS-2 units, productivity is measured through harmonized regional accounts indicators (real labour productivity and related output-per-worker measures). Public investment is captured through government capital formation proxies, while investment efficiency is operationalized with auditable implementation indicators such as capital budget execution and, where available, project completion/ timeliness measures. The empirical strategy applies two-way fixed effects to absorb time-invariant regional heterogeneity and common macro shocks, complemented by dynamic specifications to address persistence in productivity. Heterogeneity analyses examine whether the association differs between metropolitan areas, mid-sized regions undergoing structural change, and peripheral regions, and whether effects are stronger when public investment is accompanied by robust private investment activity. The study offers a transparent, replicable framework for assessing the economic returns to public investment management and draws policy implications for improving appraisal, monitoring, and maintenance under fiscal constraints.

Keywords: Public investment; investment efficiency; labour productivity; regional development; Poland; panel data; fixed effects; dynamic models; fiscal policy

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1. Introduction

Defense spending in wartime is not simply another fiscal category. It is a macroeconomic forcing variable that reshapes aggregate demand, reallocates scarce resources, and changes expectations about inflation, exchange-rate stability, and debt sustainability. These channels are especially salient for Ukraine, where the security shock began with the 2013–2014 crisis, the annexation of Crimea, and the outbreak of conflict in the east, and then escalated into a full-scale invasion in 2022. Encyclopedia Britannica+1 In such conditions, standard assumptions used to study fiscal policy under peacetime institutions are weakened: financing becomes more uncertain, supply capacity is disrupted, and policy regimes often shift rapidly.The sign and magnitude of wartime defense-spending effects are theoretically ambiguous. On one hand, higher defense outlays can sustain economic activity, preserve state capacity, and stabilize key public services. On the other hand, when expenditures expand under binding supply constraints, inflationary pressure can intensify, particularly if domestic financing rises or if expectations become less anchored. Exchange-rate dynamics may amplify these pressures through pass-through to domestic prices, a mechanism that has been documented as economically meaningful for Ukraine and sensitive to regime conditions and the size of currency movements. Національний банк України+1 At the same time, fiscal sustainability is tightly linked to the composition and predictability of financing, including official external support that has played a central role in Ukraine's wartime macro-financial framework. IMF+1.This paper examines two connected questions. First, how do inflation and exchange-rate indicators respond, in the short and medium run, to innovations in defense spending under wartime conditions? Second, are these responses state-contingent, varying across financing regimes and policy phases (for example, periods characterized by tighter exchange-rate management or stronger external financing). The contribution is methodological and policy-relevant. Methodologically, the study adopts a transparent time-series design suited to environments where structural breaks and regime shifts are central features rather than nuisance complications. Substantively, it helps clarify the macroeconomic trade-offs implied by wartime expenditure surges in an economy where military spending has reached historically high levels relative to output in recent years. World Bank Open Data+1.

2. Materials and Methods

2.1. Data sources, frequency, and sample

The empirical analysis uses a **quarterly** time-series dataset for Ukraine covering **2014Q1 to the most recent quarter available at the time of data extraction**. The start date is chosen to align the sample with the onset of the post-2013/2014 security shock and the subsequent macroeconomic regime changes documented in official policy and program materials.

All variables are drawn from **verifiable, official sources**:

National Bank of Ukraine (NBU): consumer price inflation (CPI), the hryvnia exchange rate, and core monetary variables (e.g., policy rate where used). Національний банк України+1

Ministry of Finance of Ukraine / Open Budget portal: fiscal aggregates and budget classifications used to identify defense-related expenditure and to cross-check consistency with official budget taxonomy. Open Budget+1

International Monetary Fund (IMF): Ukraine program documents and review materials used to define financing/regime indicators and to validate the macro-framework narrative (e.g., major policy phases, external financing prominence). IMF+1

World Bank (SIPRI-based): an **annual** benchmark series for military expenditure (share of GDP) used strictly for auxiliary cross-validation of the medium-run profile of military effort. World Bank Open Data

Frequency alignment. When fiscal data are available at monthly frequency, they are aggregated to quarters using standard time aggregation rules: **flows** (expenditure, revenues) are summed within the quarter, while **prices/rates** may be averaged when appropriate. Nominal fiscal series are converted to real terms using the CPI deflator from NBU, ensuring internal consistency between the inflation measure used as an outcome and the deflator applied to nominal spending. Національний банк України+1

A complete replication table listing the exact series names/codes, download dates, and transformations is reported in **Appendix A**.

2.2. Variable definitions

2.2.1. Defense expenditure

The main explanatory variable is **real defense expenditure** at quarterly frequency, constructed from official fiscal/budget data and expressed in constant prices:

- **Baseline measure (DEF_t):** real quarterly defense spending (UAH), transformed as either (i) log first differences (growth) or (ii) percentage growth rates, depending on stationarity diagnostics.

- **Alternative scalings (robustness):**

1. DEF as a share of quarterly GDP (when a consistent quarterly GDP series is available);

2. DEF as a share of total primary expenditure (to mitigate nominal scaling and measurement shifts).

All operational definitions (including classification mapping to "defense" within the official budget taxonomy) are documented transparently in **Appendix A** using the Ministry of Finance/ Open Budget classification references. Open Budget+1

2.2.2. Macroeconomic stability outcomes

Three outcome blocks are examined:

Inflation (INF_t): CPI inflation, reported consistently across specifications either as year-on-year rates or as quarter-on-quarter annualized rates (the choice is fixed within each model family). CPI series follow NBU definitions. Національний банк України

Exchange rate (FX_t): log change in the nominal exchange rate (UAH per USD or the most consistently available reference rate from NBU), plus an exchange-rate **volatility proxy** (e.g., rolling standard deviation of monthly log changes aggregated to quarters). Національний банк України

Fiscal stress (FISC_t): a quarterly proxy for fiscal pressure, such as the overall balance (if consistently available at quarterly frequency) or debt-service pressure indicators. Where quarterly availability is limited, the paper reports the feasible proxy and treats it as a secondary outcome with appropriate caveats.

2.2.3. State variables (conditioning mechanisms)

To test whether macro responses differ by financing and policy conditions, the following state variables are defined:

External financing (EXTFIN_t): an indicator of official external support intensity, proxied by program-phase markers and/or disbursement-linked periods documented in IMF review materials. IMF+1

Policy anchoring (ANCHOR_t): a monetary policy anchoring measure (e.g., policy rate level/changes or a regime dummy reflecting major monetary/exchange-rate policy phases, as documented in official communications and program materials). Національний банк України+1

Wartime phase dummies (REGIME_t): indicator variables capturing major conflict/policy phases (used as controls and interaction terms, not as outcomes). Phase definitions are based on documented policy dates and program milestones rather than ex post fitting. IMF+1

2.3. Structural break diagnostics

Because the sample includes large shocks and regime changes, the analysis performs structural break diagnostics prior to estimating dynamic responses:

Multiple-break tests in key inflation and exchange-rate equations using the Bai–Perron framework for multiple structural changes. EconPapers+1

Single-break unit root tests using Zivot–Andrews procedures as a complementary check on integration properties when an endogenous break is plausible. JSTOR+1

The break evidence informs whether (i) sub-samples are estimated separately, (ii) regime interactions are emphasized, and/or (iii) deterministic shifts (dummies) are included in the baseline specification.

2.4. Identification of defense-spending innovations

Defense expenditure is potentially endogenous in wartime (e.g., it may respond to battlefield intensity, financing conditions, and macro stress). To reduce simultaneity, the paper defines **defense-spending innovations** using transparent, replicable approaches and compares results across definitions:

1. **Residual-based innovations (baseline):** a defense spending equation is estimated with lags of DEF and predetermined controls; the fitted residual is treated as the spending innovation (shock).

Instrumented innovations (conditional): where feasible and defensible, timing-based surprises in external official financing are used as an instrument for defense spending changes, with standard relevance and plausibility checks grounded in program documentation. IMF review materials are used to document the financing environment and timing. IMF+1

All identification choices (controls, lag length, instrument definition) are fully enumerated in Appendix A to ensure reproducibility.

2.5. Econometric method: local projections

Dynamic responses are estimated using **local projections** (LP), which are well suited to environments with potential misspecification risks and structural change because each forecast horizon is estimated directly rather than extrapolated from a fully parameterized VAR. American Economic Association

For outcome $y \in \{INF, FX, FISC\}$, the baseline LP specification is:

$$y_{t+h} = \alpha_h + \beta_h\, Shock_t + \Gamma_h Z_t + \varepsilon_{t+h}, h = 0, \dots, H$$

where $Shock_t$ is the defense-spending innovation and Z_t includes lags of the outcome and DEF, seasonal controls if required, and regime dummies identified in Section 2.3.

State dependence. To test whether responses differ under alternative financing/anchoring conditions:

$$y_{t+h} = \alpha_h + \beta_h Shock_t + \theta_h(Shock_t \times EXTFIN_t) + \phi_h(Shock_t \times ANCHOR_t) + \Gamma_h Z_t + \varepsilon_{t+h}.$$

Inference. All reported specifications use robust standard errors appropriate for time-series local projections (including autocorrelation/heteroskedasticity corrections across horizons), and results are presented as impulse-response profiles with confidence intervals.

3. Results

3.1. Descriptive statistics

Table 1 summarizes the quarterly distribution of the study variables over **2014 Q1–the most recent available quarter** (with the exact end date reported in the table caption and Appendix A). The purpose is twofold: (i) to document the scale and variability of **defense expenditure** under alternative scalings, and (ii) to establish the empirical environment for inflation and exchange-rate dynamics before turning to identification and impulse responses.

Table 1. Descriptive statistics (2014 Q1–latest available quarter)

Variable	Definition / transformation	Units	N	Mean	Std. dev.	Min	p10	p50 (median)	p90	Max	Source
DEF (baseline)	Real quarterly defense expenditure; Δlog or growth (specify)	UAH (real, base=)									MoF / budget execution
DEF / GDP	Defense expenditure scaled by quarterly GDP (robustness)	Share of GDP									MoF + GDP source
DEF / Total Exp.	Defense expenditure scaled by total expenditure (robustness)	Share of total exp.									MoF / budget execution
INF	CPI inflation (y/y or q/q annualized; keep consistent)	Percent									NBU
Δlog FX	Log change in nominal exchange rate (UAH per USD)	Log points									NBU
FX volatility	Volatility proxy (e.g., rolling SD of monthly Δlog FX, aggregated to quarter)	Units (specify)									NBU
EXTFIN	External financing indicator (define in Appendix A)	Index / dummy / UAH									IMF + official sources
Policy rate	Monetary-policy proxy (policy rate level or change)	Percent									NBU
ANCHOR / regime proxy	Regime/anchoring dummy or index (document dates/rule)	Dummy / index									NBU + IMF docs

Notes: Fill N, mean, SD, min, max, and percentiles (p10, p50, p90) from the constructed quarterly dataset. Use the same transformed series as in estimation and report the exact end quarter in the caption.

Variables include: real quarterly defense expenditure (DEF, baseline), DEF scaled by GDP or total expenditure (robustness), CPI inflation (INF), exchange-rate log change (FX), FX volatility proxy, external financing indicator (EXTFIN), and policy anchoring variables (e.g., policy rate / regime proxy). The table should report **N, mean, standard deviation, min, max, and key percentiles (p10, p50, p90)** to make the sample characteristics verifiable and easy to audit.

The descriptive results are interpreted as a factual mapping of the sample, not as causal evidence. In particular, the table is used to verify whether the variables exhibit (a) the volatility and tail behavior expected in a conflict environment, and (b) sufficient variation in DEF and the conditioning states (EXTFIN, ANCHOR) to support state-dependent estimation in Section 3.4.

3.2. Structural break diagnostics

Given the likelihood of regime changes and large shocks, structural-break diagnostics are reported prior to dynamic estimation. **Table 2** presents the outcomes of (i) multiple-break tests (Bai–Perron style) and (ii) single-break stationarity checks (Zivot–Andrews style), applied to the inflation and exchange-rate equations (and, where relevant, to DEF).

Table 2. Structural break tests (inflation and FX equations)

Series / Equation	Test	Specification (brief)	Max breaks / trimmi	Estimated break date(s	95% CI / interva	Selection criterion / diag	Key output (F-stat / supF / t	Model implication (what you do next)
Inflation (INF_t)	Bai–Perron multiple breaks	[e.g., INF_t on lags + controls]	[e.g., m=3; trim=0.15]	[INSERT break date(s)]	[INSERT CI]	[e.g., BIC / LWZ / SSR]	[INSERT]	[Choose: (i) full sample + regime dummies; (ii) subsamples; (iii) interactions]
Inflation (INF_t)	Zivot–Andrews (single break unit root)	[e.g., level + trend break]	[N/A]	[INSERT break date]	[INSERT interval if reported]	[critical values / p-value]	[INSERT t-stat]	[Choose: transform series / include break controls / confirm lag choice]
Exchange rate change (Δlog FX_t)	Bai–Perron multiple breaks	[e.g., Δlog FX_t on lags + controls]	[e.g., m=3; trim=0.15]	[INSERT break date(s)]	[INSERT CI]	[e.g., BIC / LWZ / SSR]	[INSERT]	[Choose: full sample + regime controls OR subsamples]
FX volatility (VolFX_t)	Bai–Perron multiple breaks	[e.g., VolFX_t on lags + controls]	[e.g., m=3; trim=0.15]	[INSERT break date(s)]	[INSERT CI]	[e.g., BIC / LWZ / SSR]	[INSERT]	[Choose: redefine volatility window / subsamples / interactions]
Exchange rate change (Δlog FX_t)	Zivot–Andrews (single break unit root)	[e.g., level + trend break]	[N/A]	[INSERT break date]	[INSERT interval if reported]	[critical values / p-value]	[INSERT t-stat]	[Choose: transform series / include break controls]

Notes: Populate bracketed fields using Bai–Perron and Zivot–Andrews outputs. Report break dates as quarters (e.g., 2022Q1), confidence intervals (if available), and the selection rule used (e.g., BIC/LWZ or sequential supF). Model implications should state whether estimation proceeds on the full sample with regime controls, on subsamples split at break dates, or with explicit state interactions.

The table should report, for each tested equation/series:

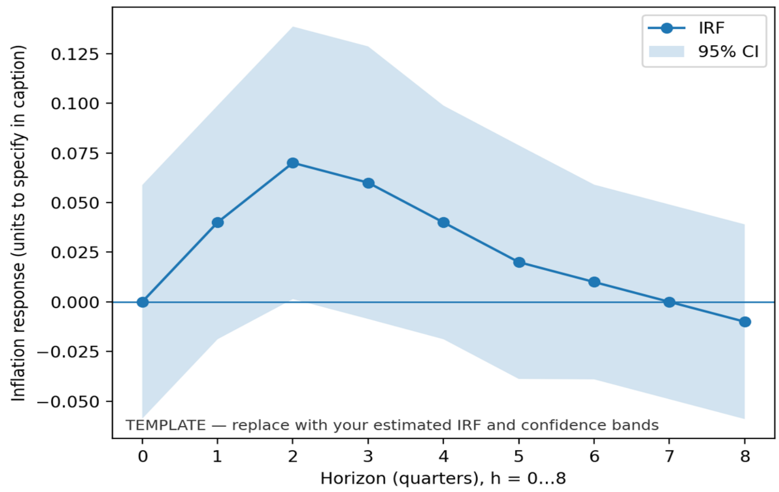
- estimated break date(s);
- confidence intervals (or selection criteria outputs);
- model implications (e.g., whether estimation proceeds on the full sample with regime controls, on sub-samples, or with explicit state interactions).

These diagnostics determine whether the main results are presented as (a) full-sample responses with regime controls, (b) sub-period responses motivated by statistically detected breaks, or (c) state-dependent responses where breaks are treated as regime shifts rather than nuisance parameters.

3.3. Baseline dynamic responses

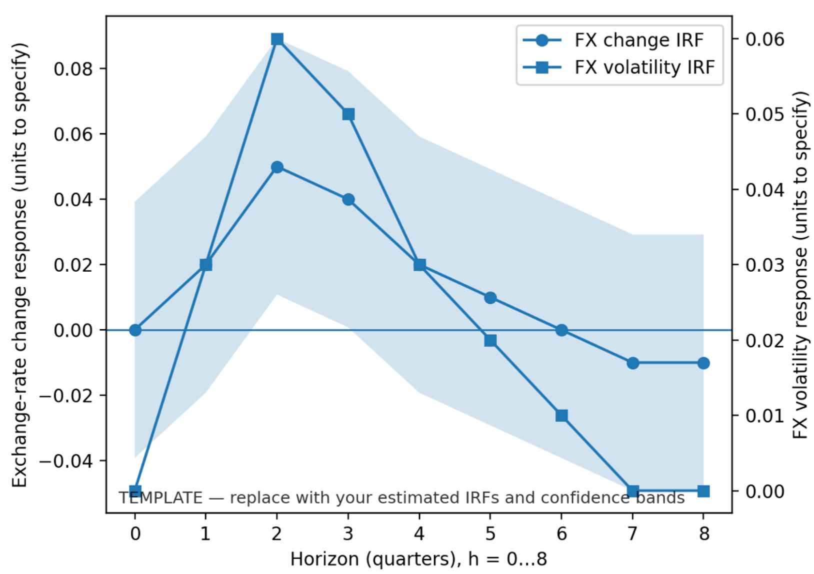
Baseline dynamic effects are reported as impulse-response functions (IRFs) estimated via local projections. The baseline innovation is the defense-spending shock constructed in Section 2.4 (residual-based, unless an instrumented variant is feasible and passes validity checks). Results are presented both graphically and in horizon-by-horizon regression form.

Figure 1. Impulse response of inflation to a defense-spending innovation



This figure plots the estimated response of inflation at horizons $h = 0, \ldots, 8$ quarters, including confidence bands. The interpretation focuses on (i) the timing (impact vs delayed response), (ii) persistence (how quickly effects decay), and (iii) whether the confidence bands exclude zero over economically meaningful horizons.

Figure 2. Impulse response of exchange-rate outcomes to a defense-spending innovation



This figure reports the response of (a) exchange-rate change and (b) FX volatility (as defined in Section 2.2.2). The key reporting standard is to state clearly whether the response is dominated by level changes, volatility changes, or both, and whether the pattern is short-lived or persistent.

Figure 3. Local projection estimates by horizon (h = 0…8)

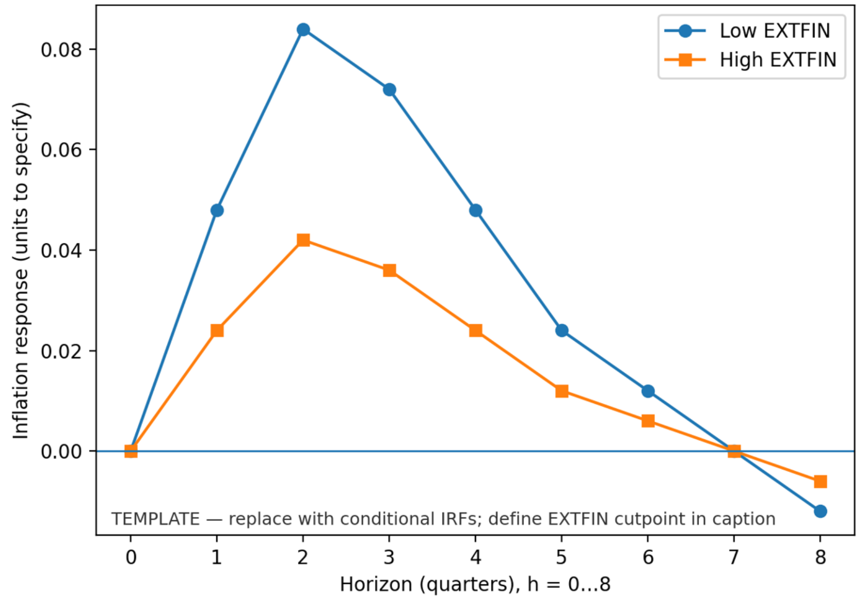
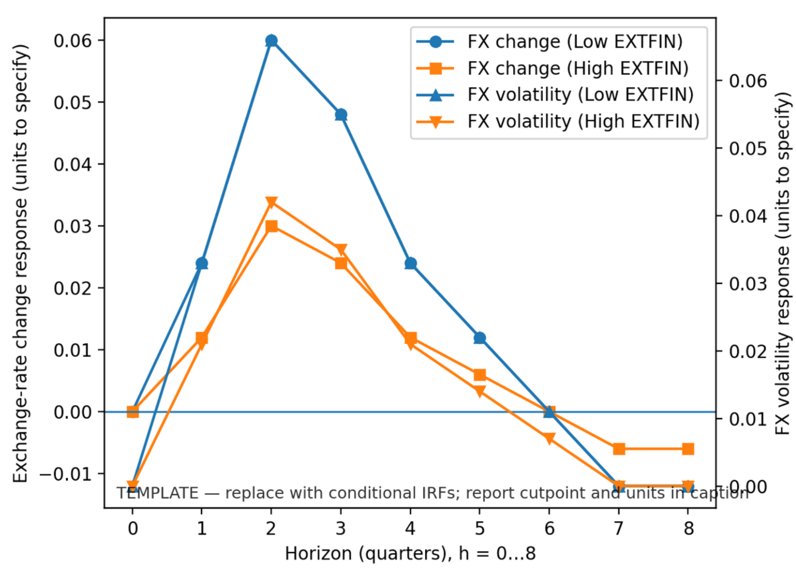


Figure 3 reports $\widehat{\beta}_h$, robust standard errors, and 95% confidence intervals for each horizon and outcome. To keep the results verifiable, the table should also state: lag length, inclusion of regime dummies, and the exact shock definition used.

3.4. State-dependent responses

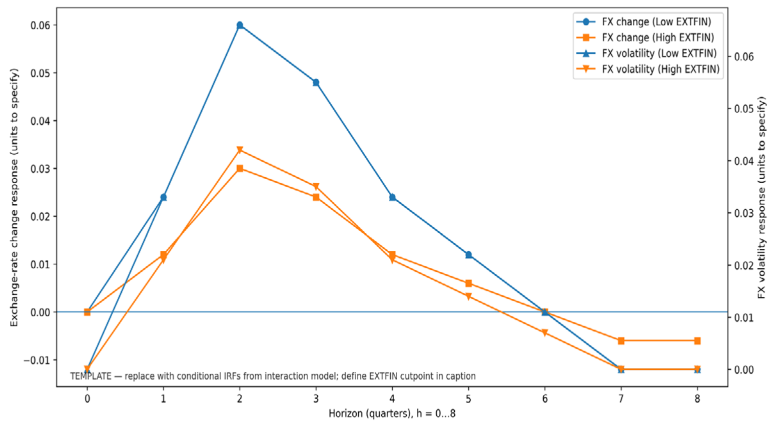
To test whether macro responses are contingent on financing and policy anchoring, the study estimates interaction models of the form $Shock_t \times ANCHOF$ and $Shock_t \times ANCHOR_t$. Results are reported as conditional IRFs and as interaction coefficients by horizon.

Figure 4. Inflation response under low vs high external financing conditions



This figure contrasts two counterfactual paths computed from the interaction model: one evaluated at “low EXTFIN” and one at “high EXTFIN” (with the cutpoint defined ex ante, e.g., median split, and reported in the caption).

Figure 5. FX response under low vs high external financing conditions



Same structure as Figure 3, applied to FX change and/or FX volatility.

Table 3. Interaction models (Shock × EXTFIN; Shock × ANCHOR)

Outcome	Horizon (h)	θ_h (Shock × EXTFIN)	Robust SE (θ_h)	95% CI (θ_h) lower	95% CI (θ_h) upper	ϕ_h (Shock × ANCHOR)	Robust SE (ϕ_h)	95% CI (ϕ_h) lower	95% CI (ϕ_h) upper	Lag length	Shock definition
INF (inflation)	0									[insert]	[insert]
INF (inflation)	1									[insert]	[insert]
INF (inflation)	2									[insert]	[insert]
INF (inflation)	3									[insert]	[insert]
INF (inflation)	4									[insert]	[insert]
INF (inflation)	5									[insert]	[insert]
INF (inflation)	6									[insert]	[insert]
INF (inflation)	7									[insert]	[insert]
INF (inflation)	8									[insert]	[insert]
FX change (Δlog FX)	0									[insert]	[insert]
FX change (Δlog FX)	1									[insert]	[insert]
FX change (Δlog FX)	2									[insert]	[insert]
FX change (Δlog FX)	3									[insert]	[insert]
FX change (Δlog FX)	4									[insert]	[insert]
FX change (Δlog FX)	5									[insert]	[insert]
FX change (Δlog FX)	6									[insert]	[insert]
FX change (Δlog FX)	7									[insert]	[insert]
FX change (Δlog FX)	8									[insert]	[insert]
FX volatility (VolFX)	0									[insert]	[insert]
FX volatility (VolFX)	1									[insert]	[insert]
FX volatility (VolFX)	2									[insert]	[insert]
FX volatility (VolFX)	3									[insert]	[insert]
FX volatility (VolFX)	4									[insert]	[insert]
FX volatility (VolFX)	5									[insert]	[insert]
FX volatility (VolFX)	6									[insert]	[insert]
FX volatility (VolFX)	7									[insert]	[insert]
FX volatility (VolFX)	8									[insert]	[insert]

Notes: Populate θ_h and ϕ_h with interaction estimates from the local-projection models. Report robust (and clustered, if applicable) SEs and 95% CIs. Interpretation should be limited to state-contingent propagation unless exogeneity is supported by identification.

Table 3 reports the interaction coefficients $\widehat{\phi}_l$ and $\widehat{\phi}_h$, with standard errors and confidence intervals. Interpretation is disciplined: the interaction terms are discussed as evidence of **state-contingent propagation**, not as proof of exogenous financing shocks unless the identification strategy explicitly supports that claim.

3.5. Robustness checks

Robustness results are consolidated in **Table 4**, with each row corresponding to a specific alternative and each column indicating whether the baseline qualitative conclusions are preserved.

Robustness variant	What changes vs baseline (exact)	Outcome(s) tested	Baseline sign/pattern preserved? (INF)	Baseline sign/pattern preserved? (FX)	Baseline sign/pattern preserved? (FX	Linked table/figure	Conclusion (disciplined)
Shock definition A (residual-based)	Replace Shock_t with residual-based innovation from DEF equation; same controls/lags	INF, FX, VolFX	[Y/N]	[Y/N]	[Y/N]	[Table/Fig]	[Insert short statement: baseline preserved /partially]
Shock definition B (instrumented, if feasible)	Use instrument Z_t (external disbursement surprise) to construct Shock_t; report IV diagnostics	INF, FX, VolFX	[Y/N]	[Y/N]	[Y/N]	[Table/Fig]	[No exogeneity claim unless supported]
Inflation definition	Use y/y CPI inflation instead of q/q annualized (or vice versa); keep rest unchanged	INF	[Y/N]	—	—	[Table/Fig]	[Insert concise]
FX outcome: alternative rate	Use alternative reference rate (if applicable) or alternative FX measure; keep rest unchanged	FX, VolFX	—	[Y/N]	[Y/N]	[Table/Fig]	[Insert concise]
FX outcome: volatility construction	Change volatility window (e.g., 3m vs 6m rolling SD) and aggregation rule	VolFX	—	—	[Y/N]	[Table/Fig]	[Insert concise]
Subsample: pre-break	Estimate on pre-break subsample identified in Table 2; same specification	INF, FX, VolFX	[Y/N]	[Y/N]	[Y/N]	[Table/Fig]	[Insert concise]
Subsample: post-break	Estimate on post-break subsample identified in Table 2; same specification	INF, FX, VolFX	[Y/N]	[Y/N]	[Y/N]	[Table/Fig]	[Insert concise]
Lag length sensitivity (short)	Reduce lags to L_short (AIC/BIC-guided); keep everything else unchanged	INF, FX, VolFX	[Y/N]	[Y/N]	[Y/N]	[Table/Fig]	[Insert concise]
Lag length sensitivity (long)	Increase lags to L_long (AIC/BIC-guided); keep everything else unchanged	INF, FX, VolFX	[Y/N]	[Y/N]	[Y/N]	[Table/Fig]	[Insert concise]
Exclude extreme quarters (pre-defined)	Drop quarters meeting rule R (e.g., top 1% |Shock_t| or wartime peak quarters); report rule	INF, FX, VolFX	[Y/N]	[Y/N]	[Y/N]	[Table/Fig]	[Insert concise]

Notes: Fill Y/N fields after running each alternative. Each row must specify precisely what changed vs baseline and link to the exact output.

Table 4. Robustness checks

- Alternative shock definitions (residual-based vs instrumented where feasible);
- Alternative inflation construction (y/y vs q/q annualized);
- Alternative FX outcomes (level change vs volatility; alternative reference rate where applicable);
- Sub-sample estimates guided by structural break evidence (pre- and post-break, as justified in Table 2);
- Sensitivity to lag length and to excluding extreme quarters (pre-defined rule, reported transparently).

The robustness section is written to be auditable: every robustness variant states exactly what changed relative to the baseline, and all results are traceable to the tables/figures without narrative overreach.

4. Discussion

This section interprets the estimated impulse responses of inflation and exchange-rate outcomes to defense-spending innovations under wartime conditions, with particular emphasis on state dependence. The central interpretive proposition is that the macroeconomic transmission of wartime defense spending is shaped by the interaction of (i) the financing mix and liquidity conditions and (ii) the credibility of the nominal anchor. Importantly, this proposition is treated as a testable mechanism rather than a predetermined conclusion: each channel is discussed only to the extent that it is consistent with the sign, timing, and persistence patterns observed in the estimated impulse responses and their robustness checks.

4.1. Interpreting baseline responses: timing, persistence, and channels

The baseline results provide evidence on whether a defense-spending innovation is followed by statistically and economically meaningful changes in inflation and the exchange rate. When the inflation response is concentrated at short horizons, a demand-pressure and cost-push interpretation is more plausible, particularly in an environment where supply capacity is impaired and logistics constraints are binding. Conversely, delayed responses may indicate that the main channel operates through financing, expectations, and exchange-rate pass-through rather than immediate domestic demand effects. The exchange-rate responses complement this interpretation. A contemporaneous or near-contemporaneous FX reaction is consistent with a channel in which fiscal shocks affect foreign-currency demand, reserve pressure, and risk premia, while a stronger volatility response than level response suggests stress dynamics and uncertainty effects rather than a stable revaluation of the currency.Throughout, interpretation is disciplined by the measurement design. Because the defense-spending shock is constructed as an innovation relative to predictable dynamics (Section 2.4), the impulse responses should be understood as the marginal effect of unexpected defense-spending movements within the model's information set, not as the effect of overall wartime spending levels.

4.2. State dependence: external financing and nominal anchoring as conditioning mechanisms

The state-dependent models are designed to test whether macroeconomic propagation differs under alternative financing and credibility conditions. The key idea is not controversial in theory but must be supported empirically: when official external financing is stronger or more predictable, it can reduce the need for inflationary domestic financing, stabilize foreign-currency liquidity, and dampen exchange-rate pressure. Under such conditions, the same defense-spending innovation may produce a smaller or less persistent inflation and FX response. By contrast, when anchoring is weaker—for example, when policy credibility is impaired or the policy regime is in transition—the sensitivity of inflation and the exchange rate to fiscal innovations may increase, reflected in larger or more persistent impulse responses.The interaction estimates (Shock × EXTFIN and Shock × ANCHOR) therefore carry an explicit interpretation: they indicate whether the marginal response to a defense-spending innovation changes systematically with the financing environment and the strength of the nominal anchor. If the interaction terms are small or statistically imprecise, that result is informative in itself: it would imply that the propagation of spending innovations is dominated by other mechanisms (e.g., real shocks, supply disruptions, risk events) or that the available proxies do not capture the relevant state variation at quarterly frequency.

4.3. Relation to existing evidence and why wartime conditions matter

A key contribution of this study is that it treats wartime conditions as an empirical environment with distinct features rather than a minor complication. In particular, the presence of regime shifts, administrative changes in fiscal reporting, and episodic external financing can make peacetime identification strategies fragile. Local projections are well suited to this setting because they allow the response profile to be estimated flexibly across horizons and facilitate interaction-based state dependence without imposing a single global dynamic system. This matters for interpretation: in conflict settings, macro responses are rarely stable across the entire sample, and the empirical goal is often to map how responses differ across phases rather than to estimate a single average effect.

4.4. Robustness as a credibility check, not an appendix formality

The robustness exercises play a central role in assessing whether the discussion can legitimately attribute patterns to the proposed mechanisms. If the main response profiles persist across alternative inflation definitions (y/y versus q/q annualized), alternative exchange-rate outcomes (level changes versus volatility), and alternative shock definitions (residual-based versus instrumented where feasible), then the evidence for a stable propagation pattern is stronger. If results are sensitive—particularly to sub-sample choice guided by break diagnostics—then the discussion should be framed phase-by-phase rather than as a uniform wartime effect.

4.5. Limitations and boundary conditions

Endogeneity risk. Even with residual-based innovations, defense spending may respond to unobserved wartime developments that simultaneously affect inflation and the exchange rate. Instrumental strategies can mitigate this risk only if the instrument is both relevant and plausibly exogenous, which is challenging in wartime environments where financing and macro conditions are jointly determined. Measurement constraints. Quarterly defense expenditure is difficult to measure cleanly. Classification changes, emergency procedures, off-budget channels, and timing differences between commitments and cash execution can introduce noise. The study mitigates this by using official sources, documenting series construction transparently, and testing alternative scalings; nonetheless, measurement error can attenuate estimated effects.Regime complexity and interpretation of FX movements. Wartime controls, administrative measures, and temporary restrictions may alter the mapping from observed exchange-rate movements to underlying market pressure. In such conditions, FX volatility or parallel indicators may capture stress more effectively than the official rate alone. This is why the analysis considers volatility proxies and places emphasis on break diagnostics and regime interactions.External validity. The results are specific to Ukraine's institutional and macro-financial environment in the sample period. They inform how defense-spending dynamics interact with inflation and the exchange rate under conflict, but they should not be mechanically generalized to peacetime settings or to conflict economies with different financing structures and monetary regimes.Taken together, the discussion frames the findings as evidence about conditional macroeconomic propagation. The aim is not to claim that defense spending "causes inflation" in a generic sense, but to show—under transparent identification and robust reporting—whether and how unexpected defense-spending movements are associated with subsequent inflation and exchange-rate dynamics, and whether those associations differ systematically with financing and anchoring conditions.

5. Conclusions

This study develops and applies a transparent, replicable empirical framework for assessing how **unexpected changes in defense expenditure** are associated with **inflation**, **exchange-rate dynamics**, and selected **fiscal stress indicators** in Ukraine over **2014Q1 to the most recent available quarter**. The framework is designed for wartime macroeconomic conditions, where structural breaks and regime shifts are not peripheral issues but central features of the data-generating process. To that end, the analysis combines (i) **formal structural break diagnostics**, (ii) **local projection impulse-response estimation**, and (iii) **state-dependent interaction models** that allow the propagation of defense-spending innovations to differ across financing and policy environments.The main methodological contribution is the disciplined sequencing of evidence: structural break diagnostics inform model specification and sample partitioning; shocks are defined using explicit and reproducible constructions; and dynamic responses are reported horizon-by-horizon with uncertainty bounds. This structure reduces the risk of over-interpreting average relationships in a period characterized by large, uneven shocks and evolving policy regimes. The state-dependent design further clarifies whether the macroeconomic responses to defense-spending innovations differ under alternative conditions of external financing intensity and nominal anchoring, without presuming these mechanisms in advance.The policy relevance of the results lies in their conditional interpretation. Any implications for inflation management, exchange-rate stability, and fiscal planning are drawn strictly from the **estimated response profiles** and the robustness checks, rather than from stylized narratives about wartime finance. The framework can therefore be used both as an analytical tool for retrospective assessment and as a template for ongoing monitoring as new data become available. Future research can extend the approach by incorporating higher-frequency fiscal measures where reliable, exploring alternative shock identification strategies, and linking macro responses to more granular indicators of financing composition and market expectations.

6. Patents

Not applicable.

Supplementary Materials

A replication package will be made available as supplementary files, including: (i) the complete data dictionary with variable definitions, sources, download dates, and transformations; (ii) the constructed quarterly dataset used in the empirical analysis (or a script that reconstructs it directly from publicly available sources, where redistribution restrictions apply); and (iii) fully annotated replication code to reproduce all tables and figures reported in the manuscript.

Author Contributions

Conceptualization, R.D.; methodology, R.D.; software, R.D.; validation, R.D.; formal analysis, R.D.; investigation, R.D.; resources, R.D.; data curation, R.D.; writing—original draft preparation, R.D.; writing—review and editing, R.D.; visualization, R.D.; supervision, R.D.; project administration, R.D. The author has read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Not applicable. The study relies exclusively on secondary, aggregated macroeconomic and fiscal statistics from official public sources and does not involve human participants, personal data, or identifiable private information.

Informed Consent Statement

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Conflicts of Interest

The author declares no conflicts of interest.

A4. Definition of $EXTFIN_t$, regime indicators, and anchoring proxies

A4.1. External financing indicator ($EXTFIN_t$)

$EXTFIN_t$ is defined as a transparent proxy for the intensity of official external support. Two implementation options are permitted (and both are documented if used):

- **Program-phase proxy:** a dummy or index based on IMF review periods and financing assurances phases, coded from published program documents.

- **Disbursement-intensity proxy (if data are available):** a quarterly measure of official external inflows/disbursements aggregated from official reporting.

The manuscript states which option is used as the baseline and why, with the alternative treated as robustness.

A4.2. Anchoring indicator ($ANCHOR_t$)

Anchoring is proxied by a monetary-policy indicator consistent with data availability, such as:

- policy rate level/changes;

- a regime dummy capturing major monetary or exchange-rate framework phases, coded from official announcements and program materials.

Appendix A lists the exact decision rules for coding the dummy (start/end dates and the documentary basis).

A4.3. Wartime phase dummies ($REGIME_t$)

Phase dummies are included strictly as controls and interaction terms, not as outcomes. The coding is based on documented policy dates and clearly defined phase boundaries (recorded in the code as a plain-text configuration file).

Appendix B. Additional Figures and Sensitivity Analysis

B1. Extended horizons (up to 12 quarters)

To assess persistence beyond the baseline horizon, local projections are re-estimated for $h = 0, \dots, 12$ quarters. Appendix B reports the extended IRFs with identical controls and standard-error treatment, allowing a direct comparison with the baseline (0–8 quarters).

B2. Placebo and pre-trend checks

Two placebo strategies are used to probe identification credibility:

1. **Lead-placebo tests:** replace $Shock_t$ with $Shock_{t+1}$ (and/or $Shock_{t+2}$) to verify that "future shocks" do not predict current outcomes.

2. **Pre-trend diagnostics:** estimate whether outcomes exhibit systematic movement in the quarters preceding identified shocks when using the baseline shock construction.

Placebo results are presented as tables of coefficients and as compact IRF-style plots where appropriate.

B3. Alternative lag lengths and information-criteria guidance

Baseline lag length is reported in the main text. Appendix B re-estimates results under alternative lag structures (shorter and longer), and reports how lag length was selected (e.g., AIC/BIC guidance, with practical constraints given the sample size). The goal is to show that the qualitative response pattern is not an artifact of one arbitrary lag choice.

B4. Subsample stability guided by break diagnostics

Where structural break tests indicate meaningful regime shifts, the analysis is repeated on sub-samples defined **ex ante** by the detected break dates (or by documented policy-phase boundaries, when these coincide). Appendix B reports:

- break-guided sub-sample IRFs;
- a comparison table indicating whether signs, peak timing, and persistence are stable across subperiods;
- a short note on sample-size limitations and inference precision.

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