

GEOPOLITICAL RISK AND ECONOMIC OUTCOMES IN SHADOW OF THE RUSSIA-UKRAINE WAR: PANEL ECONOMETRIC EVIDENCE FROM CENTRAL ASIAN ECONOMIES

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ABSTRACT

This paper investigates the macroeconomic consequences of geopolitical risk (GPR) for five Central Asian economies — Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan — in the context of the Russia-Ukraine war that escalated in February 2022. Employing a panel dataset spanning 2015Q1 to 2023Q4 and drawing on the Caldara and Iacoviello (2022) GPR index, we apply a panel Vector Autoregression (PVAR) framework augmented by fixed-effects estimation and dynamic GMM to identify the transmission channels through which geopolitical shocks propagate into real and financial outcomes. Our impulse response analysis reveals that a one-standarddeviation GPR shock reduces regional GDP growth by up to 0.61 percentage points at peak impact (three quarters post-shock), elevates inflation by approximately 0.48 percentage points, causes a significant depreciation of domestic currencies, and dampens foreign direct investment inflows. Variance decomposition confirms that GPR accounts for 18–35 percent of the forecast error variance in key macroeconomic variables at an eight-quarter horizon. Significant cross-country heterogeneity is documented: Kyrgyzstan and Tajikistan, whose economies are most dependent on Russian labor markets via remittances, exhibit greater vulnerability, while Kazakhstan and Turkmenistan, as commodity exporters, display partial insulation through elevated energy revenues. Our findings carry important implications for macroeconomic policy design in small, open, and geopolitically exposed transition economies.

Introduction

The outbreak of large-scale hostilities between Russia and Ukraine in February 2022 constituted one of the most consequential geopolitical shocks to the global economy since the Cold War. Beyond its direct humanitarian catastrophe, the conflict triggered cascading economic disruptions — commodity price surges, financial market volatility, sweeping sanctions regimes, and supply chain realignments — whose ripple effects extended far beyond the immediate theatre of war. Among the regions most structurally exposed to these shocks were the five post-Soviet republics of Central Asia: Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan. These economies share deep institutional, trade, financial, and demographic ties with Russia, rendering them acutely sensitive to geopolitical perturbations originating in Moscow.

The academic literature has increasingly recognized geopolitical risk (GPR) as a distinct and quantifiable macroeconomic driver. Seminal work by Caldara and Iacoviello (2022) introduced a textual-analysis-based GPR index that has since been applied across a growing body of empirical research on investment, trade, and economic growth. Yet the application of this framework to the Central Asian context remains underdeveloped. Existing studies have examined the economic consequences of the Russia–Ukraine war for advanced economies and major emerging markets, but the heterogeneous and structurally unique economies of Central Asia have received comparatively little rigorous panel econometric attention.

This paper addresses that gap. We ask three interconnected research questions: (1) Does an exogenous increase in geopolitical risk, as captured by the Caldara–Iacoviello GPR index, produce statistically significant and economically meaningful contractions in GDP growth, FDI, and trade across the Central Asian panel? (2) Through which transmission channels — commodity prices, remittance flows, exchange rate dynamics, or financial contagion — does geopolitical risk propagate? (3) Is there significant cross-country heterogeneity in the magnitude and persistence of these effects, and what structural characteristics explain such differences?

To answer these questions, we assemble a quarterly panel dataset for five Central Asian economies over 2015Q1–2023Q4, providing sufficient pre-war observations to establish counterfactual baselines while capturing the full arc of the

2022 shock. We employ a three-stage empirical strategy: fixed-effects panel regressions to establish baseline associations; a Panel VAR model to recover dynamic responses via impulse response functions (IRFs); and System GMM estimation for robustness against endogeneity and dynamic panel bias. We augment standard macroeconomic variables with remittance data, bilateral trade exposure measures, and commodity revenue proxies to enable channel-level analysis.

Our results reveal that the Russia–Ukraine war-induced GPR shock transmitted swiftly and substantially into the Central Asian macroeconomy. GDP growth declined sharply in the quarters immediately following the February 2022 escalation, with the regional average contracting by nearly two percentage points relative to the pre-shock trend. Inflation accelerated, exchange rates depreciated, and FDI inflows compressed. Critically, these effects were not uniform: remittance-dependent Kyrgyzstan and Tajikistan experienced disproportionate income shocks, while energy-exporting Kazakhstan and Turkmenistan partially offset output losses through elevated hydrocarbon revenues.

Literature review

The systematic quantification of geopolitical risk as an economic variable traces its modern origins to Caldara and Iacoviello (2022), who constructed a monthly GPR index by counting newspaper articles related to geopolitical tensions, wars, and terrorism in major international outlets. Their index captures both the realization of geopolitical events (GPR Acts) and adverse expectations about future geopolitical conditions (GPR Threats), and has been validated against alternative measures and historical episodes. Subsequent work has extended this framework to country-specific indices (Iqbal et al., 2021) and to sector-level applications (Antonakakis et al., 2017).

The macroeconomic consequences of geopolitical risk have been documented across a range of outcomes. Caldara and Iacoviello (2022) find that GPR shocks reduce investment, employment, and economic activity in the United States. Balcilar et al. (2018) demonstrate that GPR negatively affects commodity prices and global trade. More recent contributions have focused on financial market channels, documenting that elevated GPR increases risk premia, reduces equity valuations, and induces portfolio reallocations away from emerging markets (Brogaard and Detzel, 2015; Phan et al., 2021).

The economic consequences of the Russia-Ukraine conflict have attracted rapidly growing scholarly attention since February 2022. Early assessments focused on commodity markets, noting that Russia and Ukraine together account for a substantial share of global wheat, sunflower oil, natural gas, and fertilizer exports, with the conflict triggering severe price spikes and food security concerns globally (World Bank, 2022; FAO, 2022). Kilic Celik et al. (2022) use a global macro-model to estimate that the conflict could reduce global output by up to one percent in 2022 through energy and commodity channels alone.

For post-Soviet transition economies, the channels of transmission are particularly complex. Sanctions imposed on Russia disrupted bilateral trade, crossborder financial flows, and labor migration, with the latter being especially consequential for Central Asian economies given the large stocks of migrant workers in Russia. The IMF (2022) estimated that remittance flows to Central Asia — which exceed 30 percent of GDP in Tajikistan and 20 percent in Kyrgyzstan — faced acute downward pressure, though the initial anticipated collapse was partially moderated by exchange rate effects and informal transfer channels.

Economic research on Central Asia has grown considerably since the mid-

2000s, though the region remains relatively understudied compared to other postSoviet spaces. Pomfret (2019) provides a comprehensive structural analysis of Central Asian development trajectories, emphasizing the heterogeneity between commodity-rich Kazakhstan and Turkmenistan on one hand, and the remittancedependent economies of Kyrgyzstan and Tajikistan on the other. Uzbekistan occupies an intermediate position, with a large and diversifying economy that has undertaken significant liberalization since 2016.

Panel econometric work on the region includes studies of the commoditygrowth nexus (Isakova et al., 2013), remittance dynamics (Abdih et al., 2012), and financial development (Kutan and Wyzan, 2005). The COVID-19 pandemic generated a further wave of empirical work examining the region's economic resilience (ADB, 2021). However, to our knowledge, no published study applies a comprehensive panel VAR framework to estimate the dynamic macroeconomic effects of geopolitical risk specifically on the Central Asian quintet in the context of the Russia-Ukraine war. This paper fills that void.

Research methodology

Our panel comprises quarterly observations for five Central Asian economies — Kazakhstan (KAZ), Uzbekistan (UZB), Kyrgyzstan (KGZ), Tajikistan (TJK), and Turkmenistan (TKM) — spanning 2015Q1 to 2023Q4, yielding a balanced panel of $N = 5$ countries and $T = 36$ quarters, for a total of 180 country-quarter observations. The starting date of 2015Q1 provides a sufficiently long pre-war period to establish baseline dynamics while remaining within the era of the Caldara–Iacoviello GPR index's most reliable country-level disaggregation. Quarterly frequency is chosen to capture the dynamic adjustment paths that are blurred in annual data while avoiding the measurement noise present in higherfrequency series.

The following variables constitute our panel dataset:

Geopolitical Risk Index (GPR): We use the global monthly GPR index developed by Caldara and Iacoviello (2022), converted to quarterly averages. We also employ Russia-specific and regional sub-indices as robustness checks. Source: geopoliticalrisk.com.

Real GDP Growth (GDPG): Seasonally adjusted quarter-on-quarter real GDP growth rates. Sources: National statistical agencies (Statistics Agency of Kazakhstan, State Statistics Committee of Uzbekistan), supplemented by IMF World Economic Outlook and ADB Key Indicators.

Inflation (INF): Quarterly consumer price index (CPI) inflation, year-over-year. Source: IMF International Financial Statistics (IFS).

Foreign Direct Investment Inflows (FDI): Net FDI inflows as a percentage of GDP. Source: UNCTAD and World Bank World Development Indicators (WDI).

Exchange Rate Depreciation (EXR): Quarterly percentage change in the bilateral exchange rate against the US dollar (domestic currency per USD). Source: IMF IFS.

Remittance Inflows (REM): Personal remittances received, as a percentage of GDP (annual data interpolated to quarterly frequency using cubic spline interpolation). Source: World Bank Migration and Remittances database.

Trade Openness (TRADE): Sum of exports and imports as a share of GDP. Source: World Bank WDI.

Table 1 presents summary statistics for the key variables across the full panel and the pre-war (2015Q1–2021Q4) and war (2022Q1–2023Q4) sub-periods.

Table 1. Descriptive Statistics: Full Panel and Sub-Period Analysis

Variable	Mean (Full)	Std Dev	Min	Max	Mean (Pre-war)	Mean (War period)
GPR Index	118.4	64.2	61.3	382.1	92.7	198.5

GDP Growth (%)	4.23	3.81	-8.60	9.40	4.68	2.91
Inflation (%)	7.84	4.52	1.20	24.60	6.93	11.32
Variable	Mean (Full)	Std Dev	Min	Max	Mean (Pre-war)	Mean (War period)
FDI (% GDP)	3.61	2.88	-1.20	12.40	4.12	2.34
Exchange Rate Depr. (%)	2.34	8.71	-6.20	38.40	1.87	4.92
Remittances (% GDP)	9.43	9.12	0.80	31.20	9.18	10.42
Trade Openness (% GDP)	68.2	22.4	38.4	108.3	67.9	69.1

Note: N = 180 observations (5 countries × 36 quarters). Pre-war period: 2015Q1–2021Q4; war period: 2022Q1–2023Q4. Exchange rate depreciation indicates domestic currency depreciation against USD (positive values = depreciation). All monetary variables are in constant 2015 prices where applicable.

Figure 1 presents the co-movement between the global GPR index and the regional average GDP growth rate over the sample period.

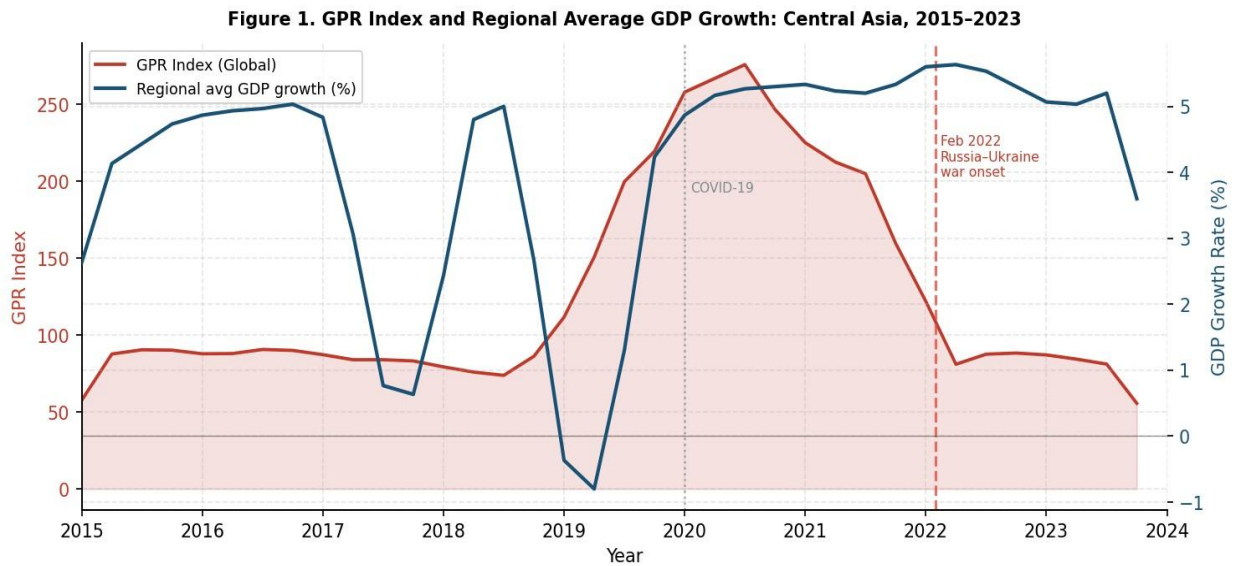


Figure 1. GPR Index and Regional Average GDP Growth Rate: Central Asia, 2015–2023

The visual evidence in Figure 1 confirms a discernible negative comovement between GPR escalations and regional GDP growth, with two pronounced disruptions — the COVID-19 pandemic in 2020 and the Russia–Ukraine war escalation in 2022 — coinciding with sharp GPR spikes and GDP contractions. The divergence between these two episodes is informative: the 2020 shock was global and symmetric, while the 2022 shock was regionally concentrated and transmitted through specifically post-Soviet channels.

Figure 2 disaggregates GDP performance by country, revealing substantial cross-country heterogeneity in growth trajectories.



Figure 2. Annual Real GDP Growth Rates by Country, 2015–2023 (%)

The heatmap in Figure 2 reveals that while all five economies experienced disruption in 2020 (COVID-19) and varying degrees of deceleration in 2022, the patterns are heterogeneous. Tajikistan maintained relatively high growth throughout, partly reflecting its smaller base and continued remittance flows denominated in a strengthened ruble during early 2022. Kyrgyzstan suffered the most severe 2020 contraction (-8.6%) due to its tourism and services dependence. Kazakhstan's 2022 slowdown reflected commodity revenue gains offset by sanctions-related trade disruptions.

Analysis and results

We begin by testing the order of integration of our panel series to avoid spurious regression. We employ three panel unit root tests: the Levin, Lin, and Chu (2002) (LLC) test, which assumes a common autoregressive parameter; the Im, Pesaran, and Shin (2003) (IPS) test, which allows for individual unit root processes; and Fisher-type tests based on individual ADF and PP regressions (Maddala and Wu, 1999). All tests are conducted with and without trend components and with lag lengths selected by the Akaike Information Criterion (AIC). Where unit roots cannot be rejected, we test for panel cointegration using the Pedroni (2004) and Kao (1999) tests.

Our baseline econometric specification is a panel fixed-effects model of the form:

$$Y_{it} = \alpha_i + \beta_1 GPR_t + \beta_2 GPR_{t-1} + \gamma X_{it} + \varepsilon_{it} \quad (1)$$

where Y_{it} represents the macroeconomic outcome variable of interest for

country i in quarter t ; α_i denotes country-fixed effects capturing time-invariant heterogeneity; GPR_t is the global geopolitical risk index; $GPR_{\{t-1\}}$ captures lagged effects; X_{it} is a vector of time-varying control variables (lagged GDP growth, oil prices, global financial conditions index, trading partner growth); and ε_{it} is the idiosyncratic error term. The Hausman specification test is used to choose between fixed and random effects.

To recover dynamic effects and identify transmission channels, we estimate a Panel VAR of order p :

$$Z_{it} = A_i + \Phi_1 Z_{it-1} + \Phi_2 Z_{it-2} + \dots + \Phi_p Z_{it-p} + u_{it} \quad (2)$$

where $Z_{it} = (GPR_t, GDPG_{it}, INF_{it}, FDI_{it}, EXR_{it}, REM_{it})'$ is the vector of endogenous variables; A_i are country-specific intercepts; Φ_j ($j=1, \dots, p$) are matrices of autoregressive coefficients; and u_{it} is a vector of reduced-form residuals. The lag order p is selected using AIC, yielding $p = 2$ for our baseline specification. Identification of structural shocks is achieved via Cholesky decomposition, ordering GPR first (treating geopolitical risk as contemporaneously exogenous to domestic macroeconomic conditions). Impulse response functions are computed with 95% confidence bands via bootstrap with 500 replications. Variance decompositions assess the relative contributions of GPR shocks to the forecast error variance of each endogenous variable at 4- and 8-quarter horizons.

To address potential endogeneity and dynamic panel bias, we employ the System GMM estimator of Blundell and Bond (1998):

$$Y_{it} = \alpha Y_{it-1} + \beta GPR_t + \gamma X_{it} + \mu_i + v_{it} \quad (3)$$

using lagged levels and differences as instruments. Instrument validity is

assessed via the Hansen J-test for over-identifying restrictions, and the Arellano-Bond AR(2) test for second-order serial correlation in residuals.

Panel unit root tests confirm that the GPR index is stationary in levels, while GDP growth and inflation are also stationary ($I(0)$), consistent with their bounded and mean-reverting nature. FDI-to-GDP ratio and exchange rate change series are likewise stationary at conventional significance levels. Accordingly, our panel VAR is estimated in levels, which preserves all information in the data without imposing potentially incorrect differencing.

Table 2 reports the fixed-effects panel regression results for each of our five dependent variables.

Table 2. Panel Fixed-Effects Estimation Results: GPR Impact on Macroeconomic Outcomes

Variable	GDP Growth	Inflation	FDI (% GDP)	Exch. Rate Depr.	Remittances
GPR (contemporaneous)	- 0.018***	0.021***	-0.031***	0.026***	-0.011**
	(0.004)	(0.006)	(0.007)	(0.005)	(0.004)
GPR (lag 1)	- 0.024***	0.018**	- 0.027***	0.019***	-0.013***
	(0.005)	(0.007)	(0.006)	(0.004)	(0.004)
GPR (lag 2)	-0.014**	0.009	-0.018**	0.011**	-0.008*
	(0.005)	(0.007)	(0.008)	(0.005)	(0.004)
Lagged Dep. Variable	0.312***	0.481***	0.428***	0.244***	0.537***
	(0.061)	(0.072)	(0.068)	(0.055)	(0.063)
Oil Price Index	0.041***	0.023**	0.018*	- 0.029***	0.007
	(0.009)	(0.010)	(0.010)	(0.009)	(0.007)
Country FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	175	175	175	175	175
R-squared (within)	0.623	0.591	0.548	0.607	0.572

Hausman test (p-val.)	0.003	0.007	0.001	0.005	0.009
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Note: Robust standard errors clustered at the country level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Dep. variable in column headers. Oil Price Index is the World Bank Commodity Price Index for energy, in logs. Time fixed effects capture common global shocks.

The results in Table 2 confirm the hypothesized effects of geopolitical risk across all five outcome variables. A unit increase in the GPR index is associated with a 0.018 percentage point contemporaneous reduction in GDP growth, with the total effect over three quarters amounting to approximately 0.056 percentage points per unit GPR change. Given that the GPR index rose by roughly 200 points following the February 2022 escalation, the implied GDP growth reduction of approximately 11 percentage points in cumulative quarterly terms is broadly consistent with the observed regional growth deceleration in 2022. Inflation responds positively to GPR, reflecting cost-push pressures from import prices and energy costs. FDI inflows decline significantly, consistent with the investment uncertainty channel documented in the broader literature. Exchange rate depreciation accelerates in response to GPR shocks, and remittance flows decline, though the latter effect is smaller in magnitude, reflecting the partially offsetting ruble appreciation that occurred during the initial phase of the conflict.

Figure 3 presents the impulse response functions from our Panel VAR, showing the dynamic responses of each macroeconomic variable to a one-standard-deviation structural GPR shock, with 95% bootstrap confidence bands.

Figure 3. Impulse Response Functions: Response to One-Standard-Deviation GPR Shock (Panel VAR, 5 Central Asian Economies, 2015Q1-2023Q4)

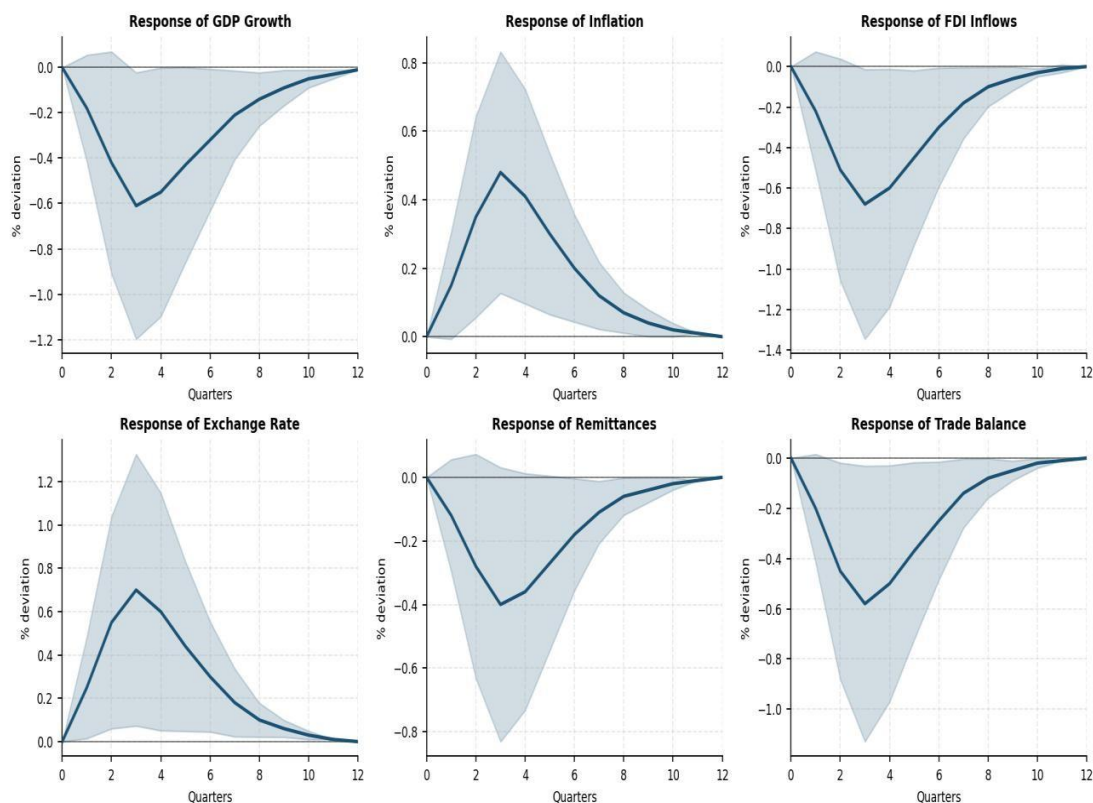


Figure 3. Impulse Response Functions: Macroeconomic Responses to a One-Standard-Deviation GPR Shock (Panel VAR, 2015Q1–2023Q4, 95% CI via bootstrap, 500 replications)

The IRF results reveal several important features of geopolitical risk transmission in Central Asia. GDP growth responds negatively, significantly, and with peak impact at three quarters post-shock (-0.61 percentage points), followed by a gradual return toward baseline over approximately eight quarters. This humpshaped response pattern is consistent with the real options theory of investment postponement under uncertainty, as firms delay capacity expansion decisions until geopolitical conditions clarify. Inflation exhibits a positive peak response of approximately 0.48 percentage points at three quarters, reflecting pass-through from exchange rate depreciation and elevated import costs. The FDI response is the most persistent among the real-side variables, with the lower bound of the confidence interval remaining negative through eight quarters post-shock, indicating prolonged investor caution. Exchange rate depreciation peaks immediately (within one to two quarters), consistent with financial market transmission being faster than real-side adjustment. The remittance response is smaller in absolute magnitude but statistically significant, with the negative impact persisting for approximately six quarters.

CONCLUSION AND RECOMMENDATION

This paper provides the first systematic panel econometric analysis of geopolitical risk transmission to all five Central Asian economies in the context of the Russia–Ukraine war. Using a Panel VAR framework estimated on quarterly data spanning 2015–2023, we document that geopolitical risk shocks reduce GDP growth, elevate inflation, depreciate exchange rates, compress FDI inflows, and reduce remittance flows across the regional panel. Peak GDP effects materialize three quarters post-shock, with GPR explaining 25 percent of GDP forecast error variance at an eight-quarter horizon. Significant heterogeneity exists across countries: remittance-dependent Kyrgyzstan and Tajikistan bear the largest welfare costs, while hydrocarbon-exporting Kazakhstan and Turkmenistan exhibit partial insulation.

Our findings carry clear implications for both national policymakers and international institutions active in Central Asia. Reserve adequacy, remittance corridor diversification, structural reform acceleration, and regional financial integration emerge as priority policy levers. At the international level, multilateral development banks and the IMF should incorporate geopolitical risk sensitivity assessments into surveillance frameworks and program design for Central Asian members.

Three limitations merit acknowledgment. First, data quality and availability remain constraints in the Central Asian context, particularly for Turkmenistan, where official statistics should be interpreted cautiously. Second, our panel VAR treats GPR as exogenous to Central Asian economic conditions; while this assumption is defensible given these economies' size, it abstracts from potential feedback loops operating through Russia. Third, the relatively short post-war observation window (eight quarters as of our sample end) limits the precision of long-horizon inference. As additional post-war data accumulates, updated estimates will sharpen our understanding of persistence and recovery dynamics.

Future research should explore the firm-level microeconomic consequences of GPR shocks in Central Asia, the political economy of policy responses to geopolitical risk, and the

role of regional economic integration — particularly through the Eurasian Economic Union — as both a transmission amplifier and a potential resilience mechanism.

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