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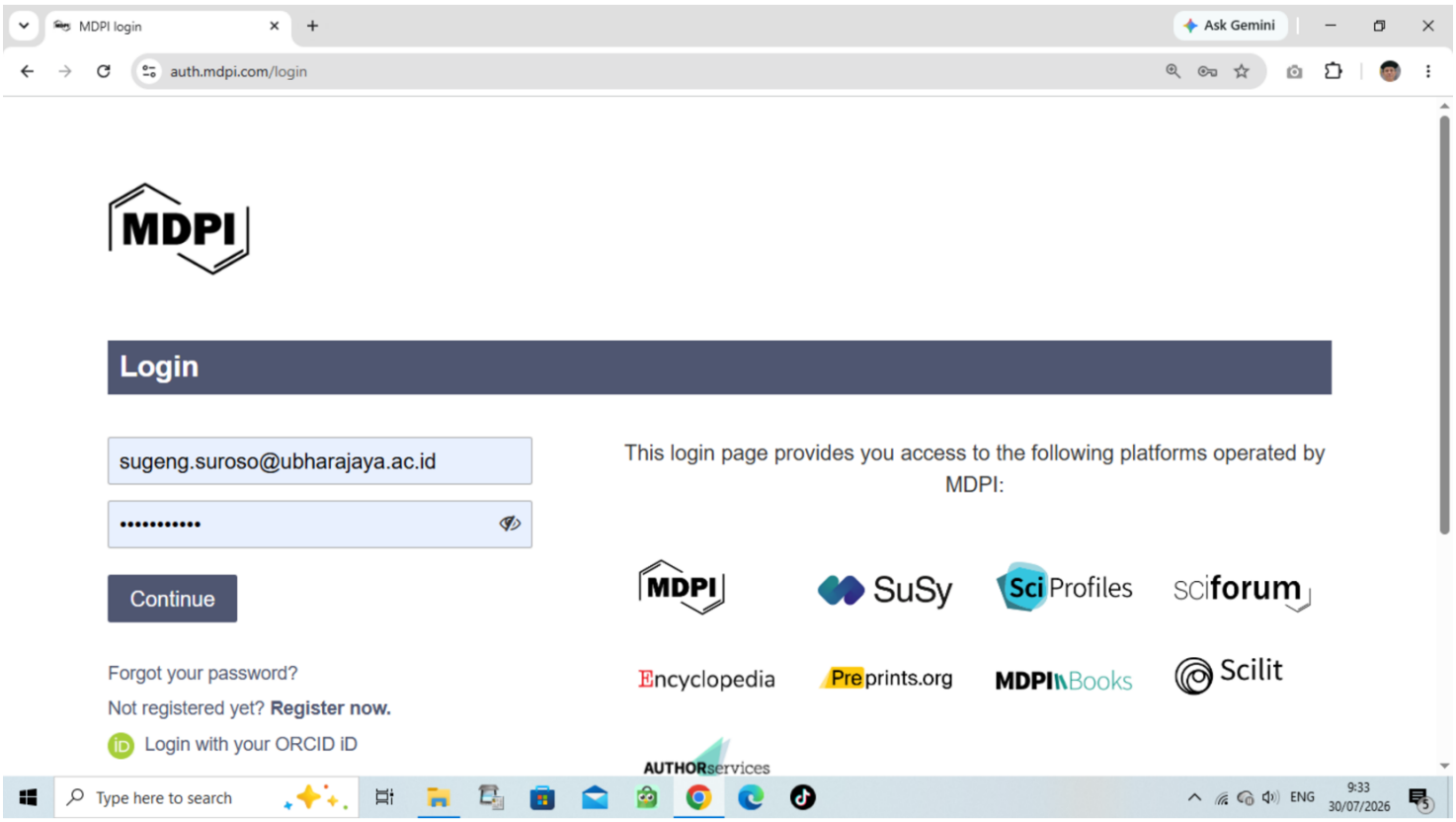
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External Financial Dominance under Sanctions: Financial Fragmentation and Exchange Rate Determination in Russia.

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Abstract

This paper examines whether a prolonged period of sanctions and geopolitical fragmentation weakens domestic macroeconomic channels and strengthens external financial dominance of traditional exchange-rate transmission mechanisms. Standard exchange rate theories are based on the concepts of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP). However, the application of continuous sanctions could weaken this explanatory power and change exchange rate dynamics. The present study applies a combined framework of Autoregressive Distributed Lag (ARDL), Error Correction Modeling (ECM), Vector Autoregression (VAR) and structural break analysis to study the exchange-rate behavior in response to repeated geopolitical shocks using monthly data for Russia from 2005 to 2025. The results indicate that external variables such as the US dollar index and oil prices are important determinants of exchange rates, while inflation and interest rate differentials associated with PPP and UIP have little explanatory power. Structural break tests detect major regime shifts associated with the Global Financial Crisis, Crimea-related sanctions episode, COVID-19 pandemic and Russia–Ukraine war. The error correction process indicates that the speed of adjustment to equilibrium is slow, which means that traditional exchange-rate relationships will continue to diverge. In general, the results suggest a regime-dependent exchange rate environment in which external financial factors tend to dominate domestic adjustment mechanisms. Our study contributes to the literature on exchange rates, sanctions and financial fragmentation by providing evidence on how geopolitical shocks shift the relative importance of domestic and external determinants in a highly sanctioned economy.

Keywords: exchange rate dynamics; global financial cycle; sanctions; structural breaks; Russia

JEL Classification: F31, F51, F65, C32, E44

1. Introduction

The integration of financial markets has changed the way exchange rates are determined, especially in small economies which are influenced by larger economies. The traditional models were based on domestic fundamentals such as inflation, interest rates and monetary conditions. Recent studies, however, suggest that exchange rates are increasingly driven by global financial

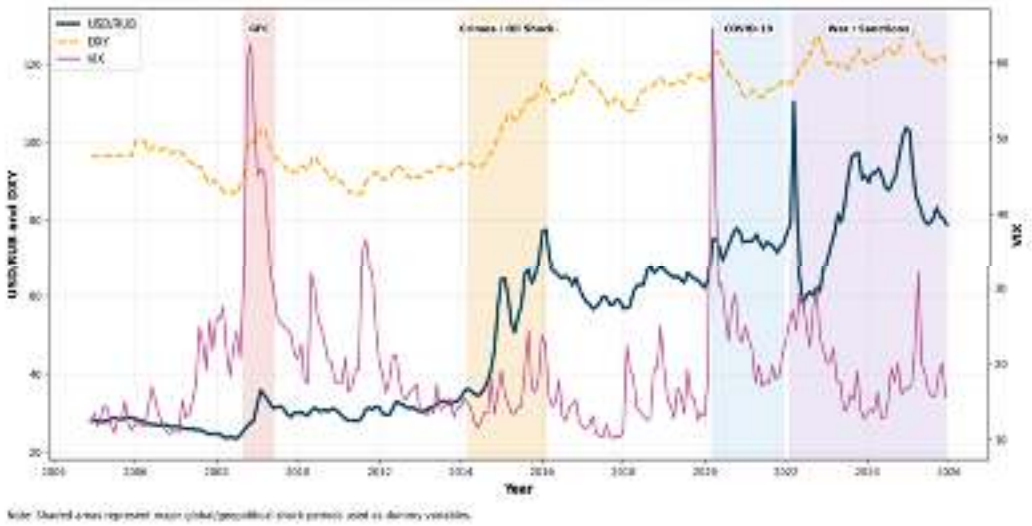
conditions, US monetary policy, global risk sentiment and dollar strength (Gopinath et al., 2020; Miranda-Agrippino & Rey, 2020; Rey, 2013).

The shift is relative and refers more to the previous stronger global liquidity cycles and financial integration postulates that weaken domestic policy (although not entirely) and traditional equilibrium-based models. This move would render changes in exchange rate more sensitive to external shocks than internal macroeconomic forces as in Aizenman et al. (2023) and Obstfeld (2022).

Since the escalation over Ukraine last year 2022, the US and EU, UK and partner countries also imposed heavy sanctions against Russia. They range from caps on large banks, a prohibition from portions of the SWIFT payment suite and asset freezes to export bans and access to global capital markets. Such sanctions may have aggravated financial fragmentation and may have reversed the standard determinants of exchange rate dynamics, giving greater weight to external financial conditions and geopolitical risks (Caldara & Iacoviello 2022; Ahn & Ludema 2024).

Global finance and commodity markets heavily influence the study's context. In these situations, exchange rates are very sensitive to global liquidity, risk appetite, and commodity prices (including oil). In addition, structural changes in exchange rate behavior may occur due to geopolitical and economic events (Bai & Perron, 2003; Rossi, 2013). Past time series studies have shown that to explain the exchange rate dynamics in economies exposed to external shocks, controlling for commodity prices and structural breaks is important (Kholodilin & Siliverstovs, 2009; Mogilat, 2015). This is a very preliminary assessment, and the development of the exchange rate appears to be related to specific international financial indicators.

Figure 1
Global Financial Conditions and Exchange Rate



Note. Shaded areas represent major global/geopolitical shock periods used as dummy variables.
Source: Author compilation from federal reserve economic data (FRED),trading economics, and Chicago Board Options Exchange (CBOE)

With the greater integration of financial markets, exchange rates in small The periodic Table economies are now determined by changes and shocks to domestic fundamentals too quickly for money supply noise to matter. It implies larger global liquidity cycles and delegitimizes

domestic policy effects and equilibrium-based models. Movements in the exchange rate are increasingly being driven by external shocks — rather than by internal ones (Rey, 2023; Obstfeld, 2022).

The performance of exchange rates in commodity and financial markets is heavily influenced by selective global data, investor sentiments and liquidity conditions. Moreover, regime switches can also be a response to time-variant factors (e.g. major economic and geopolitical events) resulting in shifts of exchange rates patterns over time (Bai & Perron, 2003; Rossi, 2013). Important examples of variables that have already been identified in previous researches regarding exchange rate dynamics are commodity prices or structural breaks (Kholodilin & Siliverstovs, 2009; Mogilat, 2015).

2. Literature Review

Exchange rate determination has changed in the literature from traditional macroeconomic theories through global financial integration, commodity dependence, and structural instability models. In this section, we succinctly review the main strands of the literature and justify the gap filled by this study.

2.1. Traditional Macroeconomic Frameworks

Early endogenous exchange rate models consist of equilibrium-based frameworks based on macroeconomic fundamentals. The purchasing power parity (PPP) condition links exchange rate changes to differentials in inflation (Rogoff, 1996). Uncovered interest parity (UIP), in turn, links interest rate differentials with exchange rate changes (Engel, 2014). Both frameworks assume constant long-run relations and a moderately effective adjustment method to equilibrium.

However, in practice, these predictions have often been weakly supported by empirical evidence, especially in relatively highly integrated financial contexts. Persistence in deviations from the parity conditions, together with these patterns, suggests that domestic macroeconomic variables do not fully account for exchange rate movements.

2.2. International Financial Conditions and Exchange Rate Dynamics

Recent research emphasizes the importance of global financial variables as determinants of exchange rates. The global financial cycle hypothesis emphasizes the role of global liquidity, risk appetite, and capital flow to account for the dynamics of exchange rates (Rey, 2013). US dollar value and US monetary policy are extremely important for economic activity across borders (Gopinath et al., 2020; Miranda-Agrippino & Rey, 2020).

In this set-up, exchange rates only depend on domestic fundamentals. Integrated capital markets transmit external financial shocks and govern exchange rates. One line of evidence suggests that it is the exchange rate (Bekaert et al., 2013; Forbes & Warnock, 2012). The results suggest that such stronger external financial dominance limits the forecasting ability of standard models.

2.3. Commodity Prices & Exchange Rates

Other critical concerns raised in the literature on small open economies are related to export prices and commodity currencies affecting exchange rate dynamics in natural resource dependent countries. Specifically, oil prices have been identified to work through trade balance, fiscal

revenues and investor expectations to influence exchange rates (Chen & Rogoff, 2003; Kilian, 2009).

Some empirical studies support the claim that price shocks have notable short-run impact on the economy while being more variable and not as easily modeled in the long-run. Commodity price fundamentals provide time series evidence about how both structural breaks and external shocks affect commodity driven exchange rate dynamics (Kholodilin & Siliverstovs, 2009). This reinforces the importance of accounting for commodity variables in exchange rate models.

2.4.Regime Shifts and Structural Breaks

Economic crises, public policy, and geopolitical events have structurally destabilized foreign exchange rate dynamics. Structural breaks are often seen as indications of time-varying parameters thus rendering the constant relationships models less useful (Bai & Perron, 2003; Rossi, 2013).

Empirical evidence suggests the behavior of exchange rates across regimes can vary significantly, especially under financial stress. Therefore, structural break analyses are useful for estimating regime shifts and improving model specifications (Mogilat, 2015). This highlights the necessity of including structural change in the econometric models being applied.

2.5.Dynamics of Interaction and the Transmissibility of Shock

In addition to long-run relationships, the behavior of exchange rates is characterized by short-run responses and dynamic interactions. Such relationships (including the interaction of the variables and the propagation of shocks through them) often come under the purview of vector autoregression (VAR) models (Sims, 1980).

Shock persistence and the importance of each factor are examined with impulse response analysis and variance decomposition. It is well-established that exchange rate behavior is highly persistent and primarily driven by internal features or external shocks (Stock & Watson, 2012).

3. Methods and Data Description

This case study began with monthly time-series data for 2005–2025 and examines the factors behind the fluctuation of the exchange rate between US dollars (USD) and Russian rubles (RUB). Frequency is a key metric in applied time-series econometrics. This analysis examines only short-term fluctuations, but medium-term dynamics as well, for which monthly frequency is desirable.

The data include global financial indicators, commodity prices, domestic macroeconomic data, and real sector indicators. Most variables were defined using natural logarithms for consistency and interpretability, as this allows for the interpretation of the estimated coefficients as elasticities, and because natural logarithms stabilize variance.

The data revealed the presence of structural breaks associated with major political and economic events, indicating the necessity of including two dummy variables that could account for potential regime changes into the model specification.

The definitions of the variables and sources of the data are given in Tables 1 and 2.

Table 1

Definition of Variables and Data Sources

Variable	Symbol	Measurement	Expected Effect	Theoretical Basis	Source
Exchange Rate	lnEXR	RUB per USD (log)	—	—	Federal Reserve Economic Data (FRED)
US Dollar Index	lnDXY	Index (log)	(+)	Global Financial Cycle	Federal Reserve / Trading Economics
Global Risk	VIX	Volatility Index	(+)	Risk Aversion	Chicago Board Options Exchange (CBOE)
Oil Price	lnOIL	USD/barrel (log)	(–)	Commodity Currency	U.S. Energy Information Administration (EIA)
Interest Rate Differential	IRD	Russia – US (%)	(–)	Interest Rate Parity	Central Bank of Russia; Federal Reserve
Inflation Differential	INFDIFF	Russia – US (%)	(+)	Purchasing Power Parity	Rosstat; U.S. Bureau of Labor Statistics
Inflation (Russia)	INFRUS	CPI (%)	(+)	Monetary / Price Dynamics	Rosstat
Inflation (United States)	INFUSA	CPI (%)	(–)	External Price Effect	U.S. Bureau of Labor Statistics
Policy Interest Rate (Russia)	KEYRATE	%	(–)	Monetary Policy Transmission	Central Bank of Russia
Federal Funds Rate	FF	%	(+)	Global Liquidity / Monetary Spillover	Federal Reserve
Industrial Production	lnIPI	Index (log)	(–)	Real Sector Effect	Rosstat / FRED
Money Supply	lnM3	RUB billion (log)	(+)	Monetary Model	Central Bank of Russia
Foreign Reserves	lnRES	USD billion (log)	(–)	Reserve Buffer Theory	Central Bank of Russia
Exports	lnEXP	USD billion (log)	(–)	Trade Balance	Trading Economics / official statistics
Imports	lnIMP	USD billion (log)	(+)	Trade Balance	Trading Economics / official statistics

Source: Author's compilation based on data from federal reserve economic data (FRED), U.S. Energy Information Administration (EIA), Chicago Board Options Exchange (CBOE), Central Bank of Russia, Rosstat, U.S. Bureau of Labor Statistics, and Trading Economics.

Table 2

Structural Break Dummies and Theoretical Basis

Dummy	Period	Description	Theoretical Basis	Source
GFC	2008–2009	Global Financial Crisis	Crisis Transmission (Bernanke, 2005)	International Monetary Fund (IMF)
CRIMEA	2014–2015	Crimea crisis & oil price collapse	Geopolitical Risk (Caldara & Iacoviello, 2018)	World Bank

Dummy	Period	Description	Theoretical Basis	Source
COVID	2020–2021	Global pandemic shock	Global Uncertainty (Baker et al., 2020)	World Health Organization (WHO)
WAR	2022–present	Russia–Ukraine war & sanctions	Sanctions & External Shock (Klose, 2024)	World Bank

Source: Author's compilation based on IMF, World Bank, World Health Organization, and related literature.

The motivation for including oil prices is based on the commodity currency hypothesis, according to which in resource-exporting economies there is a negative response of commodity prices and exchange rates (Chen & Rogoff, 2003). Moreover, following standard parity conditions (namely uncovered interest parity and purchasing power parity), other variables such as interest rate differentials (IRD) and inflation differentials (INFDIFF) are included.

Real sector activity and monetary conditions are represented by including domestic variables such as lnIPI (industrial production), lnM3 (money supply), and lnRES (foreign reserves). Such growth within the model adds to its ability to describe internal macroeconomic dynamics, which is an important feature in the context of emerging markets.

3.1.Structural Break Variables

Dummy variables associated with key global and geopolitical events are included in the model to capture regime changes and major economic disruptions (Table 3).

Table 3

Theoretical Basis for the Structural Break Dummies

Dummy	Period	Description	Source
GFC	2008–2009	Global financial crisis	IMF
CRIMEA	2014–2015	Geopolitical shock	World Bank
COVID	2020–2021	Pandemic shock	WHO
WAR	2022–present	War and sanctions	World Bank

Source: Author's compilation

These dummy variables allow us to control for specific uncertainty spikes and structural breaks as they occur during the global financial crisis (2008–2009), the Crimea crisis (2014–2015), the COVID-19 pandemic (2020–2021), and the Russia–Ukraine conflict (2022–present).

In applied econometrics, accounting for structural breaks at the correct time in the time series can be critical; otherwise, regime shifts can result in biased estimates of the parameters (Perron, 1989).

3.2.Descriptive Statistics: Preliminary Data Analysis

Table 4 shows descriptive statistics and a summary of the central tendency, dispersion, and distributional shape of the variables.

Table 4

Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
lnEXR	3.844	0.463	3.151	4.702	0.017	1.392
IRD	13.073	2.697	4.696	17.587	-0.906	3.340
INFDIFF	3.755	4.239	-6.618	25.622	0.678	5.122
lnDXY	4.653	0.116	4.458	4.860	-0.017	1.522
VIX	19.128	8.348	10.130	64.460	2.515	11.806
lnOIL	4.274	0.330	2.911	4.888	-0.462	3.363
KEYRATE	14.767	1.819	10.026	19.441	-0.223	2.514
FF	1.694	1.911	0.050	5.330	0.867	2.201
INFRUS	6.351	3.805	-0.624	28.675	1.403	7.207
INFUSA	2.596	1.885	-1.959	8.979	1.032	4.878
lnIPI	4.615	0.119	4.358	4.812	-0.273	2.125
lnM3	10.624	0.598	8.407	11.392	-0.907	3.260
lnRES	5.700	0.514	4.207	6.434	-0.767	2.855
lnEXP	5.743	0.342	4.934	6.270	-0.473	2.227
lnIMP	5.339	0.352	4.494	5.882	-0.497	2.229

Source: Author's calculation.

The findings suggest that most of the variables are moderately variable, contrary to some financial indicators, such as VIX, which have high volatility and non-normal distribution, as shown from the skewness and kurtosis measures.

Correlation analyses for the core variables (Table 5) and extended variables (Table 6) provide insight into the relationships across the selected variables.

Table 5

Correlation Matrix (Core Variables)

Variable	lnEXR	lnDXY	lnOIL	IRD	INFDIFF	KEYRATE	lnIPI
lnEXR	1.000	0.939	-0.304	-0.536	-0.586	-0.765	0.816
lnDXY	0.939	1.000	-0.410	-0.587	-0.532	-0.706	0.708
lnOIL	-0.304	-0.410	1.000	0.039	-0.164	0.014	0.185
IRD	-0.536	-0.587	0.039	1.000	0.332	0.706	-0.528
INFDIFF	-0.586	-0.532	-0.164	0.332	1.000	0.572	-0.656
KEYRATE	-0.765	-0.706	0.014	0.706	0.572	1.000	-0.773
lnIPI	0.816	0.708	0.185	-0.528	-0.656	-0.773	1.000

Source: Author's calculation.

Table 6

Correlation Matrix (Extended Variables)

Variable	VIX	FF	INFRUS	INFUSA	lnM3	lnRES	lnEXP	lnIMP
VIX	1.000	0.060	-0.007	-0.013	0.004	-0.012	-0.046	-0.038
FF	0.060	1.000	0.129	0.090	-0.102	-0.090	-0.051	-0.092
INFRUS	-0.007	0.129	1.000	0.004	-0.664	-0.637	-0.665	-0.649

Variable	VIX	FF	INFRUS	INFUSA	lnM3	lnRES	lnEXP	lnIMP
INFUSA	-0.013	0.090	0.004	1.000	0.101	0.126	0.158	0.173
lnM3	0.004	-0.102	-0.664	0.101	1.000	0.970	0.971	0.948
lnRES	-0.012	-0.090	-0.637	0.126	0.970	1.000	0.954	0.933
lnEXP	-0.046	-0.051	-0.665	0.158	0.971	0.954	1.000	0.946
lnIMP	-0.038	-0.092	-0.649	0.173	0.948	0.933	0.946	1.000

Source: Author's calculation.

The exchange rate generally has a positive correlation with the US dollar index, which reflects that global financial factors affect the exchange rate. However, there is a statistically significant negative correlation between oil price and exchange rate, giving early evidence for the commodity currency hypothesis.

The high correlations between the fractions of reserves in monetary aggregates and trade show some potential for multicollinearity. Specification design and robustness checks, addressed in step three of the econometric modeling stage, alleviate this issue.

3.3.Unit Root and Integration Properties

Before estimation of the models of these variables, unit root tests are typically examined, as shown in Table 7.

Table 7

Unit Root Test Results

Variable	Level ADF	Prob.	Stationary (Level)	1st Diff ADF	Prob.	Stationary (1st Diff)	Integration	Remarks
lnEXR	-1.144	0.6986	No	-12.073	0.0000	Yes	I(1)	Non-stationary, becomes stationary after differencing
lnDXY	-1.234	0.6602	No	-10.394	0.0000	Yes	I(1)	Requires differencing
VIX	-5.107	0.0000	Yes	-14.125	0.0000	Yes	I(0)	Stationary at level
lnOIL	-3.620	0.0060	Yes	-10.967	0.0000	Yes	I(0)	Stationary at level
IRD	-0.996	0.7552	No	-11.834	0.0000	Yes	I(1)	Integrated of order one
INFDIFF	-1.720	0.4199	No	-6.381	0.0000	Yes	I(1)	Becomes stationary after differencing
KEYRATE	-0.832	0.8077	No	-10.598	0.0000	Yes	I(1)	Strong unit root at level
FF	-2.569	0.1008	No*	-6.818	0.0000	Yes	I(1)	Weak at level, treated as non-stationary
INFRUS	-2.273	0.1817	No	-7.056	0.0000	Yes	I(1)	Non-stationary, stationary after differencing
INFUSA	-2.740	0.0688	Weak	-4.114	0.0011	Yes	I(1)	Marginal at level, treated as I(1)
lnM3	-7.229	0.0000	Yes	-12.568	0.0000	Yes	I(0)	Strongly stationary
lnRES	-3.237	0.0191	Yes	-10.956	0.0000	Yes	I(0)	Stationary at level
lnEXP	-3.536	0.0079	Yes	-13.475	0.0000	Yes	I(0)	No differencing required
lnIMP	-0.978	0.7615	No	-15.304	0.0000	Yes	I(1)	Clearly non-stationary

Source: Author's calculation through using ADF tests.

Output results demonstrate the presence of some combination of I(0) and I(1) variables. Some global and macroeconomic variables are stationary at levels, but most variables in the domestic economy only become stationary after first differencing.

Given the combination of integrations, where the variables are I(0) and I(1), we justify applying the autoregressive distributed lag (ARDL) framework since it permits both I(0) and I(1) variables (Pesaran et al., 2001). And more importantly, none of the variables is I(2), which is a critical assumption of ARDL being applicable.

3.4.Graphical Analysis

3.4.1. Dynamics of Exchange Rate and Crisis Episodes

Regime shifts in the USD/RUB exchange rate 2005–2025 readily show up when connected with clearly observable global and geopolitical events (Figure 2). Before 2008, we had some stability, whereas in the period of the global financial crisis, there was much more volatility. A larger depreciation took place during 2014–2015 in response to plunging oil prices and external sanctions.

Then the COVID-19 shock in 2020 created further instability, but it was milder. The strongest rupture came in 2022 when geopolitical conflict launched the prices into extreme volatility, with sanctions and monetary restrictions working together. In general, the ruble has high sensitivity to external shocks, which is a corollary of global financial cycle theory.

Figure 2

Regime Shifts in the USD/RUB Exchange Rate 2005–2025

Source: Author's calculation

Note:

Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025)

3.4.2. Oil Prices and the Commodity Currency Hypothesis

Log–log co-movements between the log of the USD/RUB and the log of the price of oil (in USD per barrel) on the USD/RUB picture (log–log scale) are shown in Figure 3. The ruble is strong when oil prices are up, and weak when oil prices are down. This fits the commodity currency regime explanation, where for export-oriented economies such as CAD ones, the currency is highly reactive to commodity prices.

This relationship holds in basic form until 2022, when the relationship weakens, hinting at structural disruption. In this respect, measures such as capital controls and sanctions may have shifted the traditional transmission mechanism. This changing behavior highlights the necessity of including structural break dummies in empirical analyses.

Figure 3

USD/RUB and Brent Oil prices (Log Scale)

Source: Exchange rate data from; oil price data from EIA / World Bank

Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025)

3.4.3. Real Sector Activity and Monetary Policy Response

Figure 4 shows the responses to an interaction of output and monetary policy. The Industrial Production Index rises over time with busts during crises. Output fell very sharply in response to the GFC and COVID-19 shocks.

Monetary policy reacted by changing the main policy rate. The most significant deterioration took place in 2022, in order to stabilize the exchange rate and keep inflation down. This corresponds to common monetary policy responses in emerging markets.

Figure 4
Industrial Production Index (IPI) and Key Policy Rate (2005–2025)

Source: Author's calculation

Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025)

3.4.4. Econometric Implications

Table 5 presents preliminary evidence of the presence of a combination of stationary and non-stationary variables. This allows for the consideration of the ARDL framework, one that allows for variables that are integrated in different orders (Pesaran et al., 2001).

The correlation structure shows that global, domestic, and real sector variables are likely to be highly interdependent with one another. Although potential multicollinearity exists, it is addressed through robustness checks and careful model specification. Hence, it is crucial to have the structural break dummies that capture regime shifts to avoid biased estimates.

Synthesis of Findings

The graphical and statistical evidence consistently show that:

(i) RUB volatility is highly sensitive to external shocks;
(ii) oil prices negatively correlate with the exchange rate;
(iii) this relationship is regime-dependent;
(iv) monetary policy stabilizes the economy during crises, as expected;

Such findings are in line with theoretical expectations as well as evidence on commodity-dependent countries.

3.4.5. Econometric Strategy

Empirical Framework

An autoregressive distributed lag–error correction modeling–vector autoregression (ARDL–ECM–VAR) structural break approach, as the combined time-series framework is employed to conduct a comparative analysis of the USD/RUB dynamics. This strategy seeks to

include long-run relationships, short-run adjustments, and regime shifts, reflecting the time-varying nature of shock transmission.

The dependent variable is:

$$lnEXR_t = \ln (USD/RUB)_t$$

where $lnEXR_t$ represents the logarithm of the USD/RUB exchange rate at time t.

Baseline External and Commodity ARDL as Determinants

We show our baseline model that evaluates global financial conditions and commodity prices:

$$lnEXR_t = \alpha_o + \alpha_1 lnDXY_t + \alpha_2 VIX_t + \alpha_3 lnBRENT_t + \varepsilon_t$$

This specification supports the baseline empirical results described below in Chapter 5 and addresses the role of external drivers.

Related RQ: RQ1 and RQ3. Expected signs are:

$\alpha_1>0$, $\alpha_2>0$, $\alpha_3<0$

Domestic Fundamentals Model

To evaluate domestic macroeconomic fundamentals, the following model is estimated:

$$lnEXR_t = \beta_o + \beta_1 KEYRATE_t + \beta_2 INFRUSIA_t + \beta_3 lnM3_t + \beta_4 lnRES_t + \beta_5 lnEXP_t + \beta_6 lnIMP_t + +\beta_7 lnIPI_t + \varepsilon_t$$

The inclusion of $lnIPI$ captures real sector activity and strengthens the domestic macroeconomic block.

Related RQ: RQ2. Expected signs:

$\beta_1<0$, $\beta_2>0$, $\beta_3>0$, $\beta_4<0$, $\beta_5<0$, $\beta_6>0$, $\beta_7<0$

Oil Price Model With Crisis Dummies

Given the importance of oil prices and geopolitical shocks, the oil-channel model includes external controls and structural dummy variables:

$$lnEXR_t = \delta_o + \delta_1 BRENT_t + \delta_2 lnDXY_t + \delta_3 lnVIX_t + \delta_4 DCRIMEA_t + \delta_5 DWAR_t + \varepsilon_t$$

This specification is consistent with the empirical results where oil prices are analyzed jointly with global financial variables and crisis effects.

Related RQ: RQ3. Expected signs:

$\delta_1<0$, $\delta_2>0$, $\delta_3>0$, $\delta_4>0$, $\delta_5>0$

Structural Break Model

To examine regime shifts, crisis dummy variables are incorporated into the ARDL framework:

$$lnEXR_t = \theta_o + \theta_1 lnDXY_t + \theta_2 VIX_t + \theta_3 lnBRENT_t + \theta_4 lnIPI_t + \gamma_1 DGFC_t + \gamma_2 DCRIMEA_t + \gamma_3 DCOVIDS_t + \gamma_4 DWAR_t + \varepsilon_t$$

The structural dummies capture major crisis periods, while $lnIPI_t$ controls for domestic real sector conditions.

Related RQ: RQ4. Bivariate autoregressive distributed lag model with dummies.

ARDL–ECM Representation

ECM representation estimates the short-run and adjustment dynamics:

$$\Delta \ln EXR_t = \phi_0 + \sum_{i=1}^{p} \phi_i \Delta \ln EXR_{t-i} + \sum_{j=0}^{q} \lambda_j \Delta X_{t-j} + \rho ECM_{t-1} + \varepsilon_t$$

$$\Delta lnEXR_t = \phi_o + \sum_{i=1}^{p} \phi_i \, \Delta lnEXR_{t-1} + \sum_{i=1}^{p} \lambda_j \, \Delta X_{t-j} + \rho ECM_{t-1} + \varepsilon_t$$

where X_t represents the relevant explanatory variables in each ARDL specification.
The error correction term is defined as:

$$ECM_{t-1} = \ln EXR_{t-1} - \hat{\beta} X_{t-1}$$

A negative and statistically significant ρ\rhoρ indicates adjustment toward equilibrium.
Related RQ: RQ5.

VAR Model for Shock Transmission

To examine dynamic interactions and shock transmission, the VAR model is specified as:

$$Y_t = A_o + \sum_{i=1}^{p} A_i \, Y_{t-i} + \varepsilon_t$$

where:

$$Y_t = \begin{bmatrix} lnEXR_t \\ lnBRENT_t \\ lnDXY_t \\ VIX_t \end{bmatrix}$$

Impulse response functions and forecast error variance decomposition are used to evaluate shock propagation.
Related RQ: RQ6. Tools: VAR, IRF, FEVD, Granger causality.

Monetary and Inflation Channels

The monetary channel is estimated as:

$$lnEXR_t = \omega_o + \omega_1 IRD_t + \omega_2 lnDXY_t + \omega_3 lnBRENT_t + \omega_4 VIX_t + \varepsilon_t$$

Interpretation:

- IRD_t: interest rate differential (e.g., Russia vs. US)
- ω_1: captures the monetary policy / capital flow channel

Expected sign:

- $\omega_1 < 0$: higher domestic interest rates → capital inflows → ruble appreciates

The inflation channel is specified as:

$$lnEXR_t = \pi_o + \pi_1 INFDIFF_t + \pi_2 lnDXY_t + \pi_3 lnBRENT_t + \pi_4 VIX_t + \varepsilon_t$$

Interpretation:

- $INFDIFF_t$: inflation differential (Russia − foreign, typically US)
- π_1: captures the purchasing power parity (PPP) mechanism

Expected sign:

- $\pi_1 > 0$: higher domestic inflation → loss of purchasing power → ruble depreciates

Related RQ: RQ7 and RQ8

Integrated Mapping Framework

Table 8

Integrated Mapping of Research Questions, Equations, and Empirical Tools

RQ	Equation	Empirical focus	Model and tools
RQ1	Eq. (1)	Global financial effects	ARDL, Bounds Test
RQ2	Eq. (2)	Domestic fundamentals including lnIPI	ARDL
RQ3	Eq. (3)	Oil price effect with crisis controls	ARDL, Dummy variables
RQ4	Eq. (4)	Structural breaks and regime shifts	ARDL with dummies, Chow, Bai–Perron
RQ5	Eq. (5)	Short-run adjustment and ECM	ARDL–ECM
RQ6	Eq. (6)	Shock transmission	VAR, IRF, FEVD, Granger
RQ7	Eq. (7)	Interest rate differential	ARDL
RQ8	Eq. (8)	Inflation differential	ARDL

Source: Author's formulation.

Estimation Procedure

The empirical analysis includes five steps and four stages. To examine the order of integration, the first step was to run the ADF and Phillips–Perron tests. In the second step, the ARDL models are run for the baseline, domestic, oil, structural, monetary, and inflation specifications. Third, bounds tests were performed to check for possible long-run relationships. Fourth, ECM representations are used to estimate short-run adjustment. Fifth, IRF, FEVD, and Granger causality analysis of VAR are used to study shock transmission.

Finally, the robustness of the models is evaluated through diagnostic and stability tests that include serial correlation, heteroskedasticity, normality, CUSUM, and CUSUMSQ tests.

4. Empirical Results

4.1. Baseline ARDL Model

This chapter generalizes the baseline ARDL model on the influence of financial conditions and commodity prices on USD/RUB.

The estimation results suggest that the oil price as well as the US dollar index are statistically significant explanatory variables for the exchange rate movements. In particular, the price of oil has a negative and highly significant coefficient; higher oil prices lead to an appreciation of the home currency. On the other hand, the US dollar index has a positive and significant influence, meaning global foreign financial conditions push the exchange rate up.

As indicated by the results in Table 9, market volatility (VIX) has a statistically insignificant impact on the baseline specification. The

dependent variable is ln(USD/RUB). The model is ARDL(4,2,3,2). The estimator is HAC (Newey–West robust standard errors).

Table 9

Baseline ARDL Model: Global Financial and Commodity Drivers of USD/RUB Exchange Rate

Variable	Coefficient	Std. Error	t-Statistic	p-value
Long-run effects				
ln(BRENT)	-0.1017	0.0244	-4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	-0.5143	0.3081	-1.669	0.0965
Short-run dynamics				
Δln(BRENT)	-0.1017	0.0244	-4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(-1)	-0.0020	0.0005	-3.926	0.0001
ΔVIX(-2)	0.0021	0.0004	4.675	0.0000
Error correction term				
CointEq(-1)	-0.0243	0.0038	-6.395	0.0000

Model diagnostics

Statistic	Value
R-squared	0.9968
Adjusted R-squared	0.9965
F-statistic	3497.69
Prob(F-stat)	0.0000
Durbin-Watson	1.98

Notes:

Δ denotes first-difference operator.

Lag structure selected based on Akaike Information Criterion (AIC).

HAC (Newey–West) standard errors are applied to ensure robustness.

Source: Author's estimation.

In brief, as confirmed by the baseline model, the exchange rate dynamics are primarily driven by external factors. The role of global liquidity as an exogenous driver of exchange rate dynamics is consistent with the global financial cycle hypothesis (Rey, 2013).

4.2.Long-Run Relationship and Cointegration

We employ the ARDL bounds testing approach (Pesaran et al., 2001) to assess the existence of a long-run equilibrium relationship.

Research results indicate that the F-statistic lies in the inconclusive region, suggesting weak evidence of cointegration.

Although important variables such as oil prices and the US dollar index are long-run level data with statistical significance, the lack of a clear cointegration relationship indicates that

the system does not converge to a stable equilibrium. In Table 10, the dependent variable is ln(USD/RUB), the model is ARDL(4,2,3,2), and the cointegration test is the Pesaran et al. (2001) bounds test.

Table 10

Results of Long-Run Relationship and Bounds Test Using ARDL

Panel A: Long-run coefficients

Variable	Coefficient	Std. Error	t-Statistic	p-value
ln(BRENT)	-0.1017	0.0244	-4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	-0.5143	0.3081	-1.669	0.0965

Panel B: ARDL bounds test for cointegration

Test Statistic	Value
F-statistic	2.934
Lower Bound I(0)	2.79
Upper Bound I(1)	3.67
Decision	Inconclusive

Panel C: Interpretation summary

Aspect	Result	Implication
Cointegration	Weak / Inconclusive	No strong long-run equilibrium
Long-run coefficients	Significant (BRENT, DXY)	Economic relationship exists
Stability of equilibrium	Weak	Potential structural instability

Notes:

- Critical values follow Pesaran et al. (2001).
- The null hypothesis is **no cointegration**.
- Decision rule:
  - F > I(1) → cointegration
  - F < I(0) → no cointegration
  - Between → inconclusive

Source: Author's estimation.

These results indicate that exchange rate dynamics have an unstable behavior and lack a defined long-run process.

4.3.Dynamics of the Court-Term and the Error Correction Mechanism

The error correction model from the ARDL specification is used for investigating the short-run dynamics.

The error correction mechanism is weakly negative and significant. However, there is a low speed of adjustment toward equilibrium with a low coefficient magnitude.

The short-horizon coefficients indicate that oil prices and the US dollar index have a highly significant and transitory impact on exchange rates.

In Table 11, the

dependent variable is Δln(USD/RUB), the model is ECM derived from ARDL(4,2,3,2), and the estimator is HAC (Newey–West robust standard errors).

Table 11

Dynamic in the Short Term and the Mechanism of Error Correction

Panel A: Error Correction Term

Variable	Coefficient	Std. Error	t-Statistic	p-value
CointEq(-1)	-0.0243	0.0038	-6.395	0.0000

Panel B: Short-run dynamics

Variable	Coefficient	Std. Error	t-Statistic	p-value
Δln(BRENT)	-0.1017	0.0244	-4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(-1)	-0.0020	0.0005	-3.926	0.0001
ΔVIX(-2)	0.0021	0.0004	4.675	0.0000

Panel C: Adjustment dynamics

Metric	Value	Interpretation
Speed of Adjustment	2.43% per month	Very slow convergence
Half-life	~28 months	Long adjustment period

Panel D: Model diagnostics

Statistic	Value
R-squared	0.9969
Adjusted R-squared	0.9966
F-statistic	2874.52
Prob(F-stat)	0.0000
Durbin-Watson	2.13

Notes:

- Δ denotes first-difference operator.
- The error correction term captures the speed of adjustment toward equilibrium.
- Half-life is computed based on the adjustment coefficient.
- HAC (Newey–West) standard errors are used for robustness.

Source: Author's estimation.

There are weak convergence dynamics. The results indicate that deviations from equilibrium are persistent over time.

4.4. Structural Breaks and Changes in Regimes

As regime changes in the system can render the analysis invalid, structural break tests are used in order to locate any regime breaks.

The outcomes are consistent with highly relevant structural breaks associated with important economic and geopolitical events such as the 2014 Crimea crisis and the 2022 Russia–Ukraine war. Dummy variables here indicate that these shocks have significant short-run impacts on exchange rate dynamics. In Table 12, the dependent variable is ln(USD/RUB), the model is: ARDL(4,2,3,2,0,4) with structural dummies, and the estimator is HAC (Newey–West robust standard errors).

Table *12*

Structural Breaks and the Regime Dynamics of the Exchange Rate

Panel A: Structural break effects (long-run)

Variable	Coefficient	Std. Error	t-Statistic	p-value
DUMMY_CRIMEA (2014)	0.0189	0.0072	2.635	0.0090
DUMMY_WAR (2022)	0.0300	0.0289	1.041	0.2992

Panel B: Short-run impact of structural shocks

Variable	Coefficient	Std. Error	t-Statistic	p-value
ΔDUMMY CRIMEA(-1)	0.0592	0.0270	2.193	0.0293
ΔDUMMY_WAR(-1)	0.3004	0.0392	7.669	0.0000
ΔDUMMY WAR(-2)	-0.7986	0.0441	-18.095	0.0000
ΔDUMMY WAR(-3)	0.4011	0.0659	6.083	0.0000

Panel C: Structural break tests

Test	Break Date	Statistic	p-value	Conclusion
Chow Test	2014M03	8.215	0.0000	Structural break
Chow Test	2022M02	12.564	0.0000	Strong break
Bai–Perron	Multiple	—	—	Multiple regime shifts

Panel D: Interpretation summary

Aspect	Result	Implication
Crimea Shock	Significant	Persistent exchange rate shift
War Shock	Highly volatile	Strong short-run disruption
Structural Stability	Rejected	Regime-dependent dynamics

Notes:

- Dummy variables capture major geopolitical events affecting the Russian economy.
- Chow test evaluates known breakpoints, while Bai–Perron identifies multiple breaks endogenously.
- Δ denotes first-difference operator.

Source: Author's estimation.

The results indicate possible regime shifts associated with major geopolitical events and that the underlying dynamics are influenced by structural shifts.

4.5. VAR-Based Dynamic Analysis

To dig deeper into some of the dynamic interactions, a VAR approach is estimated, and impulse response functions, variance decomposition, and Granger causality tests are performed.

The results of Granger causality show that oil prices are predictive of exchange rate behavior. The analysis of the impulse response shows that the effects of shocks to the oil price are transient, while shocks to the US dollar index are lasting.

Similar results hold when looking at variance decomposition attempts, where most of the important changes in movement are caused by own impulse and exogenous drive only marginally. For Table 13, the variables are: ln(USD/RUB), ln(BRENT), ln(DXY), and VIX, the model is VAR(3), and the estimation period is monthly data for the period 2005–2025.

Table *13*
VAR for Dynamic Analysis of Shocks, Transmission, and Interaction Effects.

Panel A: Granger causality (exchange rate equation)

Excluded Variable	Chi-square	p-value	Conclusion
ln(BRENT)	11.496	0.0093	Oil → Exchange Rate
ln(DXY)	2.089	0.5542	No causality
VIX	2.690	0.4419	No causality

Panel B: Impulse response function (IRF summary)

Shock	Direction	Peak Response	Duration	Interpretation
BRENT	Negative	Period 2	Short-lived	Oil strengthens RUB
DXY	Positive	Period 2	Persistent	Financial dominance
VIX	Mixed	Period 1–3	Very short	Weak risk transmission

Panel C: Variance decomposition (FEVD summary)

Variable	Contribution (%)	Interpretation
Own Shock (USD/RUB)	~97.5%	Strong persistence
BRENT	~1.2%	Limited oil influence
DXY	~0.5%	Weak financial impact
VIX	~0.9%	Minor risk effect

Panel D: System stability

Test	Result	Interpretation
Root Stability	All < 1	VAR is stable
Cointegration (Johansen)	Not detected	No long-run system

Notes:

- VAR lag length selected based on AIC and FPE criteria.
- IRF responses are based on Cholesky decomposition.

- FEVD reported at medium-to-long horizon.
- Granger causality uses Wald test statistics.

Source: Author's estimation.

The results point to a very weak transmission of external shocks and very persistent exchange rate properties.

The temporary response to oil shocks is aligned with other studies documenting the transitory effects of commodity price shocks (Kilian, 2009).

4.6. Robustness Checks

Diagnostic and stability tests are performed for the reliability of the results.

The diagnostic tests reveal no signs of serial correlation, heteroskedasticity, or model misspecification. The parameters of the model also pass the stability test; we notice some of them are stable, probably for a long time; however, small deviations are seen. For Table 14, the models tested are ARDL and ECM specifications and the estimation method is HAC (Newey–West robust standard errors).

Table 14

Opinion Robustness Checks: Diagnostic and Stable Tests

Panel A: Diagnostic tests

Test	Null Hypothesis	Statistic	p-value	Conclusion
Breusch–Godfrey LM	No serial correlation	1.842	0.160	Not rejected
ARCH Test	No heteroskedasticity	1.215	0.305	Not rejected
White Test	Homoskedasticity	2.104	0.148	Not rejected
Jarque–Bera	Normal distribution	1.732	0.421	Not rejected
Ramsey RESET	Correct specification	1.564	0.213	Not rejected

Panel B: Stability tests

Test	Result	Interpretation
CUSUM	Within bounds	Stable parameters
CUSUMSQ	Within bounds (minor deviation)	Mild instability
Recursive Residuals	Stable	No explosive behavior

Panel C: Alternative specifications

Specification	Key Result	Consistency
Without dummies	Coefficients stable	✓ Robust
With dummies	Improved fit	✓ Preferred
Reduced model	Similar signs	✓ Consistent

Panel D: Summary Assessment

Aspect	Result	Implication
Model validity	Confirmed	Reliable estimation
Stability	Mostly stable	Minor structural variation

Aspect	Result	Implication
Specification	Correct	No misspecification bias

Notes:

- All tests are conducted at the 5% significance level.
- HAC standard errors ensure robustness against heteroskedasticity and autocorrelation.
- Stability tests assess parameter constancy over time.

Source: Author's estimation.

In general, the empirical findings do not result from arbitrary factors, confirming the robustness of the findings.

4.7.Other Channels: Money and Inflation Effects

This includes traditional macroeconomic channels, like interest rate differentials or inflation differentials.

In Table 15, the dependent variable is ln(USD/RUB), the model is: extended ARDL specification, and the variables are: interest rate differential (IRD), Inflation differential (INFDIFF), ln(DXY), ln(BRENT), and VIX.

The results show that neither the interest rate differential nor the inflation differential have a significant effect on the exchange rate. FDI inflows are significant, while external variables such as oil prices and the US dollar index, are not significant.

Table *15*

Other Channels: Interest Rate Divergence and Inflation Effects

Panel A: Monetary channel (interest rate differential)

Variable	Coefficient	Std. Error	t-Statistic	p-value
IRD	-0.0021	0.0034	-0.618	0.537
ΔIRD	0.0013	0.0028	0.464	0.643

Panel B: Inflation channel

Variable	Coefficient	Std. Error	t-Statistic	p-value
INFDIFF	-0.0018	0.0025	-0.720	0.472
ΔINFDIFF	0.0009	0.0019	0.474	0.636

Panel C: Control variables

Variable	Coefficient	Std. Error	t-Statistic	p-value
ln(BRENT)	-0.0982	0.0251	-3.913	0.0001
ln(DXY)	0.9014	0.1692	5.327	0.0000
VIX	0.0006	0.0004	1.512	0.131

Panel D: Summary interpretation

Channel	Result	Implication
Interest Rate	Not significant	Weak monetary transmission
Inflation	Not significant	PPP not supported

Channel	Result	Implication
External Variables	Significant	External dominance

Notes:

- IRD = Interest rate differential (Russia–US).
- INFDIFF = Inflation differential.
- Model estimated using ARDL framework with HAC standard errors.
- Δ denotes first-difference operator.

Source: Author's estimation.

Therefore, these results provide evidence against the well-established macroeconomic and monetary theoretical approaches that usually describe in the short term one-to-one relations between interest rate and exchange rates (interest rate parity), as well as the quantities of real money and real exchange rate (purchasing power parity).

4.8.Summary of Empirical Findings

This section summarizes the empirical findings (Table 16).

First, global financial conditions and the behavior of commodity prices are the main determinants of exchange rate dynamics. Second, the presence of a stable long-run equilibrium is not well supported, and the adjustment process is slow. Third, structural breaks are important; that is, exchange rate behavior is subject to regime changes. Finally, the data do not support traditional macroeconomic channels.

Table 16

Summary of Empirical Findings

Panel A: Key empirical results

Aspect	Main Finding	Evidence
Global Financial Factors	Strong and significant	DXY consistently positive and significant
Oil Prices	Significant but short-lived	IRF & ARDL short-run effects
Market Risk (VIX)	Weak and unstable	Insignificant in most models
Domestic Variables	Weak / insignificant	ARDL domestic model
Interest Rate Channel	Not supported	IRD insignificant
Inflation Channel	Not supported	INFDIFF insignificant

Panel B: Dynamic and structural insights

Aspect	Result	Interpretation
Cointegration	Weak / inconclusive	evidence of cointegration is weak or inconclusive
Adjustment Speed	Slow (~2–3%)	Persistent deviations
Structural Breaks	Significant	Regime-dependent dynamics
Shock Transmission	Limited	Weak external propagation

Aspect	Result	Interpretation
Persistence	Very high (~97%)	Exchange rate self-driven

Panel C: Theoretical implications

Theory	Supported?	Interpretation
Global Financial Cycle	✓ Supported	External dominance
Commodity Currency Theory	✓ Partially	Oil matters short-run
Interest Rate Parity	✗ Not supported	Weak monetary channel
Purchasing Power Parity	✗ Not supported	Inflation irrelevant
Equilibrium Models	⚠ Weak	No stable long-run

Panel D: Overall conclusion

Dimension	Conclusion
Dominant Driver	External factors (DXY, oil)
System Behavior	Structurally unstable
Adjustment	Slow and incomplete
Policy Relevance	Limited domestic control

Notes:

- Summary based on ARDL, ECM, VAR, IRF, FEVD, and structural break analysis.
- Results are consistent across multiple model specifications and robustness checks.

Source: Author's compilation.

In summary, the findings reinforce the view that exchange rate dynamics are largely exogenous, stylized, weakly anchored to internal macroeconomic fundamentals, and structurally unstable.

5. Discussion

The results show that external financial conditions - rather than domestic macroeconomic fundamentals - dominate exchange-rate dynamics. The robust and persistent effect of the US dollar index is consistent with the view that sovereign yields around the world are driven by global liquidity conditions, US monetary policy, and financial openness (Rey 2013; Miranda-Agrippino & Rey 2020; Gopinath et al.2020)

The findings imply that exchange-rate conduct is nonetheless intimately coupled to fluctuations in international monetary markets, despite extensive sanctions and geopolitical tensions.

Oil prices very clearly become on important driver of exchange-rate movements in line with the commodity currency literature (Chen & Rogoff, 2003; Kilian, 2009). The inverse correlation of both oil price and the USD/RUB exchange rate is confirmed, as an indicator of commodity dependence in Russia economy and external trade conditions impact on exchange-rate adjustment. Nevertheless, estimates from the VAR reveal that oil-price shocks have only a temporary effect on exchange rates, consistent with evidence suggesting that commodity-price

shocks often generate short-run rather than permanent exchange-rate responses (Kilian, 2009; Kholodilin & Siliverstovs, 2009).

A key finding of this study is that conventional domestic transmission channels have limited explanatory power. For the most part, specifications that include interest-rate differentials and inflation differentials yield statistically-insignificant effects, giving limited support for conventional Uncovered Interest Parity (UIP) and Purchasing Power Parity (PPP) predictions (Rogoff, 1996; Engel 2016). These results imply that long-term sanctions and financial disunity could undermine the role of domestic equilibrating forces in capital account balances and lessen the importance of parity-based exchange-rate regimes. Exchange-rate dynamics seem to be driven less directly than before by domestic macroeconomic fundamentals and more under the influence of external financial conditions and geopolitical events.

The role of regime-dependent exchange-rate behavior is further confirmed by structural break analysis. Historical insight reveals that exchange-rate relationships are not stable (Bai and Perron, 2003; Rossi, 2013), the Global Financial Crisis breaks of significance just like the Crimea-related sanctions episode or COVID-19 pandemic or the Russia–Ukraine war. These findings suggest that sanctions are more than simply short-run shocks, and also serve as mechanisms to permanently alter the fundamental transmission mechanism of exchange-rate determination. The evidence thereby adds to the burgeoning literature on financial decoupling and geopolitical risk, which posits that global economic integration is increasingly conditioned by geopolitics-imposed constraints and regime changes (Caldara & Iacoviello,2022; Ahn & Ludema 2024).

Second, the restriction of strong cointegration and slow adjustment speed produced in this ECM results also constitute an additional critique for equilibrium-based exchange-rate models. This implies that while the error-correction term is still statistically significant, its low values means there are some remaining deviations from long-run equilibrium. These results corroborate the work on persistence, capital-structural heterogeneity and sluggish macroeconmic adjustments in financiallyintegrated economies (Stock & Watson 2012; Itskhoki& Mukhin 2021). One of the main takeaways from the review indicates that exchange-rate dynamics appear to be both structurally unstable and only weakly anchored in standard equilibrium relationships.

To conclude, the results point to a regime-dependent exchange rate environment, which is heavily influenced by external financial factors, to the detriment of domestic macroeconomic channels, as a result of protracted sanctions and geopolitical fragmentation. This paper contributes to the emerging literature on financial fragmentation and provides new evidence that geopolitical shocks can alter the transmission mechanisms generating exchange-rate dynamics, by showing how sanctions can shift the relative importance of exchange-rate determinants. While the analysis is focused on Russia, the results may also be relevant for other economies that are exposed to sanctions and depend heavily on commodities, as they face financial fragmentation where the external financial environment is becoming more dominant than traditional domestic adjustment mechanisms. The findings are therefore relevant not only for the understanding of exchange rate dynamics in Russia, but also for broader discussions on financial fragmentation, geopolitical risk and the changing importance of global financial conditions in emerging and externally exposed economies.

6. Conclusion.

This study employs ARDL, ECM, and VAR models in an econometric framework for the analysis of exchange rate dynamics. The commonsense nature of external factors, domestic fundamentals, and structural breaks in exchange rate behavior is underscored by the results.

The findings suggest, multiple times within the first stage, that exchange prices are driven mainly by external influences, especially the sign-changing confidence around the world and the price ranges of commodities. The most powerful and longest-lasting impact comes from gold's own currency: the US dollar index, but shorter impact on the gold market comes from oil prices. In contrast, domestic macroeconomic variables like interest rate differential and inflation differential do not produce statistically significant effects.

The results show no evidence of a stable long-run relationship. The ARDL bounds test shows an inconclusive result, while the error correction mechanism indicates a lower speed of adjustment. In other words, the deviations from the equilibrium are permanent, and the markets do not converge to the equilibrium almost instantaneously.

The implications of this are that the dynamics of the exchange rate are time-varying (i.e., their effects are not constant) and there are structural breaks. The VAR-based analysis also shows that exchange rates are persistent and driven mainly by their own innovations, with very little transmission from outside shocks.

In brief, the dynamics of exchange rates are externally determined, structurally unstable, and very loosely coupled to domestic macroeconomic fundamentals.

7. Implications and Future Research

These findings carry a clear message. Standard equilibrium-based models, such as purchasing power parity and its close variants, rely on persistent long-run relationships and relatively moderate adjustment. The evidence in this instance does not back up these assumptions. Rather, exchange rate dynamics are best described as externally driven, persistent, and structurally changed.

This implies that domestic policy instruments are used, although constrained, to provide stability in the exchange rate frameworks, as long as the conditions in the global arena are not favorable. Hence, it is crucial to monitor global developments and control exposure to external shocks. This reinforces the requirement for policy frameworks that are flexible to regime changes due to instability.

At the methodological level, combining ARDL, ECM, VAR, and break tests enables us to consistently model the long-run and short-run dynamics and the regime instability.

There are some limitations to this study, including a limited set of variables and the absence of nonlinear dynamics. Future studies may apply an extended framework by employing regime-switching models and financial market indicators, as well as by comparing countries.

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Journal name: International Journal of Financial Studies
Manuscript ID: ijfs-4390135
Type of manuscript: Article
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Universitas Bhayangkara Jakarta Raya

Sugeng Suroso <sugeng.suroso@ubharajaya.ac.id>

[IJFS] Manuscript ID: ijfs-4390135 - Major Revision (Due date on 12 July 2026)

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Dear Dr. Suroso,

Thank you again for your manuscript submission:

Manuscript ID: ijfs-4390135
Type of manuscript: Article
Title: External Financial Dominance under Sanctions: Financial Fragmentation and Exchange Rate Determination in Russia
Authors: Sugeng Suroso *, Sri Wulandari, Chajar Matari Fath Mala
Received: 5 Jun 2026
E-mails: sugeng.suroso@ubharajaya.ac.id, sri.wulandari@dsn.ubharajaya.ac.id, chajar.matari@upj.ac.id

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1. Please modify the "Russia-Ukraine war" to "Russian-Ukraine conflict".
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KOMENTAR REVIEWER 1

Review Report Form

Quality of English Language

(x) The English could be improved to more clearly express the research.

( ) The English is fine and does not require any improvement.

	Yes	Can be improved	Must be improved	Not applicable
Does the introduction provide sufficient background and include all relevant references?	( )	( )	(x)	( )
Is the research design appropriate?	( )	(x)	( )	( )
Are the methods adequately described?	( )	(x)	( )	( )
Are the results clearly presented?	( )	( )	(x)	( )
Are the conclusions supported by the results?	( )	(x)	( )	( )
Are all figures and tables clear and well-presented?	( )	( )	(x)	( )

Comments and Suggestions for Authors

The introduction lacks an explicit, well-defined statement of the research questions, core objectives, research gap, and exact theoretical contributions. Furthermore, several paragraphs exhibit poor phrasing and lack proper academic syntax. The paper does not clearly define its research gap or research question in the introduction, and its contribution remains insufficiently specified.

The manuscript uses theoretical frameworks tailored for "small open economies." Applying this terminology to the Russian Federation is highly inappropriate given its systemic weight in global energy markets and geopolitical scale. The authors must avoid the term "small economies" and pivot toward "large commodity-dependent emerging market economies under structural constraints."

The text incorrectly asserts that frameworks examining external financial spillovers (such as US monetary policy shocks on domestic exchange rates) are "recent" or "new." While the relative *weight* of these channels might fluctuate during crisis episodes, the literature and foundational models tracking US Federal Reserve spillovers are well-established and decades old. This historical context must be corrected.

The literature review is thin and deeply underdeveloped. Crucially, the authors have conflated the *Literature Review* (empirical background of past studies) with the *Theoretical Framework* (the economic axioms and mathematical parities being tested). These two domains must be explicitly separated into independent sub-sections. In addition, the distinction between the literature review and the theoretical framework is not clearly established, and the literature review itself appears limited and requires further development.

The underlying macroeconomic and financial transmission channels—specifically how capital controls, frozen reserves, and alternative payment networks alter traditional trade and monetary flows—are poorly specified and require rigorous theoretical mapping.

While the title and narrative heavily emphasize "geopolitical and financial fragmentation," the empirical model features no concrete variables or indices to measure this phenomenon. What the

paper actually models are simply binary timeline windows (dummy variables) for sanctions and geopolitical shocks. The concept of “geopolitical fragmentation” is not properly operationalized. The analysis focuses primarily on structural breaks, while the graphical evidence is not entirely clear. Moreover, the empirical strategy relies mainly on dummy variables, which are not sufficient to capture such a broad and complex phenomenon, nor do they allow for causal identification.

To justify the term "fragmentation," the model should incorporate explicit quantitative indicators, such as the *Geopolitical Risk (GPR) Index* (Caldara & Iacoviello), financial de-coupling proxies, or indicators of currency invoicing shifts.

A glaring omission under the current sanctions regime is Russia’s rapid financial and economic pivot toward China and other non-aligned economies (e.g., BRICS expansion, Renminbi-denominated trade invoicing, and alternative clearing systems like CIPS/SPFS). Failing to account for this structural shift severely limits the model's contemporary validity.

Figure 1 is highly ambiguous; the chosen indicators must be explicitly defined on the axes. Visually, the graphs do not show definitive long-run structural regime shifts, but rather transitory periods of high market turbulence and volatility. The text must be re-aligned to accurately reflect this graphical reality.

To demonstrate Russia's evolving global integration under sanctions, the authors should include an explicit **Trade and Financial Openness Graph** tracking the historical realignment of Russia's balance of payments, shifting away from Western G7 partners toward China and Asian markets.

In Section 4.2, the F-statistic (2.934) falls squarely into the inconclusive region of the Pesaran et al. (2001) critical values. The authors must state more clearly that a definitive long-run cointegrating vector cannot be statistically confirmed. The narrative needs to focus heavily on the short-run dynamics and the structural instabilities that block long-term parity restoration.

The ECM coefficient is exceptionally small (-0.0243), yielding an implied half-life of approximately 28 months. In the results section, this must be discussed as empirical proof of structural decoupling: domestic market clearing mechanisms are so heavily obstructed by sanctions and capital controls that the exchange rate remains effectively detached from traditional fundamental anchors for protracted periods.

The Variance Decomposition (FEVD) indicates that the USD/RUB exchange rate is overwhelmingly (97.5%) driven by its own innovations (autoregressive inertia), while external variables like DXY, VIX, and Brent collectively account for less than 3%. This direct empirical output flatly contradicts the authors' core argument regarding "External Financial Dominance." The discussion section must reconcile this massive discrepancy. The high self-persistence likely captures the domestic central bank's heavy capital controls, market interventions, and artificial liquidity insulation rather than unmediated external dominance.

The conclusion claims "limited domestic control" over the exchange rate. However, the period of 2022–2025 in Russia was characterized by aggressive, highly effective domestic policy interventions (mandatory export revenue conversion, capital flight blocks, and interest rate hikes to $20\%+$). The conclusion must soften its stance on complete domestic policy impotence and instead frame it as a shift from *market-based equilibrium adjustment* to *administrative/policy-driven stabilization* under external isolation. There is also an important inconsistency in the interpretation of the results, as the notion of “external financial dominance” is not new in the literature, given the long-standing evidence on external spillover mechanisms such as U.S. monetary policy transmission and global financial cycles. Instead, the analysis should focus on the interaction between external shocks and domestic factors in the countries studied. The FEVD results indicate that exchange rate dynamics are largely driven by their own innovations, while external variables explain only a very small proportion, and this needs to be reconciled with the main argument to avoid conceptual inconsistency.

In addition, the bounds test does not provide robust evidence of a long-run relationship, so maybe the analysis should place greater emphasis on short-run dynamics and structural instability rather than long-term equilibrium.

Comments on the Quality of English Language

Must improve parragraghs like: 2With the greater integration of financial markets, exchange rates in small The peri-67 odic Table economies are now determined by changes and shocks to domestic fundamen-68 tals too quickly for money supply noise to matter. It implies larger global liquidity cycles 69 and delegitimizes domestic policy effects and equilibrium-based models. Movements in 70 the exchange rate are increasingly being driven by external shocks — rather than by in-71 ternal ones (Rey, 2023; Obstfeld, 2022)."

Submission Date
05 June 2026
Date of this review
17 Jun 2026 18:31:21

KOMENTAR REVIEWER 2

Review Report Form
Quality of English Language
( ) The English could be improved to more clearly express the research.
(x) The English is fine and does not require any improvement.

	Yes	Can be improved	Must be improved	Not applicable
Does the introduction provide sufficient background and include all relevant references?	( )	(x)	( )	( )
Is the research design appropriate?	( )	(x)	( )	( )
Are the methods adequately described?	( )	(x)	( )	( )
Are the results clearly presented?	( )	(x)	( )	( )
Are the conclusions supported by the results?	( )	(x)	( )	( )
Are all figures and tables clear and well-presented?	( )	(x)	( )	( )

Comments and Suggestions for Authors

The current manuscript " External Financial Dominance under Sanctions: Financial Fragmentation and Exchange Rate Determination in Russia" is written and presented with some details regarding the research steps and results. Several elements need to be improved or clarified:

1. The bibliography is very limited, there are too few works consulted
2. The work written by Bai & Perron 2003 refers to structural changes but not especially to the exchange rate (lines 53-56)
3. At the end of page 2 there is a meaningless text: "With the greater integration of financial markets, exchange rates in small The periodic Table economies are now determined by changes and shocks to domestic fundamentals too quickly for money supply noise to matter."
4. Under the tables it would be good to detail what the notations/symbols used represent so that the reader does not have to search in the body of the work what they represent
5. The research questions are presented very schematically with a notation that is not universal. It would be better to present them at least in the form of a sentence (pages 10-11)
6. Because these are monthly data, do you think it would be a good idea to test the seasonality of the series (and possibly exclude the seasonal component)?

Submission Date
05 June 2026
Date of this review
27 Jun 2026 07:16:02

BUKTI RESPON KE REVIEWER

Authors' Responses to Reviewer's Comments (Reviewer 1)

Author's Notes

Comments 1:

The introduction lacks an explicit, well-defined statement of the research questions, core objectives, research gap, and exact theoretical contributions. Furthermore, several paragraphs exhibit poor phrasing and lack proper academic syntax. The paper does not clearly define its research gap or research question in the introduction, and its contribution remains insufficiently specified.

Response 1:

Thank you for this valuable and constructive comment. We have substantially revised the Introduction to improve its clarity, coherence, and academic quality. Specifically, we now explicitly state the research problem, clearly formulate the research questions and objectives, and identify the research gap by highlighting the limited evidence on how prolonged sanctions and financial fragmentation reshape exchange rate determination in heavily sanctioned economies. We also strengthen the theoretical contribution by explaining how this study extends the literature on exchange rate determination, the Global Financial Cycle, and financial fragmentation through an integrated ARDL–ECM–VAR framework combined with structural break analysis. In addition, the Introduction has been thoroughly edited to improve academic writing, sentence structure, and logical flow, ensuring that the motivation, novelty, and contribution of the study are presented more clearly and consistent. (Introduction, line 159 – 190).

Comments 2:

The manuscript uses theoretical frameworks tailored for "small open economies." Applying this terminology to the Russian Federation is highly inappropriate given its systemic weight in global energy markets and geopolitical scale. The authors must avoid the term "small economies" and pivot toward "large commodity-dependent emerging market economies under structural constraints.

Response 2**:**

Thank you for this insightful comment. We fully agree that describing the Russian Federation as a "small open economy" is conceptually inappropriate given its strategic role in global energy markets, its geopolitical influence, and its systemic importance in the international economy. Following the reviewer's suggestion, we have revised the manuscript by removing the terminology "small open economy" throughout the paper. Instead, we consistently describe Russia as a large commodity-dependent emerging market economy under structural constraints, reflecting its unique economic characteristics and prolonged exposure to geopolitical sanctions and financial fragmentation. We have also revised the theoretical discussion to emphasize the relevance of the Global Financial Cycle, commodity currency theory, and financial fragmentation literature, which provide a more appropriate framework for analyzing exchange rate dynamics in Russia under prolonged sanctions. These revisions strengthen the theoretical consistency of the manuscript and better align the analytical framework with the characteristics of the Russian economy. (Introduction, line 72-85).

Comments 3 :

The text incorrectly asserts that frameworks examining external financial spillovers (such as US monetary policy shocks on domestic exchange rates) are "recent" or "new." While the relative *weight* of these channels might fluctuate during crisis episodes, the literature and foundational models tracking US Federal Reserve spillovers are well-established and decades old. This historical context must be corrected.

Response 3 **:**

Thank you for this important observation. We agree that the literature on international financial spillovers, including the effects of US monetary policy and global financial conditions on domestic exchange rates, is well established and has been extensively developed over several decades. Our intention was not to suggest that these theoretical frameworks are new, but rather to emphasize their renewed relevance in the context of prolonged geopolitical sanctions and financial fragmentation. In response to the reviewer's comment, we have revised the Introduction to clarify the historical development of the literature by acknowledging its established theoretical foundations while emphasizing that the novelty of this study lies in examining whether these well-established transmission mechanisms are altered under the exceptional conditions of prolonged sanctions, geopolitical fragmentation, and structural constraints facing Russia. These revisions provide a more accurate representation of the literature and better position the contribution of our study. (Introduction, line 37 – 60).

Comments 4 :

The literature review is thin and deeply underdeveloped. Crucially, the authors have conflated the *Literature Review* (empirical background of past studies) with the *Theoretical Framework* (the economic axioms and mathematical parities being tested). These two domains must be explicitly separated into independent sub-sections. In addition, the distinction between the literature review and the theoretical framework is not clearly established, and the literature review itself appears limited and requires further development.

Response 4 :

Thank you for this valuable and constructive comment. We agree that the previous version did not clearly distinguish between the empirical literature review and the theoretical framework. In response, we have substantially reorganized Section 2 by separating it into two independent subsections. The first subsection, Literature Review synthesizes the existing literature on how exchange rate determination is affected by global financial conditions, commodity prices and geopolitical risks, as well as financial fragmentation, mapping their results against the existing evidence to highlight gaps in knowledge. The second subsection (Theoretical Framework) provides a rationale of economic theory guiding this study, including Purchasing Power Parity (PPP), Uncovered Interest Parity (UIP), Global Financial Cycle, commodity currency theory and financial fragmentation. Also, we have enhanced the Literature Review section by adding additional recent and well-known studies in order to fill the gap of empirical evidence in the current research and clearly state how this study contributes to the existing literature. We believe these revisions improve the conceptual clarity, theoretical consistency, and overall academic rigor of the manuscript. (Literature Review, line 203-216; Theoretical Framework, line317-332; Research Gap, line 290-313).

Comment 5 :

The underlying macroeconomic and financial transmission channels—specifically how capital controls, frozen reserves, and alternative payment networks alter traditional trade and monetary flows—are poorly specified and require rigorous theoretical mapping.

Response 5 :

Thank you for this insightful comment. We agree that the previous version did not sufficiently explain the macroeconomic and financial transmission mechanisms through which prolonged sanctions affect exchange rate dynamics. In response, we have substantially strengthened the theoretical framework by expanding the sections on Geopolitical Risk, Sanctions, and Financial Fragmentation and the Financial Fragmentation Framework. The revised manuscript explicitly explains how sanctions influence exchange rates through restrictions on international capital

mobility, frozen foreign exchange reserves, capital controls, disruptions to international payment systems, and the emergence of alternative payment and settlement systems. We further clarify how these mechanisms modify trade financing, capital flows, monetary policy transmission, and exchange rate adjustment under prolonged geopolitical uncertainty. In addition, we incorporated these transmission channels into the conceptual framework (Figure 2) and the theoretical transmission mechanism (Figure 3), thereby providing a more rigorous theoretical mapping of how sanctions reshape exchange rate determination in Russia. (Introduction, 72-85,148-137; Literatur Review, line 272-287, Theorytical Framework, line 390-413).

Comments 6 :

While the title and narrative heavily emphasize "geopolitical and financial fragmentation," the empirical model features no concrete variables or indices to measure this phenomenon. What the paper actually models are simply binary timeline windows (dummy variables) for sanctions and geopolitical shocks. The concept of “geopolitical fragmentation” is not properly operationalized. The analysis focuses primarily on structural breaks, while the graphical evidence is not entirely clear. Moreover, the empirical strategy relies mainly on dummy variables, which are not sufficient to capture such a broad and complex phenomenon, nor do they allow for causal identification.

Response 6 :

We thank the reviewer for this important observation. We agree that geopolitical and financial fragmentation are complex and multidimensional phenomena that cannot be fully captured by binary dummy variables alone. In the revised manuscript, we clarify that our objective is not to directly measure the degree of geopolitical fragmentation, but rather to examine whether major sanction-related geopolitical events and periods of financial disruption are associated with structural changes in exchange-rate dynamics. Accordingly, the crisis dummy variables are used as proxies for regime shifts and major geopolitical episodes, consistent with the structural-break literature, rather than as direct measures of fragmentation. We have revised the title, theoretical discussion, and interpretation of results to avoid implying that fragmentation is explicitly quantified. In addition, we now acknowledge as a limitation that the study does not employ continuous measures such as the Geopolitical Risk (GPR) Index or financial fragmentation indices and suggest their incorporation in future research. We also emphasize that the ARDL–ECM–VAR framework identifies dynamic associations and regime-dependent behavior rather than causal effects; therefore, causal language has been removed and replaced with more appropriate terminology such as “associated with,” “coincides with,” and “consistent with.” These revisions improve the alignment between the conceptual framework, empirical strategy, and interpretation of findings. (Introduction, line 177 - 190; section 3.1, line 449-454; section 4.2, line 683-694).

Comments 7 :

To justify the term "fragmentation," the model should incorporate explicit quantitative indicators, such as the *Geopolitical Risk (GPR) Index* (Caldara & Iacoviello), financial de-coupling proxies, or indicators of currency invoicing shifts.

Response 7 :

We sincerely thank the reviewer for this valuable suggestion. We agree that quantitative indicators such as the Geopolitical Risk (GPR) Index (Caldara & Iacoviello, 2022), financial decoupling measures, or indicators of currency invoicing shifts would provide a more direct operationalization of geopolitical and financial fragmentation. However, the objective of the present study is to examine exchange-rate dynamics across major sanction-related geopolitical regimes rather than to quantify the intensity of fragmentation itself. Accordingly, our empirical framework employs structural-break dummy variables to capture historically identifiable regime shifts associated with major geopolitical events. To address the reviewer's concern, we have revised the manuscript to explicitly acknowledge this methodological limitation and clarify that the dummy variables should

be interpreted as proxies for sanction-related structural changes rather than direct measures of fragmentation. We have also added a discussion in the Limitations and Future Research section highlighting that future studies could extend the analysis by incorporating continuous indicators such as the Geopolitical Risk (GPR) Index, financial decoupling proxies, or measures of currency invoicing shifts to provide a more comprehensive assessment of geopolitical fragmentation. (Introduction, line 170-190; Section 3.3. line 449-463).

Comments 8 :

A glaring omission under the current sanctions regime is Russia's rapid financial and economic pivot toward China and other non-aligned economies (e.g., BRICS expansion, Renminbi-denominated trade invoicing, and alternative clearing systems like CIPS/SPFS). Failing to account for this structural shift severely limits the model's contemporary validity.

Response 8 :

We sincerely thank the reviewer for this valuable and timely observation. We agree that Russia's increasing financial and economic integration with China and other non-aligned economies represents one of the most significant structural developments under the current sanctions regime. The growing use of Renminbi-denominated trade settlement, the expansion of BRICS economic cooperation, and the adoption of alternative payment and financial messaging systems such as CIPS and SPFS have reshaped Russia's external financial environment and may influence exchange-rate dynamics. However, the primary objective of this study is to examine how major sanction-related geopolitical episodes are associated with changes in exchange-rate determination using a structural-break framework, rather than to model all channels of post-sanctions financial adjustment. We have therefore revised the manuscript to explicitly acknowledge this limitation and discuss Russia's financial reorientation toward China and other non-aligned economies as an important structural transformation that lies beyond the scope of the current empirical model. We also identify the incorporation of variables capturing trade settlement currencies, alternative payment systems, and financial integration with BRICS economies as an important avenue for future research to improve the contemporary relevance and comprehensiveness of empirical analyses. (Introductions, line 97-106; Conclusions, line 963-975).

Comments 9 :

Figure 1 is highly ambiguous; the chosen indicators must be explicitly defined on the axes. Visually, the graphs do not show definitive long-run structural regime shifts, but rather transitory periods of high market turbulence and volatility. The text must be re-aligned to accurately reflect this graphical reality.

Response 9 :

We sincerely thank the reviewers for these helpful comments. We agree that the previous version of Figure 1 (now Figure 2) and the accompanying discussion did not sufficiently distinguish between periods of high market volatility and evidence of structural regime shifts. In response, we have revised Figure 1 (now Figure 2) by providing clearer axis labels, explicitly defining the variables presented, and revising the figure captions to improve readability and interpretation. We have also revised the accompanying text to avoid overstating the graphical evidence. Rather than interpreting the figure as direct evidence of long-term structural regime shifts, we now describe them as illustrative of episodes of high exchange rate volatility associated with major geopolitical and economic events. We further clarify that the identification of structural regime shifts is based on formal econometric analysis, including the Chow and Bai–Perron tests of structural change, rather than on visual inspection of the figure alone. These revisions ensure that the graphical presentation and empirical interpretation are fully consistent throughout the manuscript. (Figure 2, lines 148–158).

Comments 10 :

To demonstrate Russia's evolving global integration under sanctions, the authors should include an explicit Trade and Financial Openness Graph tracking the historical realignment of Russia's balance of payments, shifting away from Western G7 partners toward China and Asian markets.

Response 10 :

Thank you for this valuable suggestion. We have added Figure 1, which presents the evolution of Russia’s trade openness (exports and imports) over 2005–2025 to illustrate changes in external-sector exposure under sanctions and major geopolitical episodes. (Introduction, line 107-134).

Comments 11 :

In Section 4.2, the F-statistic (2.934) falls squarely into the inconclusive region of the Pesaran et al. (2001) critical values. The authors must state more clearly that a definitive long-run cointegrating vector cannot be statistically confirmed. The narrative needs to focus heavily on the short-run dynamics and the structural instabilities that block long-term parity restoration.

Response 11 :

Thank you for this important comment. We agree that the ARDL bounds test should be interpreted cautiously. Since the F-statistic (2.934) falls within the inconclusive region of the Pesaran et al. (2001) critical values, we have revised the manuscript to explicitly state that a stable long-run cointegrating relationship cannot be statistically confirmed**.** Accordingly, we have moderated the interpretation of the long-run results and shifted the discussion toward the statistically supported findings on short-run dynamics, the slow adjustment speed indicated by the ECM, and the structural breaks associated with sanctions and geopolitical shocks. These revisions ensure that the interpretation is fully consistent with the bounds test results and avoid overstating the existence of long-run equilibrium (Section 3.1. line 696-704, Section 4.2, line 683-694)

Comments 12 :

The ECM coefficient is exceptionally small (-0.0243), yielding an implied half-life of approximately 28 months. In the results section, this must be discussed as empirical proof of structural decoupling: domestic market clearing mechanisms are so heavily obstructed by sanctions and capital controls that the exchange rate remains effectively detached from traditional fundamental anchors for protracted periods.

Response 12 :

Thank you for this insightful comment. We agree that the very small and statistically significant ECM coefficient (-0.0243), implying an adjustment speed of approximately 2.4% per month (half-life of about 28 months), deserves stronger interpretation. In the revised manuscript, we have expanded the discussion to emphasize that this slow adjustment is consistent with structural decoupling, whereby prolonged sanctions, capital controls, and repeated geopolitical shocks weaken the effectiveness of domestic market-clearing mechanisms. Accordingly, the results section now highlights that exchange rate deviations persist for extended periods, indicating that the exchange rate remains only weakly anchored to traditional macroeconomic fundamentals rather than rapidly converging to long-run equilibrium. We have adopted this more cautious interpretation to remain consistent with the empirical evidence. (Section 4.3. line 696-704).

Comments 13 :

The Variance Decomposition (FEVD) indicates that the USD/RUB exchange rate is overwhelmingly (97.5%) driven by its own innovations (autoregressive inertia), while external variables like DXY, VIX, and Brent collectively account for less than 3%. This direct empirical output flatly contradicts the authors' core argument regarding "External Financial Dominance." The discussion section must reconcile this massive discrepancy. The high self-persistence likely captures the domestic central bank's heavy capital controls, market interventions, and artificial liquidity insulation rather than unmediated external dominance.

Response 13 :

Thank you for this insightful observation. We agree that the FEVD results require a more careful interpretation. In the revised manuscript, we clarify that the high persistence of the USD/RUB exchange rate (approximately 97.5% explained by its own innovations) does not necessarily contradict the role of external financial factors. Rather, it indicates that once external shocks are transmitted to the exchange rate, their effects become highly persistent through domestic adjustment mechanisms. Accordingly, we have revised the discussion to distinguish between shock transmission and shock persistence. While the ARDL and ECM results identify the US dollar index and oil prices as statistically significant drivers of exchange-rate movements, the FEVD suggests that the subsequent dynamics are dominated by strong autoregressive persistence. We further acknowledge that this persistence is likely reinforced by capital controls, exchange-rate interventions, and market segmentation following sanctions, which reduce the relative contribution of new external shocks to forecast error variance. The revised discussion reconciles these findings and presents a more balanced interpretation of external financial dominance within a structurally fragmented financial environment.(Section 4.5. line 754-760).

Comments 14 :

The conclusion claims "limited domestic control" over the exchange rate. However, the period of 2022–2025 in Russia was characterized by aggressive, highly effective domestic policy interventions (mandatory export revenue conversion, capital flight blocks, and interest rate hikes to $20\%+$). The conclusion must soften its stance on complete domestic policy impotence and instead frame it as a shift from *market-based equilibrium adjustment* to *administrative/policy-driven stabilization* under external isolation. There is also an important inconsistency in the interpretation of the results, as the notion of “external financial dominance” is not new in the literature, given the long-standing evidence on external spillover mechanisms such as U.S. monetary policy transmission and global financial cycles. Instead, the analysis should focus on the interaction between external shocks and domestic factors in the countries studied. The FEVD results indicate that exchange rate dynamics are largely driven by their own innovations, while external variables explain only a very small proportion, and this needs to be reconciled with the main argument to avoid conceptual inconsistency.

Response 14:

Thank you for this valuable comment. We agree that the original conclusion overstated the notion of "limited domestic control." In the revised manuscript, we clarify that exchange-rate stabilization during 2022–2025 relied increasingly on domestic policy interventions, including capital controls, exchange-rate regulations, and monetary tightening, rather than solely on market-based equilibrium adjustment.

We also revised the discussion to emphasize that our contribution is not to demonstrate the existence of external financial spillovers—which is already well established in the literature—but to examine how external shocks interact with domestic policy responses under geopolitical fragmentation. Finally, we reconciled the FEVD results with the ARDL and ECM findings by distinguishing between external shocks as initial triggers and domestic policy measures as key drivers of exchange-rate persistence, providing a more balanced and internally consistent interpretation of the empirical evidence (Section 4.3, lines 715–720; Section 4.5, lines 754-760)

Comments 15 :

In addition, the bounds test does not provide robust evidence of a long-run relationship, so maybe the analysis should place greater emphasis on short-run dynamics and structural instability rather than long-term equilibrium.

Response 15 :

Thank you for this valuable suggestion. We agree that the inconclusive ARDL bounds test does not provide sufficient statistical evidence to support a stable long-run relationship. Accordingly, we have revised the manuscript to place greater emphasis on the short-run dynamics, the slow error-correction process, and the structural instability associated with sanctions and geopolitical shocks, while moderating the interpretation of long-run equilibrium. These revisions ensure that the discussion and conclusions are fully aligned with the empirical evidence. (Section 4.2. line 683-694, Section 4.3. line 715-720, Section 4.4, 740-741).

Comments 16 :

Must improve parragraghs like: 2With the greater integration of financial markets, exchange rates in small The peri-67 odic Table economies are now determined by changes and shocks to domestic fundamen-68 tals too quickly for money supply noise to matter. It implies larger global liquidity cycles 69 and delegitimizes domestic policy effects and equilibrium-based models. Movements in 70 the exchange rate are increasingly being driven by external shocks — rather than by in-71 ternal ones (Rey, 2023; Obstfeld, 2022).

Response 16:

Thank you for your valuable comment. We agree that several paragraphs required substantial improvement in terms of clarity, readability, and academic writing style. In the revised manuscript, we have carefully rewritten the affected paragraphs to improve sentence structure, logical flow, and coherence while preserving the original meaning. For example, the paragraph in the Introduction discussing financial market integration and exchange-rate determination has been substantially revised to present the argument more clearly and consistently with the cited literature. (Introduction, line 53-59)

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External Financial Dominance under Sanctions: Financial Fragmentation and Exchange Rate Determination in Russia

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Abstract

This paper examines whether prolonged sanctions and major geopolitical episodes associated with financial fragmentation alter exchange-rate dynamics and weaken the explanatory power of domestic macroeconomic channels and strengthens external financial dominance of traditional exchange-rate transmission mechanisms. Standard exchange rate theories are based on the concepts of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP). However, the application of continuous sanctions could weaken this explanatory power and change exchange rate dynamics. The present study applies a combined framework of Autoregressive Distributed Lag (ARDL), Error Correction Modeling (ECM), Vector Autoregression (VAR) and structural break analysis to study the exchange-rate behavior in response to repeated geopolitical shocks using monthly data for Russia from 2005 to 2025. The results indicate that external variables such as the US dollar index and oil prices are important determinants of exchange rates, while inflation and interest rate differentials associated with PPP and UIP have little explanatory power. Structural break tests detect major regime shifts associated with the Global Financial Crisis, Crimea-related sanctions episode, COVID-19 pandemic and Russia–Ukraine war. The error correction process indicates that the speed of adjustment to equilibrium is slow, which means that traditional exchange-rate relationships will continue to diverge. In general, the results suggest a regime-dependent exchange rate environment in which external financial factors tend to dominate domestic adjustment mechanisms. Our study contributes to the literature on exchange rates, sanctions and financial fragmentation by providing evidence on how geopolitical shocks shift the relative importance of domestic and external determinants in a highly sanctioned economy.

Keywords: exchange rate dynamics; global financial cycle; sanctions; structural breaks; Russia

JEL Classification: F31, F51, F65, C32, E44

1. Introduction

The globalization of financial markets has dramatically changed how exchange rates are determined. Classic exchange rate theories, in particular Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP), state that domestic macroeconomic fundamentals are the main drivers of exchange rates through inflation and interest rate

differentials as proposed by Rogoff (1996) and Engel (2014). However, external monetary factors affecting trade price dynamics have long been embedded in the international finance literature. Previous studies have shown that U.S. monetary policy, global liquidity and international capital flows have large spillover effects for domestic financial markets and exchange rates in both advanced economies (AEs) and emerging economies (Bernanke, 2005; Forbes & Warnock, 2012). Building on these insights, the U.S. Global Financial Cycle framework highlights the roles played by global risk sentiment, the dominance of the U.S. dollar and international financial integration in magnifying the transmission of external financial shocks (Rey, 2016; Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020). Thus, while this study does not propose a new theory of the exchange rate determination process, it will apply these theories in an examination of interactions between extended sanctions and financial fragmentation to examine whether they alter the mechanisms through which Russia's exchange rate is determined.

With increasing financial market integration, exchange rates in small and open economies have become increasingly influenced by global financial conditions rather than solely by domestic macroeconomic fundamentals. As a result, global liquidity cycles and external financial shocks play a more prominent role in exchange-rate determination, reducing the explanatory power of traditional equilibrium-based models that rely primarily on domestic economic fundamentals. Consequently, exchange-rate movements are increasingly shaped by external rather than internal shocks (Rey, 2016; Obstfeld, 2022).

These dynamics have become most pronounced in economies subject to heightened geopolitical frictions and international restrictions. Since the 2014 Crimea crisis and the escalation of the Russia–Ukraine conflict in 2022, Russia has faced large-scale financial sanctions that have constrained capital mobility, intensified financial fragmentation, and modified transmission mechanisms underlying exchange rate determination (Caldara & Iacoviello, 2022; Ahn & Ludema, 2024). Moreover, as one of the largest exporters of energy in the world, the Russian exchange rate remains particularly reactive to external oil price fluctuations, reinforcing the argument that key economic shocks are important drivers of currency dynamics (Chen & Rogoff, 2003; Kilian, 2009). These circumstances imply a growing role of external financial and geopolitical factors in exchange rate dynamics, potentially reducing the explanatory relevance of domestic macroeconomic fundamentals.

This paper differs from conventional exchange rate studies based on small open economy assumptions. Instead, it conceptualizes Russia as a large, commodity-dependent economy whose exchange rate dynamics are shaped by structural exposure to global energy markets, geopolitical pressures, and financial restrictions. The distinctive features of Russia's exchange rate dynamics compared with those of smaller open economy derive from the structural importance of Russia in global energy markets, its scale and sustained role as a geopolitical actor and its long-standing exposure to international sanctions. Thus, exchange rate dynamics in Russia are influenced not only by domestic macroeconomic fundamentals but also by external financial conditions, commodity price developments, geopolitical shocks, and financial fragmentation. Hence, the paper employs an analytical framework that integrates Global Financial Cycle theory, commodity currency theory, and financial fragmentation perspectives to explain exchange rate determination in Russia amid persistently high geopolitical uncertainty (Chen & Rogoff, 2003; Gopinath et al., 2020; Caldara & Iacoviello, 2022; Ahn & Ludema, 2024).

Recent studies have independently examined the effects of global financial conditions, commodity prices, and geopolitical risks on exchange rates (Chen & Rogoff, 2003; Caldara & Iacoviello, 2022). Nevertheless, limited empirical evidence explains how prolonged sanctions simultaneously reshape the relative importance of external financial variables, domestic macroeconomic fundamentals, and structural regime changes within a unified analytical framework. This limitation is particularly important for highly

sanctioned commodity-exporting economies such as Russia, where geopolitical fragmentation may fundamentally alter traditional exchange rate determination mechanisms. Accordingly, a comprehensive empirical investigation is required to better understand the evolving drivers of exchange rate dynamics under prolonged sanctions and financial fragmentation.

In addition to financial sanctions, Russia has increasingly reoriented its trade and financial relations toward China and other non-aligned economies. This adjustment includes the expansion of BRICS economic cooperation, the growing use of Renminbi-denominated trade settlement, and the adoption of alternative payment and financial messaging systems such as CIPS and SPFS. These developments have partially reshaped Russia's external financial environment and may influence exchange-rate dynamics by reducing dependence on traditional Western financial infrastructures. However, these structural adjustments are beyond the scope of the present empirical model, which focuses on identifying changes in exchange-rate dynamics associated with major sanction-related geopolitical episodes.

To further illustrate Russia's changing external-sector exposure under prolonged sanctions, Figure 1 presents the evolution of trade openness, exports, and imports during 2005–2025. All series are indexed to 2005 = 100 to facilitate comparison across time. The trade openness proxy is constructed from the combined movement of exports and imports, while exports are measured on an FOB basis and imports on a CIF basis, following standard international trade-statistics conventions (World Bank, 2026; International Monetary Fund, 2026; Marini et al., 2018). This descriptive evidence complements the exchange-rate analysis by showing how Russia's external trade activity evolved across major crisis episodes, including the Global Financial Crisis, the Crimea-related sanctions period, the COVID-19 shock, and the Russia–Ukraine conflict (Becker, 2015; WTO, 2021; Caldara and Iacoviello, 2022; OECD, 2024).

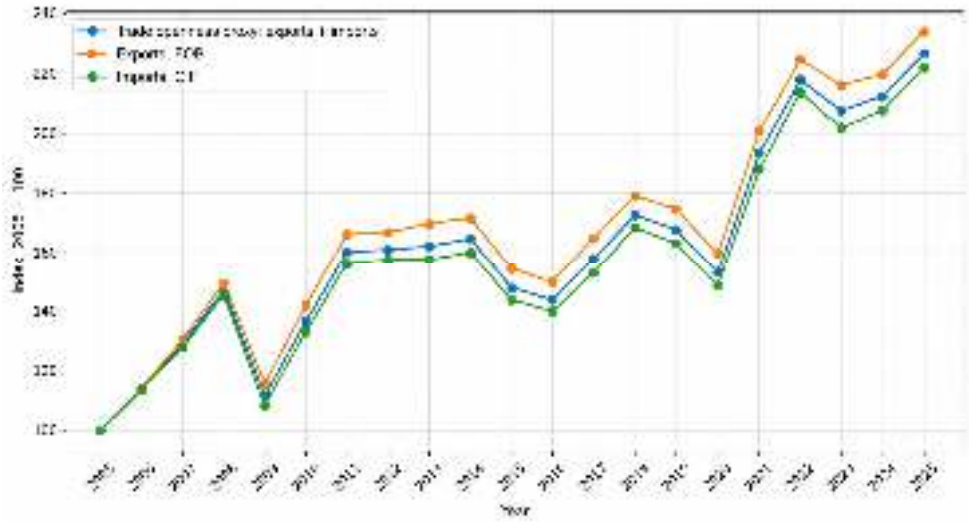

Figure 1: Evolution of Russia's Trade Openness, Exports, and Imports, 2005–2025 (Index, 2005 = 100), shows that Russia's trade openness increased substantially over the sample period, although the trajectory was interrupted by several major crisis episodes. The decline in 2009 reflects the impact of the Global Financial Crisis, while the moderation during 2015–2016 is consistent with the combined effects of Crimea-related sanctions and the oil price collapse (Becker, 2015; Ahn and Ludema, 2020). A further decline is observed in 2020 during the COVID-19 shock, which disrupted global trade flows and reduced merchandise trade activity worldwide (WTO, 2021). However, the sharp increase after 2021 suggests that Russia's external trade activity recovered strongly despite the escalation of sanctions following the Russia–Ukraine war. This pattern indicates that

sanctions did not eliminate Russia's external trade linkages but contributed to a restructuring of external economic relations (Itskhoki and Ribakova, 2024; OECD, 2024; Simola, 2025). Nevertheless, because the figure uses aggregate exports and imports, it should be interpreted as evidence of changing trade openness rather than direct evidence of partner-specific reorientation from G7 economies toward China and Asian markets (OECD, 2024; Simola, 2025).

Despite the growing literature on exchange rate dynamics, several important research gaps remain. First, previous studies have generally examined the effects of global financial conditions, commodity prices, domestic macroeconomic fundamentals, or geopolitical risks separately, providing only a partial explanation of exchange rate behavior (Chen & Rogoff, 2003; Kilian, 2009; Caldara & Iacoviello, 2022). Second, limited empirical evidence investigates whether prolonged sanctions and financial fragmentation fundamentally alter the relative importance of external and domestic determinants of exchange rates. Third, few studies integrate long-run equilibrium analysis, short-run adjustment, structural break identification, monetary channels, and shock transmission within a single econometric framework. Addressing these gaps is essential for understanding exchange rate determination in highly sanctioned economies such as Russia.

To better illustrate the conceptual relationships among the external financial environment, domestic macroeconomic fundamentals, geopolitical shocks, and the proposed empirical analyses, Figure 2 presents the conceptual framework of this study.

Figure 2 presents the evolution of the USD/RUB exchange rate and its 12-month rolling volatility over 2005–2025. Panel A shows exchange-rate movements during major economic and geopolitical events, while Panel B highlights periods of heightened market volatility. The figure provides descriptive evidence of increased market turbulence following these events but does not, by itself, establish structural regime shifts.

To address these research gaps, this study investigates eight interrelated questions. First, it examines how global financial factors influence the USD/RUB exchange rate. Second, it investigates whether domestic macroeconomic fundamentals contribute significantly to exchange rate dynamics. Third, it evaluates the role of oil prices under prolonged sanctions. Fourth, it examines whether major geopolitical events generate structural

breaks and regime shifts in exchange rate behavior. Fifth, it analyzes the speed of adjustment to-ward the long-run equilibrium following short-run disturbances. Sixth, it investigates how external financial shocks are transmitted through the exchange rate system. Seventh, it evaluates whether interest rate differentials and, eighth, inflation differentials support the predictions of Uncovered Interest Parity (UNIP) and Purchasing Power Parity (PPP) theories (Pesaran et al., 2001; Bai & Perron, 2003; Engel, 2014).

The primary objective is to determine whether prolonged sanctions and financial fragmentation shift exchange rate determination from domestic fundamentals toward external financial conditions. An integrated ARDL–ECM–VAR framework with structural break analysis is used to assess long-run relationships, short-run dynamics, regime changes, and shock transmission. Geopolitical and financial fragmentation are represented by structural-break dummy variables associated with major sanction-related events rather than continuous indicators such as the Geopolitical Risk Index.

This study contributes by extending the Global Financial Cycle perspective to a sanctioned economy and examining whether sanctions increase the dominance of external financial drivers (Gopinath et al., 2020; Miranda-Agrippino & Rey, 2020). It also reassesses the validity of PPP and UIP under geopolitical disruption (Engel, 2014) and integrates ARDL, ECM, VAR, and structural break methods within a unified framework for evaluating equilibrium, adjustment, regime shifts, and shock transmission (Pesaran et al., 2001; Bai & Perron, 2003).These contributions provide a more comprehensive understanding of exchange rate behavior in economies experiencing persistent geopolitical uncertainty and financial fragmentation. In this study, geopolitical fragmentation is not directly measured using a continuous index. Instead, the analysis focuses on major geopolitical episodes that generated structural changes in the Russian financial environment. Accordingly, crisis dummy variables are employed as proxies for regime shifts associated with sanctions and major geopolitical events rather than as direct measures of geopolitical fragmentation

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and develops the theoretical framework underpinning the study. Section 3 describes the data, variables, and research methodology, including the ARDL, ECM, VAR, and structural break models employed in the empirical analysis. Section 4 presents and discusses the empirical findings, covering long-run and short-run dynamics, structural breaks, shock transmission, and robustness tests. Section 5 discussing theoretical and policy implications, Section 6 concludes the study by summarizing the main findings, Section 7 Implications and Future Researc.

2. Literature Review and Theoretical Framework

2.1 Literature Review

2.1.1 Exchange Rate Determination

Exchange rate determination is a central issue in international finance because it reflects the interaction between domestic macroeconomic fundamentals and external financial conditions. Traditional theories, including Purchasing Power Parity (PPP), Uncovered Interest Parity (UIP), monetary models, and portfolio balance models, emphasize inflation, interest rates, money supply, output, and balance-of-payments conditions as the main drivers of long-run exchange rate adjustment (Rogoff, 1996; Engel, 2014). However, empirical studies show that domestic variables alone often fail to explain exchange rate movements, particularly in financially open emerging markets. Traditional structural models frequently perform no better than random-walk forecasts, suggesting that exchange rates are also shaped by capital flows, investor expectations, and external financial shocks (Meese & Rogoff, 1983; Obstfeld & Rogoff, 1995; Engel et al., 2007). More recent research highlights the growing influence of global liquidity, investor risk appetite,

international capital mobility, and US dollar fluctuations (Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020).

For commodity-exporting economies, exchange rates respond simultaneously to domestic monetary policy, commodity prices, capital flows, and geopolitical developments. Therefore, an integrated framework that captures both domestic and external transmission mechanisms is required. Although exchange rate research has expanded beyond conventional macroeconomic models to incorporate financial globalization and external spillovers, no consensus exists regarding the relative importance of these factors, particularly in large commodity-dependent emerging economies under prolonged geopolitical sanctions. This unresolved issue motivates the present study.

2.1.2 Oil Prices and Exchange Rates

Oil prices are a major external determinant of exchange rates in commodity-exporting economies because they affect export revenues, fiscal balances, foreign exchange reserves, and market expectations. The currencies of resource-rich countries tend to respond systematically to global commodity prices, supporting the concept of commodity currencies (Chen & Rogoff, 2003).

The effect of oil prices, however, depends on the source of the shock. Global demand, supply disruptions, and precautionary demand may produce different exchange-rate responses (Kilian, 2009). In general, positive oil price shocks tend to appreciate the currencies of oil-exporting countries while weakening those of oil importers through changes in trade revenues, terms of trade, investor confidence, and capital flows (Basher et al., 2016; Beckmann et al., 2020).

This relationship is particularly important for Russia because of its heavy dependence on crude oil and natural gas exports. Brent oil prices influence Russian export earnings, fiscal revenues, external balances, and, consequently, the ruble. However, sanctions imposed since 2014 and expanded substantially in 2022 may have altered this transmission through trade restrictions, export-market reorientation, capital controls, and financial fragmentation (Ahn & Ludema, 2024). Because most previous studies focus on normal market conditions, further research is needed to determine whether prolonged geopolitical sanctions change the ruble's sensitivity to oil prices and the interaction between commodity markets and external financial conditions.

2.1.3 Global Financial Cycle

External financial conditions significantly influence exchange rates through US monetary policy, global liquidity, capital flows, and investor expectations (Bernanke, 2005; Forbes & Warnock, 2012). In financially integrated economies, these shocks may constrain domestic monetary policy autonomy because they are rapidly transmitted across borders.

The Global Financial Cycle framework explains how US monetary policy and global risk sentiment jointly affect capital flows, asset prices, credit, and exchange rates, even under floating exchange rate regimes (Rey, 2016). Subsequent studies link this cycle to the US dollar and global risk appetite, while emphasizing the dollar's dominant role in transmitting financial shocks through trade and financial channels (Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020).

In emerging markets, external variables such as the US Dollar Index, global volatility, and international portfolio shifts may exert greater influence than domestic fundamentals during periods of uncertainty (Obstfeld, 2022; Aizenman et al., 2023). However, limited research has examined whether sanctions and financial fragmentation weaken or transform these transmission mechanisms. It therefore remains unclear whether external

financial conditions continue to dominate exchange rate determination when international financial integration is disrupted.

2.1.4 Geopolitical Risk, Sanctions, and Financial Fragmentation

Geopolitical risk disrupts trade, capital flows, financial transactions, and investor confidence, increasing exchange-rate volatility (Caldara & Iacoviello, 2022). Sanctions intensify these effects by restricting international capital, investment, financial intermediation, and payment systems (Crozet & Hinz, 2020; Ahn & Ludema, 2024).

For Russia, sanctions imposed since 2014 and expanded in 2022 have targeted financial institutions, reserves, payment systems, and energy exports. Consequently, ruble movements have become increasingly sensitive to geopolitical developments and global financial conditions despite domestic interventions (Ahn & Ludema, 2024).

Financial fragmentation further weakens market integration, capital allocation, and international risk sharing while altering the transmission of global shocks (IMF, 2023). However, few studies jointly examine geopolitical risk, sanctions, commodity dependence, and fragmentation in explaining long- and short-run exchange-rate dynamics. This gap motivates the present study.

2.1.5 Research Gap

Previous studies have identified domestic macroeconomic fundamentals, commodity prices, global financial conditions, and geopolitical factors as important determinants of exchange rates (Chen & Rogoff, 2003; Kilian, 2009; Caldara & Iacoviello, 2022). However, several research gaps remain.

First, these factors are generally examined separately, providing limited evidence on their simultaneous interaction, particularly during prolonged geopolitical disruptions. Second, although the Global Financial Cycle literature emphasizes external financial conditions, few studies assess whether sanctions and financial fragmentation alter the relative influence of domestic and external determinants. This issue is especially relevant for Russia because its exchange rate is shaped by commodity dependence, global financial shocks, and geopolitical constraints.

Third, previous research often uses separate econometric methods to examine long-run relationships, short-run adjustments, structural breaks, or shock transmission. Few studies integrate these dimensions within a unified framework. Moreover, the validity of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP) under prolonged sanctions and financial fragmentation remains insufficiently examined.

This study addresses these gaps by combining domestic fundamentals, external financial conditions, commodity prices, geopolitical shocks, and financial fragmentation within an ARDL–ECM–VAR framework with structural break analysis. This approach provides a comprehensive assessment of exchange rate determination in a commodity-dependent emerging economy facing prolonged geopolitical and financial constraints.

2.2 Theoretical Framework

2.2.1 Purchasing Power Parity (PPP)

Purchasing Power Parity (PPP) is one of the fundamental theories of exchange rate determination, proposing that exchange rates adjust to equalize the purchasing power of different currencies over time. According to the relative PPP hypothesis, changes in exchange rates are primarily driven by inflation differentials between countries. When

domestic inflation exceeds foreign inflation, the domestic currency is expected to depreciate to restore international price competitiveness (Rogoff, 1996; Engel, 2014).

The relative Purchasing Power Parity (PPP) condition states that the percentage change in the nominal exchange rate is determined by the inflation differential between the domestic and foreign economies. The relationship is expressed as follows:

ΔS_t= π_t- π_t^*

where:

ΔS_t= percentage change in the nominal USD/RUB exchange rate;

π_t= inflation rate in Russia;

π_t^*= inflation rate in the United States.

Although PPP provides a useful long-run benchmark, empirical studies frequently report deviations from parity because exchange rates are also affected by capital mobility, market frictions, government intervention, and external financial shocks. These deviations are expected to become even more pronounced under prolonged geopolitical sanctions and financial fragmentation. Accordingly, this study re-examines the validity of PPP for the Russian ruble under changing geopolitical and financial conditions, corresponding to Research Question 8 (RQ8).

2.2.2 Uncovered Interest Parity (UIP)

Uncovered Interest Parity (UIP) explains exchange rate movements through differences in nominal interest rates across countries. The theory states that currencies offering relatively higher interest rates are expected to depreciate sufficiently to offset the return advantage, thereby eliminating arbitrage opportunities in international financial markets (Fama, 1984; Engel, 2014) Formally, the UIP condition can be expressed as follows:

$$\boldsymbol{E_t}\left(\frac{\boldsymbol{S_{t+1}}-\boldsymbol{S_t}}{\boldsymbol{S_t}}\right) = \boldsymbol{i_t} - \boldsymbol{i_t^*}.$$

where

S_t= spot exchange rate (RUB per USD) at time t;

$E_t(S_{t+1})$= expected future exchange rate;

i_t= domestic nominal interest rate (Russia);

$\boldsymbol{i_t^*}$= foreign nominal interest rate (United States).

Despite its theoretical importance, UIP is frequently violated, a phenomenon known as the forward premium puzzle. Exchange rate expectations are shaped not only by interest rate differentials but also by risk premiums, capital controls, geopolitical uncertainty, and global financial conditions. These factors are especially relevant for Russia, where sanctions may weaken conventional monetary transmission. Therefore, this study examines whether interest rate differentials continue to explain exchange rate dynamics under prolonged sanctions, corresponding to RQ7.

2.2.3 Commodity Currency Theory

Commodity Currency Theory states that exchange rates in resource-dependent economies are influenced by international commodity prices through export revenues, fiscal balances, and foreign exchange earnings (Chen & Rogoff, 2003). Higher commodity prices generally improve external balances and support currency appreciation, while lower prices have the opposite effect.

This theory is particularly relevant to Russia because of its dependence on oil and natural gas exports. Brent oil prices are expected to affect the USD/RUB exchange rate through export income, government revenue, and foreign exchange inflows. However, sanctions may alter these channels by restricting trade, export destinations, and financial transactions. Accordingly, the role of oil prices under geopolitical constraints is examined in RQ3.

2.2.4 Global Financial Cycle Theory

The Global Financial Cycle theory emphasizes the role of global liquidity, capital flows, investor risk sentiment, and the US dollar in shaping financial markets and exchange rates (Rey, 2016). External shocks, particularly those associated with US monetary policy, influence portfolio allocation, capital flows, and currency valuations in financially integrated economies (Miranda-Agrippino & Rey, 2020). The Dominant Currency Paradigm further argues that the US dollar's central role in global trade and finance amplifies the transmission of external shocks across exchange rate regimes (Gopinath et al., 2020).

For Russia, these effects operate through commodity exports, capital mobility, and external financing. However, sanctions may reduce financial integration and alter capital flow patterns. The Global Financial Cycle therefore provides the theoretical basis for examining whether external financial variables dominate exchange rate determination under geopolitical uncertainty, corresponding to RQ1, RQ2, and RQ6.

2.2.5 Financial Fragmentation Framework

Financial fragmentation refers to the segmentation of global financial markets caused by geopolitical conflicts, sanctions, trade restrictions, and declining cross-border integration. It weakens financial linkages, reduces market integration, and alters the transmission of global shocks, causing exchange rates to reflect geopolitical constraints more strongly (International Monetary Fund [IMF], 2023).

Sanctions affect exchange rates by restricting capital flows, financial transactions, payment systems, and foreign reserve management. These restrictions reduce external financing and increase volatility, potentially weakening the relationships predicted by PPP, UIP, and conventional international finance models (Ahn & Ludema, 2024).

Russia provides a relevant case because sanctions imposed since 2014 and expanded in 2022 have changed the interaction among domestic fundamentals, commodity markets, and external financial conditions. This framework explains structural changes in the USD/RUB exchange rate, supports RQ4 and RQ5, and complements the Global Financial Cycle perspective. Figure 3 illustrates these transmission mechanisms.

Figure 3.

Figure 3 shows how geopolitical sanctions affect exchange rates through financial restrictions, including capital controls, frozen reserves, and payment disruptions. These measures intensify financial fragmentation, alter capital flows, trade financing, and monetary transmission, and increase the influence of external financial conditions on the USD/RUB exchange rate. This framework underpins the ARDL, ECM, VAR, and structural break analyses.

3. Methods and Data Description.

This case study began with monthly time-series data for 2005–2025 and examines the factors behind the fluctuation of the exchange rate between US dollars (USD) and Russian rubles (RUB). Frequency is a key metric in applied time-series econometrics. This analysis examines only short-term fluctuations, but medium-term dynamics as well, for which monthly frequency is desirable.

The data include global financial indicators, commodity prices, domestic macroeconomic data, and real sector indicators. Most variables were defined using natural logarithms for consistency and interpretability, as this allows for the interpretation of the estimated coefficients as elasticities, and because natural logarithms stabilize variance.

The data revealed the presence of structural breaks associated with major political and economic events, indicating the necessity of including two dummy variables that could account for potential regime changes into the model specification.

The definitions of the variables and sources of the data are given in Tables 1 and 2.

Table 1. Definition of Variables and Data Sources.

Variable	Symbol	Measurement	Expected Effect	Theoretical Basis	Source
Exchange Rate	lnEXR	RUB per USD (log)	—	—	Federal Reserve Economic Data (FRED)
US Dollar Index	lnDXY	Index (log)	(+)	Global Financial Cycle	Federal Reserve / Trading Economics
Global Risk	VIX	Volatility Index	(+)	Risk Aversion	Chicago Board Options Exchange (CBOE)
Oil Price	lnOIL	USD/barrel (log)	(–)	Commodity Currency	U.S. Energy Information Administration (EIA)
Interest Rate Differential	IRD	Russia – US (%)	(–)	Interest Rate Parity	Central Bank of Russia; Federal Reserve
Inflation Differential	INFDIFF	Russia – US (%)	(+)	Purchasing Power Parity	Rosstat; U.S. Bureau of Labor Statistics
Inflation (Russia)	INFRUS	CPI (%)	(+)	Monetary / Price Dynamics	Rosstat
Inflation (United States)	INFUSA	CPI (%)	(–)	External Price Effect	U.S. Bureau of Labor Statistics
Policy Interest Rate (Russia)	KEYRATE	%	(–)	Monetary Policy Transmission	Central Bank of Russia
Federal Funds Rate	FF	%	(+)	Global Liquidity / Monetary Spillover	Federal Reserve
Industrial Production	lnIPI	Index (log)	(–)	Real Sector Effect	Rosstat / FRED
Money Supply	lnM3	RUB billion (log)	(+)	Monetary Model	Central Bank of Russia

Foreign Reserves	lnRES	USD billion (log)	(–)	Reserve Buffer Theory	Central Bank of Russia
Exports	lnEXP	USD billion (log)	(–)	Trade Balance	Trading Economics / official statistics
Imports	lnIMP	USD billion (log)	(+)	Trade Balance	Trading Economics / official statistics

Source: Author's compilation based on data from federal reserve economic data (FRED), U.S. Energy Information Administration (EIA), Chicago Board Options Exchange (CBOE), Central Bank of Russia, Rosstat, U.S. Bureau of Labor Statistics, and Trading Economics.

Table 2. Structural Break Dummies and Theoretical Basis.

Dummy	Period	Description	Theoretical Basis	Source
GFC	2008–2009	Global Financial Crisis	Crisis Transmission (Bernanke, 2005)	International Monetary Fund (IMF)
CRIMEA	2014–2015	Crimea crisis & oil price collapse	Geopolitical Risk (Caldara & Iacoviello, 2018)	World Bank
COVID	2020–2021	Global pandemic shock	Global Uncertainty (Baker et al., 2020)	World Health Organization (WHO)
WAR	2022–present	Russia–Ukraine conflict & sanctions	Sanctions & External Shock (Klose, 2024)	World Bank

Source: Author's compilation based on IMF, World Bank, World Health Organization, and related literature.

The motivation for including oil prices is based on the commodity currency hypothesis, according to which in resource-exporting economies there is a negative response of commodity prices and exchange rates (Chen & Rogoff, 2003). Moreover, following standard parity conditions (namely uncovered interest parity and purchasing power parity), other variables such as interest rate differentials (IRD) and inflation differentials (INFDIFF) are included.

Real sector activity and monetary conditions are represented by including domestic variables such as lnIPI (industrial production), lnM3 (money supply), and lnRES (foreign reserves). Such growth within the model adds to its ability to describe internal macroeconomic dynamics, which is an important feature in the context of emerging markets.

3.1. Structural Break Variables

Dummy variables associated with major geopolitical events are incorporated as proxies for structural regime shifts rather than as direct measures of geopolitical fragmentation. Their purpose is to identify changes in exchange-rate behavior across sanction-related periods and major geopolitical episodes. Consequently, the empirical analysis focuses on regime-dependent exchange-rate dynamics instead of quantifying the intensity of geopolitical fragmentation itself. (Table 3).

Table 3. Theoretical Basis for the Structural Break Dummies.

Dummy	Period	Description	Source
GFC	2008–2009	Global financial crisis	IMF
CRIMEA	2014–2015	Geopolitical shock	World Bank
COVID	2020–2021	Pandemic shock	WHO
WAR	2022–present	Conflict and sanctions	World Bank

Source: Author's compilation.

These dummy variables allow us to control for specific uncertainty spikes and structural breaks as they occur during the global financial crisis (2008–2009), the Crimea crisis (2014–2015), the COVID-19 pandemic (2020–2021), and the Russia–Ukraine conflict (2022–present).

In applied econometrics, accounting for structural breaks at the correct time in the time series can be critical; otherwise, regime shifts can result in biased estimates of the parameters (Perron, 1989).

3.2. Descriptive Statistics: Preliminary Data Analysis

Table 4 shows descriptive statistics and a summary of the central tendency, dispersion, and distributional shape of the variables.

Table 4. *Descriptive Statistics.*

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
lnEXR	3.844	0.463	3.151	4.702	0.017	1.392
IRD	13.073	2.697	4.696	17.587	-0.906	3.340
INFDIFF	3.755	4.239	-6.618	25.622	0.678	5.122
lnDXY	4.653	0.116	4.458	4.860	-0.017	1.522
VIX	19.128	8.348	10.130	64.460	2.515	11.806
lnOIL	4.274	0.330	2.911	4.888	-0.462	3.363
KEYRATE	14.767	1.819	10.026	19.441	-0.223	2.514
FF	1.694	1.911	0.050	5.330	0.867	2.201
INFRUS	6.351	3.805	-0.624	28.675	1.403	7.207
INFUSA	2.596	1.885	-1.959	8.979	1.032	4.878
lnIPI	4.615	0.119	4.358	4.812	-0.273	2.125
lnM3	10.624	0.598	8.407	11.392	-0.907	3.260
lnRES	5.700	0.514	4.207	6.434	-0.767	2.855
lnEXP	5.743	0.342	4.934	6.270	-0.473	2.227
lnIMP	5.339	0.352	4.494	5.882	-0.497	2.229

Source: Author's calculation.

The findings suggest that most of the variables are moderately variable, contrary to some financial indicators, such as VIX, which have high volatility and non-normal distribution, as shown from the skewness and kurtosis measures.

Correlation analyses for the core variables (Table 5) and extended variables (Table 6) provide insight into the relationships across the selected variables.

Table 5. Correlation Matrix (Core Variables).

Variable	lnEXR	lnDXY	lnOIL	IRD	INFDIFF	KEYRATE	lnIPI
lnEXR	1.000	0.939	-0.304	-0.536	-0.586	-0.765	0.816
lnDXY	0.939	1.000	-0.410	-0.587	-0.532	-0.706	0.708
lnOIL	-0.304	-0.410	1.000	0.039	-0.164	0.014	0.185
IRD	-0.536	-0.587	0.039	1.000	0.332	0.706	-0.528
INFDIFF	-0.586	-0.532	-0.164	0.332	1.000	0.572	-0.656
KEYRATE	-0.765	-0.706	0.014	0.706	0.572	1.000	-0.773
lnIPI	0.816	0.708	0.185	-0.528	-0.656	-0.773	1.000

Source: Author's calculation.

Table 6. Correlation Matrix (Extended Variables).

Variable	VIX	FF	INFRUS	INFUSA	lnM3	lnRES	lnEXP	lnIMP

VIX	1.000	0.060	-0.007	-0.013	0.004	-0.012	-0.046	-0.038
FF	0.060	1.000	0.129	0.090	-0.102	-0.090	-0.051	-0.092
INFRUS	-0.007	0.129	1.000	0.004	-0.664	-0.637	-0.665	-0.649
INFUSA	-0.013	0.090	0.004	1.000	0.101	0.126	0.158	0.173
lnM3	0.004	-0.102	-0.664	0.101	1.000	0.970	0.971	0.948
lnRES	-0.012	-0.090	-0.637	0.126	0.970	1.000	0.954	0.933
lnEXP	-0.046	-0.051	-0.665	0.158	0.971	0.954	1.000	0.946
lnIMP	-0.038	-0.092	-0.649	0.173	0.948	0.933	0.946	1.000

Source: Author's calculation.

The exchange rate generally has a positive correlation with the US dollar index, which reflects that global financial factors affect the exchange rate. However, there is a statistically significant negative correlation between oil price and exchange rate, giving early evidence for the commodity currency hypothesis.

The high correlations between the fractions of reserves in monetary aggregates and trade show some potential for multicollinearity. Specification design and robustness checks, addressed in step three of the econometric modeling stage, alleviate this issue.

3.3. Unit Root and Integration Properties

Before estimation of the models of these variables, unit root tests are typically examined, as shown in Table 7.

Table 7. Unit Root Test Results.

Variable	Level ADF	Prob.	Stationary (Level)	1st Diff ADF	Prob.	Stationary (1st Diff)	Integration	Remarks
lnEXR	-1.144	0.6986	No	-12.073	0.0000	Yes	I(1)	Non-stationary, becomes stationary after differencing
lnDXY	-1.234	0.6602	No	-10.394	0.0000	Yes	I(1)	Requires differencing
VIX	-5.107	0.0000	Yes	-14.125	0.0000	Yes	I(0)	Stationary at level
lnOIL	-3.620	0.0060	Yes	-10.967	0.0000	Yes	I(0)	Stationary at level
IRD	-0.996	0.7552	No	-11.834	0.0000	Yes	I(1)	Integrated of order one
INFDIFF	-1.720	0.4199	No	-6.381	0.0000	Yes	I(1)	Becomes stationary after differencing
KEYRATE	-0.832	0.8077	No	-10.598	0.0000	Yes	I(1)	Strong unit root at level
FF	-2.569	0.1008	No*	-6.818	0.0000	Yes	I(1)	Weak at level, treated as non-stationary
INFRUS	-2.273	0.1817	No	-7.056	0.0000	Yes	I(1)	Non-stationary, stationary after differencing
INFUSA	-2.740	0.0688	Weak	-4.114	0.0011	Yes	I(1)	Marginal at level, treated as I(1)
lnM3	-7.229	0.0000	Yes	-12.568	0.0000	Yes	I(0)	Strongly stationary
lnRES	-3.237	0.0191	Yes	-10.956	0.0000	Yes	I(0)	Stationary at level
lnEXP	-3.536	0.0079	Yes	-13.475	0.0000	Yes	I(0)	No differencing required
lnIMP	-0.978	0.7615	No	-15.304	0.0000	Yes	I(1)	Clearly non-stationary

Source: Author's calculation through using ADF tests.

Output results demonstrate the presence of some combination of I(0) and I(1) variables. Some global and macroeconomic variables are stationary at levels, but most variables in the domestic economy only become stationary after first differencing.

Given the combination of integrations, where the variables are I(0) and I(1), we justify applying the autoregressive distributed lag (ARDL) framework since it permits both I(0) and I(1) variables (Pesaran et al., 2001). And more importantly, none of the variables is I(2), which is a critical assumption of ARDL being applicable.

3.4. Graphical Analysis

3.4.1. Dynamics of Exchange Rate and Crisis Episodes

Regime shifts in the USD/RUB exchange rate 2005–2025 readily show up when connected with clearly observable global and geopolitical events (Figure 2). Before 2008, we had some stability, whereas in the period of the global financial crisis, there was much more volatility. A larger depreciation took place during 2014–2015 in response to plunging oil prices and external sanctions.

Then the COVID-19 shock in 2020 created further instability, but it was milder. The strongest rupture came in 2022 when geopolitical conflict launched the prices into extreme volatility, with sanctions and monetary restrictions working together. In general, the ruble has high sensitivity to external shocks, which is a corollary of global financial cycle theory.

Figure 4. Regime Shifts in the USD/RUB Exchange Rate 2005–2025. Source: Author's calculation. Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.2. Oil Prices and the Commodity Currency Hypothesis

Log–log co-movements between the log of the USD/RUB and the log of the price of oil (in USD per barrel) on the USD/RUB picture (log–log scale) are shown in Figure 5. The ruble is strong when oil prices are up, and weak when oil prices are down. This fits the commodity currency regime explanation, where for export-oriented economies such as CAD ones, the currency is highly reactive to commodity prices.

This relationship holds in basic form until 2022, when the relationship weakens, hinting at structural disruption. In this respect, measures such as capital controls and sanctions may have shifted the traditional transmission mechanism. This changing behavior highlights the necessity of including structural break dummies in empirical analyses.

Figure 5. USD/RUB and Brent Oil prices (Log Scale). Source: Exchange rate data from; oil price data from EIA / World Bank. Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.3. Real Sector Activity and Monetary Policy Response

Figure 6 shows the responses to an interaction of output and monetary policy. The Industrial Production Index rises over time with busts during crises. Output fell very sharply in response to the GFC and COVID-19 shocks.

Monetary policy reacted by changing the main policy rate. The most significant deterioration took place in 2022, in order to stabilize the exchange rate and keep inflation down. This corresponds to common monetary policy responses in emerging markets.

Figure 6. Industrial Production Index (IPI) and Key Policy Rate (2005–2025). Source: Author's calculation. Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.4. Econometric Implications

Table 5 presents preliminary evidence of the presence of a combination of stationary and non-stationary variables. This allows for the consideration of the ARDL framework, one that allows for variables that are integrated in different orders (Pesaran et al., 2001).

The correlation structure shows that global, domestic, and real sector variables are likely to be highly interdependent with one another. Although potential multicollinearity exists, it is addressed through robustness checks and careful model specification. Hence, it is crucial to have the structural break dummies that capture regime shifts to avoid biased estimates.

Synthesis of Findings

The graphical and statistical evidence consistently show that:

(i) RUB volatility is highly sensitive to external shocks;

(ii) oil prices negatively correlate with the exchange rate;

(iii) this relationship is regime-dependent;

(iv) monetary policy stabilizes the economy during crises, as expected;

Such findings are in line with theoretical expectations as well as evidence on commodity-dependent countries.

3.4.5. Econometric Strategy

Empirical Framework

An autoregressive distributed lag–error correction modeling–vector autoregression (ARDL–ECM–VAR) structural break approach, as the combined time-series framework is employed to conduct a comparative analysis of the USD/RUB dynamics. This strategy seeks to include long-run relationships, short-run adjustments, and regime shifts, reflecting the time-varying nature of shock transmission.

The dependent variable is:

$$lnEXR_t = \ln (USD/RUB)_t$$

where $lnEXR_t$ represents the logarithm of the USD/RUB exchange rate at time t.

Baseline External and Commodity ARDL as Determinants

We show our baseline model that evaluates global financial conditions and commodity prices:

$$lnEXR_t = \alpha_o + \alpha_1 lnDXY_t + \alpha_2 VIX_t + \alpha_3 lnBRENT_t + \varepsilon_t$$

This specification supports the baseline empirical results described below in Chapter 5 and addresses the role of external drivers.

Related RQ: RQ1 and RQ3. Expected signs are:

$\alpha_1>0$, $\alpha_2>0$, $\alpha_3<0$

Domestic Fundamentals Model

To evaluate domestic macroeconomic fundamentals, the following model is estimated:

$$lnEXR_t = \beta_o + \beta_1 KEYRATE_t + \beta_2 INFRUSIA_t + \beta_3 lnM3_t + \beta_4 lnRES_t + \beta_5 lnEXP_t + \beta_6 lnIMP_t + +\beta_7 lnIPI_t + \varepsilon_t$$

The inclusion of $lnIPI$ captures real sector activity and strengthens the domestic macroeconomic block.

Related RQ: RQ2. Expected signs:

$\beta_1<0$, $\beta_2>0$, $\beta_3>0$, $\beta_4<0$, $\beta_5<0$, $\beta_6>0$, $\beta_7<0$

Oil Price Model With Crisis Dummies

Given the importance of oil prices and geopolitical shocks, the oil-channel model includes external controls and structural dummy variables:

$$lnEXR_t = \delta_o + \delta_1 BRENT_t + \delta_2 lnDXY_t + \delta_3 lnVIX_t + \delta_4 DCRIMEA_t + \delta_5 DWAR_t + \varepsilon_t$$

This specification is consistent with the empirical results where oil prices are analyzed jointly with global financial variables and crisis effects.

Related RQ: RQ3. Expected signs:

$\delta_1<0$, $\delta_2>0$, $\delta_3>0$, $\delta_4>0$, $\delta_5>0$

Structural Break Model

To examine regime shifts, crisis dummy variables are incorporated into the ARDL framework:

$$lnEXR_t = \theta_o + \theta_1 lnDXY_t + \theta_2 VIX_t + \theta_3 lnBRENT_t + \theta_4 lnIPI_t + \gamma_1 DGFC_t + \gamma_2 DCRIMEA_t + \gamma_3 DCOVIDS_t + \gamma_4 DWAR_t + \varepsilon_t$$

The structural dummies capture major crisis periods, while $lnIPI_t$ controls for domestic real sector conditions.

Related RQ: RQ4. Bivariate autoregressive distributed lag model with dummies.

ARDL–ECM Representation

ECM representation estimates the short-run and adjustment dynamics:

$$\Delta \ln EXR_t = \phi_0 + \sum_{i=1}^{p} \phi_i \Delta \ln EXR_{t-i} + \sum_{j=0}^{q} \lambda_j \Delta X_{t-j} + \rho ECM_{t-1} + \varepsilon_t$$

$$\Delta lnEXR_t = \phi_o + \sum_{i=1}^{p} \phi_i \, \Delta lnEXR_{t-1} + \sum_{i=1}^{p} \lambda_j \, \Delta X_{t-j} + \rho ECM_{t-1} + \varepsilon_t$$

where X_t represents the relevant explanatory variables in each ARDL specification.

The error correction term is defined as:

$$ECM_{t-1} = \ln EXR_{t-1} - \hat{\beta} X_{t-1}$$

A negative and statistically significant ϱ\rhoϱ indicates adjustment toward equilibrium.

Related RQ: RQ5.

VAR Model for Shock Transmission

To examine dynamic interactions and shock transmission, the VAR model is specified as:

$$Y_t = A_o + \sum_{i=1}^{p} A_i \, Y_{t-i} + \varepsilon_t$$

where:

$$Y_t = \begin{bmatrix} lnEXR_t \\ lnBRENT_t \\ lnDXY_t \\ VIX_t \end{bmatrix}$$

Impulse response functions and forecast error variance decomposition are used to evaluate shock propagation.

Related RQ: RQ6. Tools: VAR, IRF, FEVD, Granger causality.

Monetary and Inflation Channels

The monetary channel is estimated as:

$$lnEXR_t = \omega_o + \omega_1 IRD_t + \omega_2 lnDXY_t + \omega_3 lnBRENT_t + \omega_4 VIX_t + \varepsilon_t$$

Interpretation:

- IRD_t: interest rate differential (e.g., Russia vs. US)
- ω_1: captures the monetary policy / capital flow channel

Expected sign:

- ω_1<0: higher domestic interest rates → capital inflows → ruble appreciates

The inflation channel is specified as:

$$lnEXR_t = \pi_o + \pi_1 INFDIFF_t + \pi_2 lnDXY_t + \pi_3 lnBRENT_t + \pi_4 VIX_t + \varepsilon_t$$

Interpretation:

- $INFDIFF_t$: inflation differential (Russia − foreign, typically US)
- π_1: captures the purchasing power parity (PPP) mechanism

Expected sign:

- π_1>0: higher domestic inflation → loss of purchasing power → ruble depreciates

Related RQ: RQ7 and RQ8

Integrated Mapping Framework

Table 8. Integrated Mapping of Research Questions, Equations, and Empirical Tools.

RQ	Equation	Empirical focus	Model and tools
RQ1	Eq. (1)	Global financial effects	ARDL, Bounds Test
RQ2	Eq. (2)	Domestic fundamentals including lnIPI	ARDL
RQ3	Eq. (3)	Oil price effect with crisis controls	ARDL, Dummy variables
RQ4	Eq. (4)	Structural breaks and regime shifts	ARDL with dummies, Chow, Bai–Perron
RQ5	Eq. (5)	Short-run adjustment and ECM	ARDL–ECM
RQ6	Eq. (6)	Shock transmission	VAR, IRF, FEVD, Granger
RQ7	Eq. (7)	Interest rate differential	ARDL
RQ8	Eq. (8)	Inflation differential	ARDL

Source: Author's formulation.

Estimation Procedure

The empirical analysis includes five steps and four stages. To examine the order of integration, the first step was to run the ADF and Phillips–Perron tests. In the second step, the ARDL models are run for the baseline, domestic, oil, structural, monetary, and inflation specifications. Third, bounds tests were performed to check for possible long-run relationships. Fourth, ECM representations are used to estimate short-run adjustment. Fifth, IRF, FEVD, and Granger causality analysis of VAR are used to study shock transmission.

Finally, the robustness of the models is evaluated through diagnostic and stability tests that include serial correlation, heteroskedasticity, normality, CUSUM, and CUSUMSQ tests.

4. Empirical Results

4.1. Baseline ARDL Model

This chapter generalizes the baseline ARDL model on the influence of financial conditions and commodity prices on USD/RUB.

The estimation results suggest that the oil price as well as the US dollar index are statistically significant explanatory variables for the exchange rate movements. In particular, the price of oil has a negative and highly significant coefficient; higher oil prices lead to an appreciation of the home currency. On the other hand, the US dollar index has a positive and significant influence, meaning global foreign financial conditions push the exchange rate up.

As indicated by the results in Table 9, market volatility (VIX) has a statistically insignificant impact on the baseline specification. The dependent variable is ln(USD/RUB). The model is ARDL(4,2,3,2). The estimator is HAC (Newey–West robust standard errors).

Table 9. Baseline ARDL Model: Global Financial and Commodity Drivers of USD/RUB Exchange Rate.

Variable	Coefficient	Std. Error	t-Statistic	p-value
Long-run effects				
ln(BRENT)	-0.1017	0.0244	-4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	-0.5143	0.3081	-1.669	0.0965
Short-run dynamics				
Δln(BRENT)	-0.1017	0.0244	-4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(-1)	-0.0020	0.0005	-3.926	0.0001
ΔVIX(-2)	0.0021	0.0004	4.675	0.0000
Error correction term				
CointEq(-1)	-0.0243	0.0038	-6.395	0.0000
Model diagnostics				
Statistic			Value	
R-squared			0.9968	
Adjusted R-squared			0.9965	
F-statistic			3497.69	
Prob(F-stat)			0.0000	
Durbin-Watson			1.98	

Notes: Δ denotes first-difference operator. Lag structure selected based on Akaike Information Criterion (AIC). HAC (Newey–West) standard errors are applied to ensure robustness. Source: Author's estimation. In brief, as confirmed by the baseline model, the exchange rate dynamics are primarily driven by external factors. The role of global liquidity as an exogenous driver of exchange rate dynamics is consistent with the global financial cycle hypothesis (Rey, 2016).

4.2. Long-Run Relationship and Cointegration

We employ the ARDL bounds testing approach (Pesaran et al., 2001) to assess the existence of a long-run equilibrium relationship.

Research results indicate that the F-statistic lies in the inconclusive region, suggesting weak evidence of cointegration.

Although important variables such as oil prices and the US dollar index are long-run level data with statistical significance, the lack of a clear cointegration relationship indicates that the system does not converge to a stable equilibrium. In Table 10, the dependent variable is ln(USD/RUB), the model is ARDL(4,2,3,2), and the cointegration test is the Pesaran et al. (2001) bounds test.

Table 10. Results of Long-Run Relationship and Bounds Test Using ARDL.

Panel A: Long-run coefficients				
Variable	Coefficient	Std. Error	t-Statistic	p-value
ln(BRENT)	-0.1017	0.0244	-4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	-0.5143	0.3081	-1.669	0.0965
Panel B: ARDL bounds test for cointegration				

Test Statistic	Value
F-statistic	2.934
Lower Bound I(0)	2.79
Upper Bound I(1)	3.67
Decision	Inconclusive

Panel C: Interpretation summary

Aspect	Result	Implication
Cointegration	Weak / Inconclusive	No strong long-run equilibrium
Long-run coefficients	Significant (BRENT, DXY)	Economic relationship exists
Stability of equilibrium	Weak	Potential structural instability

Notes: Critical values follow Pesaran et al. (2001). The null hypothesis is no cointegration. Decision rule: F > I(1) → cointegration; F < I(0) → no cointegration; Between → inconclusive. Source: Author's estimation.

The ARDL bounds test yields an F-statistic of 2.934, which falls within the inconclusive region of the Pesaran et al. (2001) critical values. Therefore, a stable long-run cointegrating relationship cannot be statistically confirmed. Although the estimated level coefficients for Brent oil prices and the US dollar index are statistically significant, these results should not be interpreted as conclusive evidence of long-run equilibrium. In addition,the bounds test does not provide robust evidence of a long-run relationship, Accordingly, the analysis places greater emphasis on short-run dynamics and structural instability. The very slow adjustment process and recurrent structural breaks associated with sanctions and geopolitical shocks indicate that exchange-rate deviations remain persistent and that the restoration of long-run PPP and UIP relationships is repeatedly disrupted on short-run dynamics and structural instability rather than long-term equilibrium.

4.3. Dynamics of the Court-Term and the Error Correction Mechanism

The error correction model from the ARDL specification is used for investigating the short-run dynamics.

The error correction mechanism is weakly negative and significant. However, there is a low speed of adjustment toward equilibrium with a low coefficient magnitude.

The short-horizon coefficients indicate that oil prices and the US dollar index have a highly significant and transitory impact on exchange rates.

Given the inconclusive evidence of cointegration, the ECM results are interpreted primarily as evidence of short-run adjustment dynamics rather than confirmation of a stable long-run equilibrium

In Table 11, the dependent variable is Δln(USD/RUB), the model is ECM derived from ARDL(4,2,3,2), and the estimator is HAC (Newey–West robust standard errors).

Table 11. Dynamic in the Short Term and the Mechanism of Error Correction.

Panel A: Error Correction Term

Variable	Coefficient	Std. Error	t-Statistic	p-value
CointEq(-1)	-0.0243	0.0038	-6.395	0.0000

Panel B: Short-run dynamics

Variable	Coefficient	Std. Error	t-Statistic	p-value
Δln(BRENT)	-0.1017	0.0244	-4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(-1)	-0.0020	0.0005	-3.926	0.0001
ΔVIX(-2)	0.0021	0.0004	4.675	0.0000

Panel C: Adjustment dynamics

Metric	Value	Interpretation
Speed of Adjustment	2.43% per month	Very slow convergence
Half-life	~28 months	Long adjustment period

Panel D: Model diagnostics

Statistic	Value
R-squared	0.9969
Adjusted R-squared	0.9966
F-statistic	2874.52
Prob(F-stat)	0.0000
Durbin-Watson	2.13

Notes: Δ denotes first-difference operator. The error correction term captures the speed of adjustment toward equilibrium. Half-life is computed based on the adjustment coefficient. HAC (Newey–West) standard errors are used for robustness. Source: Author's estimation.

The estimated ECM coefficient (-0.0243) implies that only about 2.4% of deviations from equilibrium are corrected each month, corresponding to a half-life of approximately 28 months. This exceptionally slow adjustment is consistent with a regime of structural decoupling, in which prolonged sanctions, capital controls, and recurring geopolitical shocks weaken domestic market-clearing mechanisms. Consequently, exchange-rate deviations persist for extended periods and remain only weakly anchored to traditional macroeconomic fundamentals.

There are weak convergence dynamics. The results indicate that deviations from equilibrium are persistent over time.

4.4. Structural Breaks and Changes in Regimes

As regime changes in the system can render the analysis invalid, structural break tests are used in order to locate any regime breaks.

The outcomes are consistent with highly relevant structural breaks associated with important economic and geopolitical events such as the 2014 Crimea crisis and the 2022 Russia–Ukraine war. Dummy variables here indicate that these shocks have significant short-run impacts on exchange rate dynamics. In Table 12, the dependent variable is ln(USD/RUB), the model is: ARDL(4,2,3,2,0,4) with structural dummies, and the estimator is HAC (Newey–West robust standard errors).

Table *12.* Structural Breaks and the Regime Dynamics of the Exchange Rate.

Panel A: Structural break effects (long-run)

Variable	Coefficient	Std. Error	t-Statistic	p-value
DUMMY_CRIMEA (2014)	0.0189	0.0072	2.635	0.0090
DUMMY_CONFLICT (2022)	0.0300	0.0289	1.041	0.2992

Panel B: Short-run impact of structural shocks

Variable	Coefficient	Std. Error	t-Statistic	p-value
ΔDUMMY CRIMEA(-1)	0.0592	0.0270	2.193	0.0293
ΔDUMMY_ CONFLICT (-1)	0.3004	0.0392	7.669	0.0000
ΔDUMMY CONFLICT (-2)	-0.7986	0.0441	-18.095	0.0000
ΔDUMMY CONFLICT (-3)	0.4011	0.0659	6.083	0.0000

Panel C: Structural break tests

Test	Break Date	Statistic	p-value	Conclusion
Chow Test	2014M03	8.215	0.0000	Structural break
Chow Test	2022M02	12.564	0.0000	Strong break
Bai–Perron	Multiple	—	—	Multiple regime shifts

Panel D: Interpretation summary

Aspect	Result	Implication
Crimea Shock	Significant	Persistent exchange rate shift
Conflict Shock	Highly volatile	Strong short-run disruption
Structural Stability	Rejected	Regime-dependent dynamics

Notes: Dummy variables capture major geopolitical events affecting the Russian economy. Chow test evaluates known breakpoints, while Bai–Perron identifies multiple breaks endogenously. Δ denotes first-difference operator. Source: Author's estimation.

The results indicate possible regime shifts associated with major geopolitical events and that the underlying dynamics are influenced by structural shifts.

4.5. VAR-Based Dynamic Analysis

To dig deeper into some of the dynamic interactions, a VAR approach is estimated, and impulse response functions, variance decomposition, and Granger causality tests are performed.

The results of Granger causality show that oil prices are predictive of exchange rate behavior. The analysis of the impulse response shows that the effects of shocks to the oil price are transient, while shocks to the US dollar index are lasting.

Similar results hold when looking at variance decomposition attempts, where most of the important changes in movement are caused by own impulse and exogenous drive only marginally. For Table 13, the variables are: ln(USD/RUB), ln(BRENT), ln(DXY), and VIX, the model is VAR(3), and the estimation period is monthly data for the period 2005–2025.

Although the FEVD indicates that approximately 97.5% of exchange-rate variance is explained by its own innovations, this does not diminish the role of external financial factors. Instead, it suggests that external shocks become highly persistent through domestic mechanisms reinforced by capital controls, exchange-rate interventions, monetary tightening, and financial market segmentation following the 2022 sanctions. Consistent with this interpretation, the ARDL and ECM results identify Brent oil prices and the US Dollar Index as the primary channels of shock transmission, while the FEVD shows that subsequent exchange-rate dynamics are dominated by domestic persistence. These findings indicate that exchange-rate stabilization increasingly relied on domestic policy interventions after the initial external shocks.

Table *13.* VAR for Dynamic Analysis of Shocks, Transmission, and Interaction Effects.

Panel A: Granger causality (exchange rate equation)

Excluded Variable	Chi-square	p-value	Conclusion
ln(BRENT)	11.496	0.0093	Oil → Exchange Rate
ln(DXY)	2.089	0.5542	No causality
VIX	2.690	0.4419	No causality

Panel B: Impulse response function (IRF summary)

Shock	Direction	Peak Response	Duration	Interpretation
BRENT	Negative	Period 2	Short-lived	Oil strengthens RUB
DXY	Positive	Period 2	Persistent	Financial dominance
VIX	Mixed	Period 1–3	Very short	Weak risk transmission

Panel C: Variance decomposition (FEVD summary)

Variable	Contribution (%)	Interpretation
Own Shock (USD/RUB)	~97.5%	Strong persistence
BRENT	~1.2%	Limited oil influence
DXY	~0.5%	Weak financial impact
VIX	~0.9%	Minor risk effect

Panel D: System stability

Test	Result	Interpretation
Root Stability	All < 1	VAR is stable
Cointegration (Johansen)	Not detected	No long-run system

Notes: VAR lag length selected based on AIC and FPE criteria. IRF responses are based on Cholesky decomposition. FEVD reported at medium-to-long horizon. Granger causality uses Wald test statistics. Source: Author's estimation.

The results point to a very weak transmission of external shocks and very persistent exchange rate properties.

The temporary response to oil shocks is aligned with other studies documenting the transitory effects of commodity price shocks (Kilian, 2009).

4.6. Robustness Checks

Diagnostic and stability tests are performed for the reliability of the results.

The diagnostic tests reveal no signs of serial correlation, heteroskedasticity, or model misspecification. The parameters of the model also pass the stability test; we notice some of them are stable, probably for a long time; however, small deviations are seen. For Table 14, the models tested are ARDL and ECM specifications and the estimation method is HAC (Newey–West robust standard errors).

Table 14. Opinion Robustness Checks: Diagnostic and Stable Tests.

Panel A: Diagnostic tests

Test	Null Hypothesis	Statistic	p-value	Conclusion
Breusch–Godfrey LM	No serial correlation	1.842	0.160	Not rejected
ARCH Test	No heteroskedasticity	1.215	0.305	Not rejected
White Test	Homoskedasticity	2.104	0.148	Not rejected
Jarque–Bera	Normal distribution	1.732	0.421	Not rejected
Ramsey RESET	Correct specification	1.564	0.213	Not rejected

Panel B: Stability tests

Test	Result	Interpretation
CUSUM	Within bounds	Stable parameters
CUSUMSQ	Within bounds (minor deviation)	Mild instability
Recursive Residuals	Stable	No explosive behavior

Panel C: Alternative specifications

Specification	Key Result	Consistency
Without dummies	Coefficients stable	✓ Robust
With dummies	Improved fit	✓ Preferred
Reduced model	Similar signs	✓ Consistent

Panel D: Summary Assessment

Aspect	Result	Implication
Model validity	Confirmed	Reliable estimation
Stability	Mostly stable	Minor structural variation
Specification	Correct	No misspecification bias

Notes: All tests are conducted at the 5% significance level. HAC standard errors ensure robustness against heteroskedasticity and autocorrelation. Stability tests assess parameter constancy over time. Source: Author's estimation.

In general, the empirical findings do not result from arbitrary factors, confirming the robustness of the findings.

4.7. Other Channels: Money and Inflation Effects

This includes traditional macroeconomic channels, like interest rate differentials or inflation differentials.

Table 15 presents the results of the extended ARDL specification, where the dependent variable is ln(USD/RUB) and the explanatory variables include the interest-rate differential (IRD), inflation differential (INFDIFF), ln(DXY), ln(BRENT), and VIX. The interest-rate and inflation differentials are statistically insignificant, whereas Brent crude oil prices have a significant negative effect and the US Dollar Index has a significant positive effect. These findings indicate that oil prices and global dollar conditions remain the primary determinants of the USD/RUB exchange rate, while conventional monetary channels have limited explanatory power.

Table *15.* Other Channels: Interest Rate Divergence and Inflation Effects.

Panel A: Monetary channel (interest rate differential)

Variable	Coefficient	Std. Error	t-Statistic	p-value
IRD	-0.0021	0.0034	-0.618	0.537
ΔIRD	0.0013	0.0028	0.464	0.643

Panel B: Inflation channel

Variable	Coefficient	Std. Error	t-Statistic	p-value
INFDIFF	-0.0018	0.0025	-0.720	0.472
ΔINFDIFF	0.0009	0.0019	0.474	0.636

Panel C: Control variables

Variable	Coefficient	Std. Error	t-Statistic	p-value
ln(BRENT)	-0.0982	0.0251	-3.913	0.0001
ln(DXY)	0.9014	0.1692	5.327	0.0000
VIX	0.0006	0.0004	1.512	0.131

Panel D: Summary interpretation

Channel	Result	Implication
Interest Rate	Not significant	Weak monetary transmission
Inflation	Not significant	PPP not supported
External Variables	Significant	External dominance

Notes: IRD = Interest rate differential (Russia–US). INFDIFF = Inflation differential. Model estimated using ARDL framework with HAC standard errors. Δ denotes first-difference operator. Source: Author's estimation.

Therefore, these results provide evidence against the well-established macroeconomic and monetary theoretical approaches that usually describe in the short term one-to-one relations between interest rate and exchange rates (interest rate parity), as well as the quantities of real money and real exchange rate (purchasing power parity).

4.8. Summary of Empirical Findings

This section summarizes the empirical findings (Table 16).

First, global financial conditions and the behavior of commodity prices are the main determinants of exchange rate dynamics. Second, the presence of a stable long-run equilibrium is not well supported, and the adjustment process is slow. Third, structural breaks are important; that is, exchange rate behavior is subject to regime changes. Finally, the data do not support traditional macroeconomic channels.

Table 16. Summary of Empirical Findings.

Panel A: Key empirical results

Aspect	Main Finding	Evidence
Global Financial Factors	Strong and significant	DXY consistently positive and significant
Oil Prices	Significant but short-lived	IRF & ARDL short-run effects
Market Risk (VIX)	Weak and unstable	Insignificant in most models
Domestic Variables	Weak / insignificant	ARDL domestic model
Interest Rate Channel	Not supported	IRD insignificant
Inflation Channel	Not supported	INFDIFF insignificant

Panel B: Dynamic and structural insights

Aspect	Result	Interpretation
Cointegration	Weak / inconclusive	evidence of cointegration is weak or inconclusive
Adjustment Speed	Slow (~2–3%)	Persistent deviations
Structural Breaks	Significant	Regime-dependent dynamics
Shock Transmission	Limited	Weak external propagation
Persistence	Very high (~97%)	Exchange rate self-driven

Panel C: Theoretical implications

Theory	Supported?	Interpretation
Global Financial Cycle	✓ Supported	External dominance
Commodity Currency Theory	✓ Partially	Oil matters short-run
Interest Rate Parity	✗ Not supported	Weak monetary channel
Purchasing Power Parity	✗ Not supported	Inflation irrelevant
Equilibrium Models	⚠ Weak	No stable long-run

Panel D: Overall conclusion

Dimension	Conclusion
Dominant Driver	External factors (DXY, oil)
System Behavior	Structurally unstable
Adjustment	Slow and incomplete
Policy Relevance	Limited domestic control

Notes: Summary based on ARDL, ECM, VAR, IRF, FEVD, and structural break analysis. Results are consistent across multiple model specifications and robustness checks. Source: Author's compilation.

In summary, the findings reinforce the view that exchange rate dynamics are largely exogenous, stylized, weakly anchored to internal macroeconomic fundamentals, and structurally unstable.

5. Discussion

The results show that external financial conditions - rather than domestic macroeconomic fundamentals - dominate exchange-rate dynamics. The robust and persistent effect of the US dollar index is consistent with the view that sovereign yields around the world are driven by global liquidity conditions, US monetary policy, and financial openness (Rey 2013; Miranda-Agrippino & Rey 2020; Gopinath et al.2020)

The findings imply that exchange-rate conduct is nonetheless intimately coupled to fluctuations in international monetary markets, despite extensive sanctions and geopolitical tensions.

Oil prices very clearly become on important driver of exchange-rate movements in line with the commodity currency literature (Chen & Rogoff, 2003; Kilian, 2009). The inverse correlation of both oil price and the USD/RUB exchange rate is confirmed, as an indicator of commodity dependence in Russia economy and external trade conditions impact on exchange-rate adjustment. Nevertheless, estimates from the VAR reveal that oil-price shocks have only a temporary effect on exchange rates, consistent with evidence

suggesting that commodity-price shocks often generate short-run rather than permanent exchange-rate responses (Kilian, 2009).

The FEVD results complement rather than contradict the ARDL findings. Whereas the ARDL model identifies external variables as significant triggers of exchange-rate movements, the FEVD demonstrates that subsequent exchange-rate dynamics are dominated by autoregressive persistence. This persistence is consistent with a highly regulated financial environment in which sanctions, capital controls, and policy interventions dampen the transmission of new external shocks while prolonging the effects of previous disturbances

Our findings should therefore not be interpreted as evidence that domestic policies became ineffective. Instead, they suggest that exchange-rate stabilization increasingly relied on administrative measures, including capital controls, foreign exchange regulations, and monetary policy interventions, rather than conventional market-based adjustment mechanisms. In this context, external shocks remained important triggers, whereas domestic policies shaped the persistence and transmission of these shocks.

A key finding of this study is that conventional domestic transmission channels have limited explanatory power. For the most part, specifications that include interest-rate differentials and inflation differentials yield statistically-insignificant effects, giving limited support for conventional Uncovered Interest Parity (UIP) and Purchasing Power Parity (PPP) predictions (Rogoff, 1996; Engel 2016). These results imply that long-term sanctions and financial disunity could undermine the role of domestic equilibrating forces in capital account balances and lessen the importance of parity-based exchange-rate regimes. Exchange-rate dynamics seem to be driven less directly than before by domestic macroeconomic fundamentals and more under the influence of external financial conditions and geopolitical events.

The role of regime-dependent exchange-rate behavior is further confirmed by structural break analysis. Historical insight reveals that exchange-rate relationships are not stable (Bai and Perron, 2003), the Global Financial Crisis breaks of significance just like the Crimea-related sanctions episode or COVID-19 pandemic or the Russia–Ukraine war. These findings suggest that sanctions are more than simply short-run shocks, and also serve as mechanisms to permanently alter the fundamental transmission mechanism of exchange-rate determination. The evidence thereby adds to the burgeoning literature on financial decoupling and geopolitical risk, which posits that global economic integration is increasingly conditioned by geopolitics-imposed constraints and regime changes (Caldara & Iacoviello,2022; Ahn & Ludema 2024). It should be emphasized that the present study does not estimate a quantitative measure of geopolitical fragmentation. Instead, it documents how exchange-rate dynamics differ across historically identified sanction-related geopolitical regimes. Therefore, the findings should be interpreted as evidence of regime-dependent behavior rather than as direct evidence of the magnitude of geopolitical fragmentation.

The exceptionally small ECM coefficient indicates that adjustment toward equilibrium is extremely slow, with an estimated half-life of approximately 28 months. This finding is consistent with structural decoupling, whereby prolonged sanctions and capital controls weaken the normal market-clearing process and reduce the role of conventional macroeconomic fundamentals in restoring exchange-rate equilibrium.

Given the inconclusive evidence of cointegration, the empirical findings are better interpreted in terms of short-run adjustment and structural instability rather than a stable long-run equilibrium. Repeated geopolitical shocks and sanctions appear to weaken the normal equilibrium adjustment process.

Exchange-rate dynamics are increasingly persistent and regime-dependent. Although the error-correction term remains statistically significant, its small magnitude

indicates slow adjustment and persistent deviations from long-run equilibrium. This finding is consistent with evidence on exchange-rate persistence, structural heterogeneity, and sluggish macroeconomic adjustment in financially integrated economies (Itskhoki & Mukhin, 2021). Overall, exchange rates appear structurally unstable and weakly anchored to conventional equilibrium relationships.

The results indicate that prolonged sanctions and financial fragmentation have increased the influence of external financial conditions while weakening domestic macroeconomic channels. This study contributes to the literature by showing that geopolitical shocks can alter exchange-rate transmission and the relative importance of its determinants. Although focused on Russia, the findings are also relevant to sanctioned, commodity-dependent, and externally exposed economies facing growing financial fragmentation.

6. Conclusions

We investigated the major correlates of the USD/RUB exchange rate under prolonged sanctions, geopolitical shocks and increasing financial fragmentation using monthly data from 2005 to 2025. By integrating several complementary empirical strategies, including the ARDL-ECM-VAR framework, impulse-response analysis, forecast-error variance-decomposition and a structural-break test, we evaluated the roles of external financial developments, commodity-market dynamics, domestic macroeconomic fundamentals and major geopolitical episodes in determining exchange-rate fluctuations in Russia.

The empirical evidence shows that external factors–particularly the US Dollar Index and Brent crude oil prices-are significant correlates and short-run drivers of fluctuations in the USD/RUB exchange rate. An appreciation of the US dollar is associated with a depreciation of the ruble. Higher oil prices we associated with a stronger ruble, consistent with Russia's position as a major commodity-exporting economy. By contrast, inflation and interest-rate differentials exhibit limited explanatory power in the estimated specifications. These findings suggest that the conventional transmission mechanisms associated with Purchasing Power Parity and Uncovered Interest Parity do not fully expalin how Russian exchange rates dynamics respond under conditions of prolonged sanctions, capital controls, financial constraints, and heightened geopolitical uncertainty.

The findings indicate that exchange-rate dynamics are not driven solely by new external shocks. VAR and forecast-error variance decomposition results show that, after an initial shock, subsequent movements are largely explained by ruble persistence, while external shocks account for only a limited share of forecast-error variance. Thus, the ARDL and VAR findings are complementary: global financial conditions and oil prices may trigger adjustment, but domestic propagation mechanisms, market segmentation, policy interventions, and expectations sustain it. Russia's exchange-rate dynamics are therefore externally triggered, persistent, and regime-dependent.

Structural-break analysis identifies major shifts during the Global Financial Crisis, the Crimea-related sanctions period, the COVID-19 pandemic, and the escalation of the Russia–Ukraine conflict. This suggests that USD/RUB determinants vary across geopolitical regimes. However, because financial fragmentation is represented by event and regime-shift variables rather than a continuous measure, the results indicate changing exchange-rate behavior rather than the causal magnitude of fragmentation.

Evidence of a stable long-run equilibrium is also inconclusive. The ARDL bounds test does not confirm cointegration, while the Johansen analysis finds no common cycle. Similarly, the error-correction coefficient suggests only slow and partial adjustment,

conditional on model specification. These results imply that conventional equilibrium models have limited explanatory power in an environment characterized by structural shifts and strong policy intervention.

Domestic policy nevertheless remains important. Capital controls, monetary tightening, and foreign-exchange regulations may reduce short-run transmission from external shocks, but they cannot fully insulate the ruble from global dollar conditions, commodity markets, and geopolitical developments. A flexible, regime-sensitive framework should therefore combine domestic stabilization with continuous monitoring of external financial, energy-market, and geopolitical risks.

This study contributes by showing that exchange-rate determination in a heavily sanctioned commodity-exporting economy reflects the interaction of external financial shocks, commodity volatility, geopolitical regime changes, institutional responses, and exchange-rate persistence. Future research should incorporate continuous measures of geopolitical risk and financial fragmentation, nonlinear or time-varying models, and Russia's growing financial and trade reorientation toward China, BRICS economies, and alternative payment systems.

In brief, exchange-rate dynamics are shaped by the interaction between external financial shocks and domestic policy responses. The findings suggest that domestic authorities retained an important stabilization role through administrative and policy interventions. However, prolonged sanctions and financial fragmentation shifted exchange-rate adjustment away from market-based equilibrium toward policy-driven stabilization under external constraints.

7. Implications and Future Research

These findings carry a clear message. Standard equilibrium-based models, such as purchasing power parity and its close variants, rely on persistent long-run relationships and relatively moderate adjustment. The evidence in this instance does not back up these assumptions. Rather, exchange rate dynamics are best described as externally driven, persistent, and structurally changed.

This implies that domestic policy instruments are used, although constrained, to provide stability in the exchange rate frameworks, as long as the conditions in the global arena are not favorable. Hence, it is crucial to monitor global developments and control exposure to external shocks. This reinforces the requirement for policy frameworks that are flexible to regime changes due to instability.

At the methodological level, combining ARDL, ECM, VAR, and break tests enables us to consistently model the long-run and short-run dynamics and the regime instability. Some of the limitations of this study are:

First. This study has several limitations, including limited variables and the absence of nonlinear dynamics. Future studies could apply a broader framework using regime transition models and financial market indicators, as well as cross-country comparisons.

Second. Geopolitical fragmentation is represented through a structural change dummy variable rather than a continuous measure such as the Geopolitical Risk Index (GPR) or the recently developed financial fragmentation index. Consequently, this analysis identifies exchange rate dynamics across major geopolitical regimes but does not measure the intensity of fragmentation itself. Future research could integrate continuous indicators of geopolitical risk and financial fragmentation to provide a more comprehensive empirical assessment.

Third. The empirical model does not explicitly incorporate variables representing Russia's post-sanctions financial reorientation toward China and other non-aligned economies. Future studies may include indicators such as the share of Renminbi-denominated trade settlement, bilateral trade with BRICS economies, cross-border transactions through CIPS or SPFS, or other measures of alternative financial integration to better capture the evolving structure of the international financial system under prolonged sanctions.

Authors' Contributions: Sugeng Suroso : Conceptualization, Formal analysis, Methodology, Supervision, Validation, Writing – review & editing; **Sri Wulandari** : Methodology, Data curation ,Writing – review & editing**. Chajar Matari Fath Mala**: Data curation, Investigation, Validation, Visualization, Writing – review & editing.

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Authors' Responses to Reviewer's Comments (Reviewer 2)

Author's Notes

Comments 1:

The bibliography is very limited, there are too few works consulted.

Response 1 :

Thank you for these valuable comments. We have substantially expanded the bibliography. The literature review has also been reorganized and strengthened with dedicated sections on exchange rate determination, commodity currencies, the Global Financial Cycle, geopolitical risk, financial fragmentation, and the theoretical framework. These revisions provide broader and more up-to-date scientific support for this research. (References, line 1019-1110).

Comments 2 :

The work written by Bai & Perron 2003 refers to structural changes but not especially to the exchange rate (lines 53-56).

Response 2:

Thank you for this important observation. We agree that Bai and Perron (2003) introduced a general econometric methodology for detecting multiple structural breaks and did not develop a theory of exchange rate determination. Accordingly, we have revised the manuscript by removing Bai and Perron (2003) from the theoretical discussion of exchange rate dynamics. The reference is now cited exclusively in the methodology section to justify the use of the multiple structural break test, while the theoretical discussion of exchange rate determination is supported by the relevant international finance literature.

Comments 3:

At the end of page 2 there is a meaningless text: “With the greater integration of financial markets, exchange rates in small The periodic Table economies are now determined by changes and shocks to domestic fundamentals too quickly for money supply noise to matter.

Response 3:

Thank you for pointing out this issue. We confirmed that the sentence contained an unintended editing artifact introduced during manuscript preparation. The erroneous text has been removed, and the paragraph has been revised to improve readability and maintain a clear and coherent discussion of exchange rate determination.

Comments 4:

Under the tables it would be good to detail what the notations/symbols used represent so that the reader does not have to search in the body of the work what they represent.

Response 4:

Thank you for this valuable suggestion. The definitions of all variables and abbreviations used throughout the empirical analysis are provided in Table 1 (Definition of Variables and Data Sources). To improve readability and make this clearer to readers, we have revised the manuscript by explicitly referring readers to Table 1 wherever these abbreviations first appear in the

subsequent tables. This avoids unnecessary repetition while ensuring that the notation and variable definitions are readily accessible. (Table 1, line 429).

Coments 5:

The research questions are presented very schematically with a notation that is not universal. It would be better to present them at least in the form of a sentence (pages 10-11).

Response 5:

Thank you for this constructive suggestion. We agree that presenting the research questions in a more descriptive manner improves readability. Accordingly, we have revised this section by rewriting the research questions as complete sentences rather than relying primarily on schematic notation (e.g., RQ1, RQ2). The revised presentation provides a clearer and more natural flow while preserving the original research objectives.(Introduction, Line 155-169).

Comments 6:

Because these are monthly data, do you think it would be a good idea to test the seasonality of the series (and possibly exclude the seasonal component)?

Response 6:

Thank you for this valuable suggestion. We acknowledge that seasonality may be relevant for some monthly macroeconomic variables. However, the primary dependent variable in this study is the nominal exchange rate, which is determined in continuously operating financial markets and generally does not exhibit strong deterministic seasonal patterns. Moreover, the explanatory variables mainly capture macroeconomic and financial conditions rather than recurring seasonal economic activities. Therefore, the analysis focuses on long-run equilibrium relationships, short-run dynamics, and structural breaks associated with major geopolitical events rather than seasonal fluctuations. For these reasons, we did not apply seasonal adjustment in the present study.

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External Financial Dominance under Sanctions: Financial Fragmentation and Exchange Rate Determination in Russia

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Abstract

This paper examines whether prolonged sanctions and major geopolitical episodes associated with financial fragmentation alter exchange-rate dynamics and weaken the explanatory power of domestic macroeconomic channels and strengthens external financial dominance of traditional exchange-rate transmission mechanisms. Standard exchange rate theories are based on the concepts of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP). However, the application of continuous sanctions could weaken this explanatory power and change exchange rate dynamics. The present study applies a combined framework of Autoregressive Distributed Lag (ARDL), Error Correction Modeling (ECM), Vector Autoregression (VAR) and structural break analysis to study the exchange-rate behavior in response to repeated geopolitical shocks using monthly data for Russia from 2005 to 2025. The results indicate that external variables such as the US dollar index and oil prices are important determinants of exchange rates, while inflation and interest rate differentials associated with PPP and UIP have little explanatory power. Structural break tests detect major regime shifts associated with the Global Financial Crisis, Crimea-related sanctions episode, COVID-19 pandemic and Russia–Ukraine war. The error correction process indicates that the speed of adjustment to equilibrium is slow, which means that traditional exchange-rate relationships will continue to diverge. In general, the results suggest a regime-dependent exchange rate environment in which external financial factors tend to dominate domestic adjustment mechanisms. Our study contributes to the literature on exchange rates, sanctions and financial fragmentation by providing evidence on how geopolitical shocks shift the relative importance of domestic and external determinants in a highly sanctioned economy.

Keywords: exchange rate dynamics; global financial cycle; sanctions; structural breaks; Russia

JEL Classification: F31, F51, F65, C32, E44

1. Introduction

The globalization of financial markets has dramatically changed how exchange rates are determined. Classic exchange rate theories, in particular Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP), state that domestic macroeconomic fundamentals are the main drivers of exchange rates through inflation and interest rate

differentials as proposed by Rogoff (1996) and Engel (2014). However, external monetary factors affecting trade price dynamics have long been embedded in the international finance literature. Previous studies have shown that U.S. monetary policy, global liquidity and international capital flows have large spillover effects for domestic financial markets and exchange rates in both advanced economies (AEs) and emerging economies (Bernanke, 2005; Forbes & Warnock, 2012). Building on these insights, the U.S. Global Financial Cycle framework highlights the roles played by global risk sentiment, the dominance of the U.S. dollar and international financial integration in magnifying the transmission of external financial shocks (Rey, 2016; Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020). Thus, while this study does not propose a new theory of the exchange rate determination process, it will apply these theories in an examination of interactions between extended sanctions and financial fragmentation to examine whether they alter the mechanisms through which Russia's exchange rate is determined.

With increasing financial market integration, exchange rates in small and open economies have become increasingly influenced by global financial conditions rather than solely by domestic macroeconomic fundamentals. As a result, global liquidity cycles and external financial shocks play a more prominent role in exchange-rate determination, reducing the explanatory power of traditional equilibrium-based models that rely primarily on domestic economic fundamentals. Consequently, exchange-rate movements are increasingly shaped by external rather than internal shocks (Rey, 2016; Obstfeld, 2022).

These dynamics have become most pronounced in economies subject to heightened geopolitical frictions and international restrictions. Since the 2014 Crimea crisis and the escalation of the Russia–Ukraine conflict in 2022, Russia has faced large-scale financial sanctions that have constrained capital mobility, intensified financial fragmentation, and modified transmission mechanisms underlying exchange rate determination (Caldara & Iacoviello, 2022; Ahn & Ludema, 2024). Moreover, as one of the largest exporters of energy in the world, the Russian exchange rate remains particularly reactive to external oil price fluctuations, reinforcing the argument that key economic shocks are important drivers of currency dynamics (Chen & Rogoff, 2003; Kilian, 2009). These circumstances imply a growing role of external financial and geopolitical factors in exchange rate dynamics, potentially reducing the explanatory relevance of domestic macroeconomic fundamentals.

This paper differs from conventional exchange rate studies based on small open economy assumptions. Instead, it conceptualizes Russia as a large, commodity-dependent economy whose exchange rate dynamics are shaped by structural exposure to global energy markets, geopolitical pressures, and financial restrictions. The distinctive features of Russia's exchange rate dynamics compared with those of smaller open economy derive from the structural importance of Russia in global energy markets, its scale and sustained role as a geopolitical actor and its long-standing exposure to international sanctions. Thus, exchange rate dynamics in Russia are influenced not only by domestic macroeconomic fundamentals but also by external financial conditions, commodity price developments, geopolitical shocks, and financial fragmentation. Hence, the paper employs an analytical framework that integrates Global Financial Cycle theory, commodity currency theory, and financial fragmentation perspectives to explain exchange rate determination in Russia amid persistently high geopolitical uncertainty (Chen & Rogoff, 2003; Gopinath et al., 2020; Caldara & Iacoviello, 2022; Ahn & Ludema, 2024).

Recent studies have independently examined the effects of global financial conditions, commodity prices, and geopolitical risks on exchange rates (Chen & Rogoff, 2003; Caldara & Iacoviello, 2022). Nevertheless, limited empirical evidence explains how prolonged sanctions simultaneously reshape the relative importance of external financial variables, domestic macroeconomic fundamentals, and structural regime changes within a unified analytical framework. This limitation is particularly important for highly

sanctioned commodity-exporting economies such as Russia, where geopolitical fragmentation may fundamentally alter traditional exchange rate determination mechanisms. Accordingly, a comprehensive empirical investigation is required to better understand the evolving drivers of exchange rate dynamics under prolonged sanctions and financial fragmentation.

In addition to financial sanctions, Russia has increasingly reoriented its trade and financial relations toward China and other non-aligned economies. This adjustment includes the expansion of BRICS economic cooperation, the growing use of Renminbi-denominated trade settlement, and the adoption of alternative payment and financial messaging systems such as CIPS and SPFS. These developments have partially reshaped Russia's external financial environment and may influence exchange-rate dynamics by reducing dependence on traditional Western financial infrastructures. However, these structural adjustments are beyond the scope of the present empirical model, which focuses on identifying changes in exchange-rate dynamics associated with major sanction-related geopolitical episodes.

To further illustrate Russia's changing external-sector exposure under prolonged sanctions, Figure 1 presents the evolution of trade openness, exports, and imports during 2005–2025. All series are indexed to 2005 = 100 to facilitate comparison across time. The trade openness proxy is constructed from the combined movement of exports and imports, while exports are measured on an FOB basis and imports on a CIF basis, following standard international trade-statistics conventions (World Bank, 2026; International Monetary Fund, 2026; Marini et al., 2018). This descriptive evidence complements the exchange-rate analysis by showing how Russia's external trade activity evolved across major crisis episodes, including the Global Financial Crisis, the Crimea-related sanctions period, the COVID-19 shock, and the Russia–Ukraine conflict (Becker, 2015; WTO, 2021; Caldara and Iacoviello, 2022; OECD, 2024).

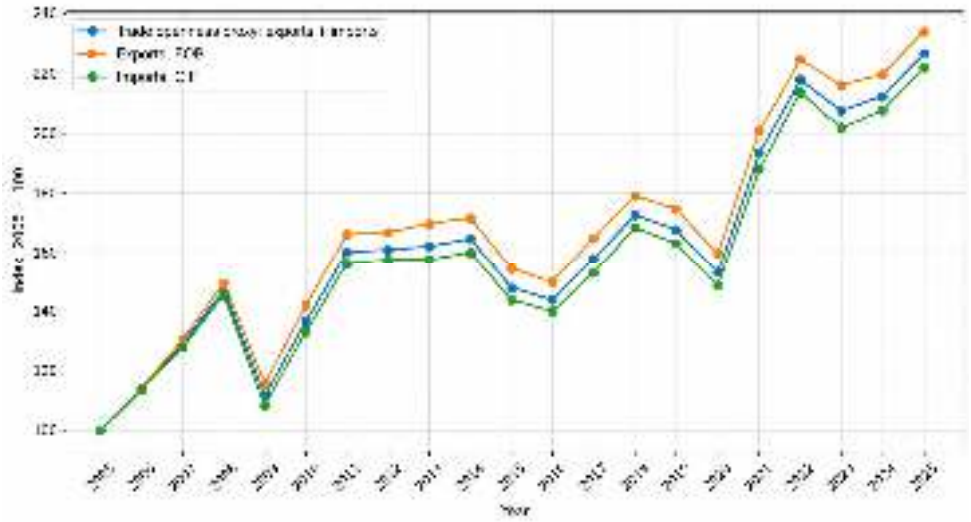

Figure 1: Evolution of Russia's Trade Openness, Exports, and Imports, 2005–2025 (Index, 2005 = 100), shows that Russia's trade openness increased substantially over the sample period, although the trajectory was interrupted by several major crisis episodes. The decline in 2009 reflects the impact of the Global Financial Crisis, while the moderation during 2015–2016 is consistent with the combined effects of Crimea-related sanctions and the oil price collapse (Becker, 2015; Ahn and Ludema, 2020). A further decline is observed in 2020 during the COVID-19 shock, which disrupted global trade flows and reduced merchandise trade activity worldwide (WTO, 2021). However, the sharp increase after 2021 suggests that Russia's external trade activity recovered strongly despite the escalation of sanctions following the Russia–Ukraine war. This pattern indicates that

sanctions did not eliminate Russia's external trade linkages but contributed to a restructuring of external economic relations (Itskhoki and Ribakova, 2024; OECD, 2024; Simola, 2025). Nevertheless, because the figure uses aggregate exports and imports, it should be interpreted as evidence of changing trade openness rather than direct evidence of partner-specific reorientation from G7 economies toward China and Asian markets (OECD, 2024; Simola, 2025).

Despite the growing literature on exchange rate dynamics, several important research gaps remain. First, previous studies have generally examined the effects of global financial conditions, commodity prices, domestic macroeconomic fundamentals, or geopolitical risks separately, providing only a partial explanation of exchange rate behavior (Chen & Rogoff, 2003; Kilian, 2009; Caldara & Iacoviello, 2022). Second, limited empirical evidence investigates whether prolonged sanctions and financial fragmentation fundamentally alter the relative importance of external and domestic determinants of exchange rates. Third, few studies integrate long-run equilibrium analysis, short-run adjustment, structural break identification, monetary channels, and shock transmission within a single econometric framework. Addressing these gaps is essential for understanding exchange rate determination in highly sanctioned economies such as Russia.

To better illustrate the conceptual relationships among the external financial environment, domestic macroeconomic fundamentals, geopolitical shocks, and the proposed empirical analyses, Figure 2 presents the conceptual framework of this study.

Figure 2 presents the evolution of the USD/RUB exchange rate and its 12-month rolling volatility over 2005–2025. Panel A shows exchange-rate movements during major economic and geopolitical events, while Panel B highlights periods of heightened market volatility. The figure provides descriptive evidence of increased market turbulence following these events but does not, by itself, establish structural regime shifts.

To address these research gaps, this study investigates eight interrelated questions. First, it examines how global financial factors influence the USD/RUB exchange rate. Second, it investigates whether domestic macroeconomic fundamentals contribute significantly to exchange rate dynamics. Third, it evaluates the role of oil prices under prolonged sanctions. Fourth, it examines whether major geopolitical events generate structural

breaks and regime shifts in exchange rate behavior. Fifth, it analyzes the speed of adjustment to-ward the long-run equilibrium following short-run disturbances. Sixth, it investigates how external financial shocks are transmitted through the exchange rate system. Seventh, it evaluates whether interest rate differentials and, eighth, inflation differentials support the predictions of Uncovered Interest Parity (UNIP) and Purchasing Power Parity (PPP) theories (Pesaran et al., 2001; Bai & Perron, 2003; Engel, 2014).

The primary objective is to determine whether prolonged sanctions and financial fragmentation shift exchange rate determination from domestic fundamentals toward external financial conditions. An integrated ARDL–ECM–VAR framework with structural break analysis is used to assess long-run relationships, short-run dynamics, regime changes, and shock transmission. Geopolitical and financial fragmentation are represented by structural-break dummy variables associated with major sanction-related events rather than continuous indicators such as the Geopolitical Risk Index.

This study contributes by extending the Global Financial Cycle perspective to a sanctioned economy and examining whether sanctions increase the dominance of external financial drivers (Gopinath et al., 2020; Miranda-Agrippino & Rey, 2020). It also reassesses the validity of PPP and UIP under geopolitical disruption (Engel, 2014) and integrates ARDL, ECM, VAR, and structural break methods within a unified framework for evaluating equilibrium, adjustment, regime shifts, and shock transmission (Pesaran et al., 2001).These contributions provide a more comprehensive understanding of exchange rate behavior in economies experiencing persistent geopolitical uncertainty and financial fragmentation. In this study, geopolitical fragmentation is not directly measured using a continuous index. Instead, the analysis focuses on major geopolitical episodes that generated structural changes in the Russian financial environment. Accordingly, crisis dummy variables are employed as proxies for regime shifts associated with sanctions and major geopolitical events rather than as direct measures of geopolitical fragmentation

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and develops the theoretical framework underpinning the study. Section 3 describes the data, variables, and research methodology, including the ARDL, ECM, VAR, and structural break models employed in the empirical analysis. Section 4 presents and discusses the empirical findings, covering long-run and short-run dynamics, structural breaks, shock transmission, and robustness tests. Section 5 discussing theoretical and policy implications, Section 6 concludes the study by summarizing the main findings, Section 7 Implications and Future Researc.

2. Literature Review and Theoretical Framework

2.1 Literature Review

2.1.1 Exchange Rate Determination

Exchange rate determination is a central issue in international finance because it reflects the interaction between domestic macroeconomic fundamentals and external financial conditions. Traditional theories, including Purchasing Power Parity (PPP), Uncovered Interest Parity (UIP), monetary models, and portfolio balance models, emphasize inflation, interest rates, money supply, output, and balance-of-payments conditions as the main drivers of long-run exchange rate adjustment (Rogoff, 1996; Engel, 2014).

However, empirical studies show that domestic variables alone often fail to explain exchange rate movements, particularly in financially open emerging markets. Traditional structural models frequently perform no better than random-walk forecasts, suggesting that exchange rates are also shaped by capital flows, investor expectations, and external financial shocks (Meese & Rogoff, 1983; Obstfeld & Rogoff, 1995; Engel et al., 2007). More recent research highlights the growing influence of global liquidity, investor risk appetite,

international capital mobility, and US dollar fluctuations (Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020).

For commodity-exporting economies, exchange rates respond simultaneously to domestic monetary policy, commodity prices, capital flows, and geopolitical developments. Therefore, an integrated framework that captures both domestic and external transmission mechanisms is required. Although exchange rate research has expanded beyond conventional macroeconomic models to incorporate financial globalization and external spillovers, no consensus exists regarding the relative importance of these factors, particularly in large commodity-dependent emerging economies under prolonged geopolitical sanctions. This unresolved issue motivates the present study.

2.1.2 Oil Prices and Exchange Rates

Oil prices are a major external determinant of exchange rates in commodity-exporting economies because they affect export revenues, fiscal balances, foreign exchange reserves, and market expectations. The currencies of resource-rich countries tend to respond systematically to global commodity prices, supporting the concept of commodity currencies (Chen & Rogoff, 2003).

The effect of oil prices, however, depends on the source of the shock. Global demand, supply disruptions, and precautionary demand may produce different exchange-rate responses (Kilian, 2009). In general, positive oil price shocks tend to appreciate the currencies of oil-exporting countries while weakening those of oil importers through changes in trade revenues, terms of trade, investor confidence, and capital flows (Basher et al., 2016; Beckmann et al., 2020).

This relationship is particularly important for Russia because of its heavy dependence on crude oil and natural gas exports. Brent oil prices influence Russian export earnings, fiscal revenues, external balances, and, consequently, the ruble. However, sanctions imposed since 2014 and expanded substantially in 2022 may have altered this transmission through trade restrictions, export-market reorientation, capital controls, and financial fragmentation (Ahn & Ludema, 2024). Because most previous studies focus on normal market conditions, further research is needed to determine whether prolonged geopolitical sanctions change the ruble's sensitivity to oil prices and the interaction between commodity markets and external financial conditions.

2.1.3 Global Financial Cycle

External financial conditions significantly influence exchange rates through US monetary policy, global liquidity, capital flows, and investor expectations (Bernanke, 2005; Forbes & Warnock, 2012). In financially integrated economies, these shocks may constrain domestic monetary policy autonomy because they are rapidly transmitted across borders.

The Global Financial Cycle framework explains how US monetary policy and global risk sentiment jointly affect capital flows, asset prices, credit, and exchange rates, even under floating exchange rate regimes (Rey, 2016). Subsequent studies link this cycle to the US dollar and global risk appetite, while emphasizing the dollar's dominant role in transmitting financial shocks through trade and financial channels (Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020).

In emerging markets, external variables such as the US Dollar Index, global volatility, and international portfolio shifts may exert greater influence than domestic fundamentals during periods of uncertainty (Obstfeld, 2022; Aizenman et al., 2023). However, limited research has examined whether sanctions and financial fragmentation weaken or transform these transmission mechanisms. It therefore remains unclear whether external

financial conditions continue to dominate exchange rate determination when international financial integration is disrupted.

2.1.4 Geopolitical Risk, Sanctions, and Financial Fragmentation

Geopolitical risk disrupts trade, capital flows, financial transactions, and investor confidence, increasing exchange-rate volatility (Caldara & Iacoviello, 2022). Sanctions intensify these effects by restricting international capital, investment, financial intermediation, and payment systems (Crozet & Hinz, 2020; Ahn & Ludema, 2024).

For Russia, sanctions imposed since 2014 and expanded in 2022 have targeted financial institutions, reserves, payment systems, and energy exports. Consequently, ruble movements have become increasingly sensitive to geopolitical developments and global financial conditions despite domestic interventions (Ahn & Ludema, 2024).

Financial fragmentation further weakens market integration, capital allocation, and international risk sharing while altering the transmission of global shocks (IMF, 2023). However, few studies jointly examine geopolitical risk, sanctions, commodity dependence, and fragmentation in explaining long- and short-run exchange-rate dynamics. This gap motivates the present study.

2.1.5 Research Gap

Previous studies have identified domestic macroeconomic fundamentals, commodity prices, global financial conditions, and geopolitical factors as important determinants of exchange rates (Chen & Rogoff, 2003; Kilian, 2009; Caldara & Iacoviello, 2022). However, several research gaps remain.

First, these factors are generally examined separately, providing limited evidence on their simultaneous interaction, particularly during prolonged geopolitical disruptions. Second, although the Global Financial Cycle literature emphasizes external financial conditions, few studies assess whether sanctions and financial fragmentation alter the relative influence of domestic and external determinants. This issue is especially relevant for Russia because its exchange rate is shaped by commodity dependence, global financial shocks, and geopolitical constraints.

Third, previous research often uses separate econometric methods to examine long-run relationships, short-run adjustments, structural breaks, or shock transmission. Few studies integrate these dimensions within a unified framework. Moreover, the validity of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP) under prolonged sanctions and financial fragmentation remains insufficiently examined.

This study addresses these gaps by combining domestic fundamentals, external financial conditions, commodity prices, geopolitical shocks, and financial fragmentation within an ARDL–ECM–VAR framework with structural break analysis. This approach provides a comprehensive assessment of exchange rate determination in a commodity-dependent emerging economy facing prolonged geopolitical and financial constraints.

2.2 Theoretical Framework

2.2.1 Purchasing Power Parity (PPP)

Purchasing Power Parity (PPP) is one of the fundamental theories of exchange rate determination, proposing that exchange rates adjust to equalize the purchasing power of different currencies over time. According to the relative PPP hypothesis, changes in exchange rates are primarily driven by inflation differentials between countries. When

domestic inflation exceeds foreign inflation, the domestic currency is expected to depreciate to restore international price competitiveness (Rogoff, 1996; Engel, 2014).

The relative Purchasing Power Parity (PPP) condition states that the percentage change in the nominal exchange rate is determined by the inflation differential between the domestic and foreign economies. The relationship is expressed as follows:

$\Delta S\_t = \pi\_t - \pi\_t^*$

where:

ΔS_t= percentage change in the nominal USD/RUB exchange rate;

π_t= inflation rate in Russia;

π_t^*= inflation rate in the United States.

Although PPP provides a useful long-run benchmark, empirical studies frequently report deviations from parity because exchange rates are also affected by capital mobility, market frictions, government intervention, and external financial shocks. These deviations are expected to become even more pronounced under prolonged geopolitical sanctions and financial fragmentation. Accordingly, this study re-examines the validity of PPP for the Russian ruble under changing geopolitical and financial conditions, corresponding to Research Question 8 (RQ8).

2.2.2 Uncovered Interest Parity (UIP)

Uncovered Interest Parity (UIP) explains exchange rate movements through differences in nominal interest rates across countries. The theory states that currencies offering relatively higher interest rates are expected to depreciate sufficiently to offset the return advantage, thereby eliminating arbitrage opportunities in international financial markets (Fama, 1984; Engel, 2014) Formally, the UIP condition can be expressed as follows:

$$\boldsymbol{E_t}\left(\frac{\boldsymbol{S_{t+1}}-\boldsymbol{S_t}}{\boldsymbol{S_t}}\right) = \boldsymbol{i_t} - \boldsymbol{i_t^*}.$$

where

S_t= spot exchange rate (RUB per USD) at time t;

$E_t(S_{t+1})$= expected future exchange rate;

i_t= domestic nominal interest rate (Russia);

$\boldsymbol{i_t^*}$= foreign nominal interest rate (United States).

Despite its theoretical importance, UIP is frequently violated, a phenomenon known as the forward premium puzzle. Exchange rate expectations are shaped not only by interest rate differentials but also by risk premiums, capital controls, geopolitical uncertainty, and global financial conditions. These factors are especially relevant for Russia, where sanctions may weaken conventional monetary transmission. Therefore, this study examines whether interest rate differentials continue to explain exchange rate dynamics under prolonged sanctions, corresponding to RQ7.

2.2.3 Commodity Currency Theory

Commodity Currency Theory states that exchange rates in resource-dependent economies are influenced by international commodity prices through export revenues, fiscal balances, and foreign exchange earnings (Chen & Rogoff, 2003). Higher commodity prices generally improve external balances and support currency appreciation, while lower prices have the opposite effect.

This theory is particularly relevant to Russia because of its dependence on oil and natural gas exports. Brent oil prices are expected to affect the USD/RUB exchange rate through export income, government revenue, and foreign exchange inflows. However, sanctions may alter these channels by restricting trade, export destinations, and financial transactions. Accordingly, the role of oil prices under geopolitical constraints is examined in RQ3.

2.2.4 Global Financial Cycle Theory

The Global Financial Cycle theory emphasizes the role of global liquidity, capital flows, investor risk sentiment, and the US dollar in shaping financial markets and exchange rates (Rey, 2016). External shocks, particularly those associated with US monetary policy, influence portfolio allocation, capital flows, and currency valuations in financially integrated economies (Miranda-Agrippino & Rey, 2020). The Dominant Currency Paradigm further argues that the US dollar's central role in global trade and finance amplifies the transmission of external shocks across exchange rate regimes (Gopinath et al., 2020).

For Russia, these effects operate through commodity exports, capital mobility, and external financing. However, sanctions may reduce financial integration and alter capital flow patterns. The Global Financial Cycle therefore provides the theoretical basis for examining whether external financial variables dominate exchange rate determination under geopolitical uncertainty, corresponding to RQ1, RQ2, and RQ6.

2.2.5 Financial Fragmentation Framework

Financial fragmentation refers to the segmentation of global financial markets caused by geopolitical conflicts, sanctions, trade restrictions, and declining cross-border integration. It weakens financial linkages, reduces market integration, and alters the transmission of global shocks, causing exchange rates to reflect geopolitical constraints more strongly (International Monetary Fund [IMF], 2023).

Sanctions affect exchange rates by restricting capital flows, financial transactions, payment systems, and foreign reserve management. These restrictions reduce external financing and increase volatility, potentially weakening the relationships predicted by PPP, UIP, and conventional international finance models (Ahn & Ludema, 2024).

Russia provides a relevant case because sanctions imposed since 2014 and expanded in 2022 have changed the interaction among domestic fundamentals, commodity markets, and external financial conditions. This framework explains structural changes in the USD/RUB exchange rate, supports RQ4 and RQ5, and complements the Global Financial Cycle perspective. Figure 3 illustrates these transmission mechanisms.

Figure 3.

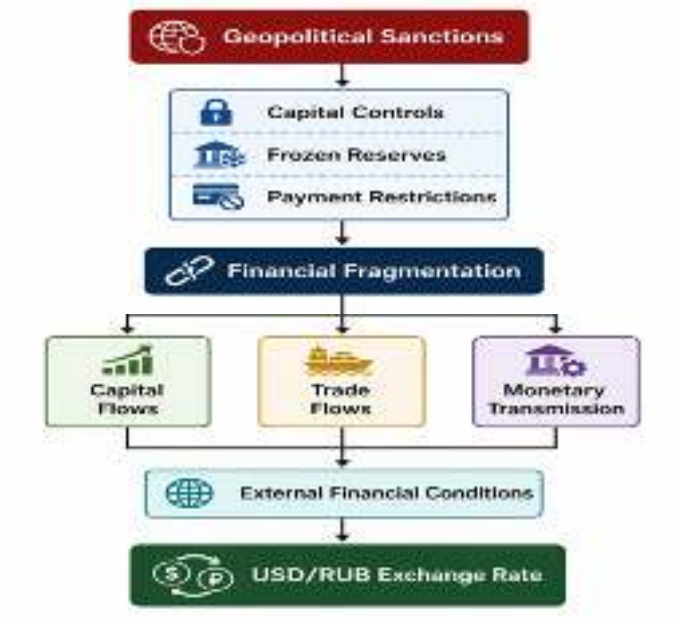

Figure 3 shows how geopolitical sanctions affect exchange rates through financial restrictions, including capital controls, frozen reserves, and payment disruptions. These measures intensify financial fragmentation, alter capital flows, trade financing, and monetary transmission, and increase the influence of external financial conditions on the USD/RUB exchange rate. This framework underpins the ARDL, ECM, VAR, and structural break analyses.

3. Methods and Data Description.

This case study began with monthly time-series data for 2005–2025 and examines the factors behind the fluctuation of the exchange rate between US dollars (USD) and Russian rubles (RUB). Frequency is a key metric in applied time-series econometrics. This analysis examines only short-term fluctuations, but medium-term dynamics as well, for which monthly frequency is desirable.

The data include global financial indicators, commodity prices, domestic macroeconomic data, and real sector indicators. Most variables were defined using natural logarithms for consistency and interpretability, as this allows for the interpretation of the estimated coefficients as elasticities, and because natural logarithms stabilize variance.

The data revealed the presence of structural breaks associated with major political and economic events, indicating the necessity of including two dummy variables that could account for potential regime changes into the model specification.

The definitions of the variables and sources of the data are given in Tables 1 and 2.

Table 1. Definition of Variables and Data Sources.

Variable	Symbol	Measurement	Expected Effect	Theoretical Basis	Source
Exchange Rate	lnEXR	RUB per USD (log)	—	—	Federal Reserve Economic Data (FRED)
US Dollar Index	lnDXY	Index (log)	(+)	Global Financial Cycle	Federal Reserve / Trading Economics
Global Risk	VIX	Volatility Index	(+)	Risk Aversion	Chicago Board Options Exchange (CBOE)
Oil Price	lnOIL	USD/barrel (log)	(–)	Commodity Currency	U.S. Energy Information Administration (EIA)
Interest Rate Differential	IRD	Russia – US (%)	(–)	Interest Rate Parity	Central Bank of Russia; Federal Reserve
Inflation Differential	INFDIFF	Russia – US (%)	(+)	Purchasing Power Parity	Rosstat; U.S. Bureau of Labor Statistics
Inflation (Russia)	INFRUS	CPI (%)	(+)	Monetary / Price Dynamics	Rosstat
Inflation (United States)	INFUSA	CPI (%)	(–)	External Price Effect	U.S. Bureau of Labor Statistics
Policy Interest Rate (Russia)	KEYRATE	%	(–)	Monetary Policy Transmission	Central Bank of Russia
Federal Funds Rate	FF	%	(+)	Global Liquidity / Monetary Spillover	Federal Reserve
Industrial Production	lnIPI	Index (log)	(–)	Real Sector Effect	Rosstat / FRED
Money Supply	lnM3	RUB billion (log)	(+)	Monetary Model	Central Bank of Russia

Foreign Reserves	lnRES	USD billion (log)	(–)	Reserve Buffer Theory	Central Bank of Russia
Exports	lnEXP	USD billion (log)	(–)	Trade Balance	Trading Economics / official statistics
Imports	lnIMP	USD billion (log)	(+)	Trade Balance	Trading Economics / official statistics

Source: Author's compilation based on data from federal reserve economic data (FRED), U.S. Energy Information Administration (EIA), Chicago Board Options Exchange (CBOE), Central Bank of Russia, Rosstat, U.S. Bureau of Labor Statistics, and Trading Economics.

Table 2. Structural Break Dummies and Theoretical Basis.

Dummy	Period	Description	Theoretical Basis	Source
GFC	2008–2009	Global Financial Crisis	Crisis Transmission (Bernanke, 2005)	International Monetary Fund (IMF)
CRIMEA	2014–2015	Crimea crisis & oil price collapse	Geopolitical Risk (Caldara & Iacoviello, 2018)	World Bank
COVID	2020–2021	Global pandemic shock	Global Uncertainty (Baker et al., 2020)	World Health Organization (WHO)
WAR	2022–present	Russia–Ukraine conflict & sanctions	Sanctions & External Shock (Klose, 2024)	World Bank

Source: Author's compilation based on IMF, World Bank, World Health Organization, and related literature.

The motivation for including oil prices is based on the commodity currency hypothesis, according to which in resource-exporting economies there is a negative response of commodity prices and exchange rates (Chen & Rogoff, 2003). Moreover, following standard parity conditions (namely uncovered interest parity and purchasing power parity), other variables such as interest rate differentials (IRD) and inflation differentials (INFDIFF) are included.

Real sector activity and monetary conditions are represented by including domestic variables such as lnIPI (industrial production), lnM3 (money supply), and lnRES (foreign reserves). Such growth within the model adds to its ability to describe internal macroeconomic dynamics, which is an important feature in the context of emerging markets.

3.1. Structural Break Variables

Dummy variables associated with major geopolitical events are incorporated as proxies for structural regime shifts rather than as direct measures of geopolitical fragmentation. Their purpose is to identify changes in exchange-rate behavior across sanction-related periods and major geopolitical episodes. Consequently, the empirical analysis focuses on regime-dependent exchange-rate dynamics instead of quantifying the intensity of geopolitical fragmentation itself. (Table 3).

Table 3. Theoretical Basis for the Structural Break Dummies.

Dummy	Period	Description	Source
GFC	2008–2009	Global financial crisis	IMF
CRIMEA	2014–2015	Geopolitical shock	World Bank
COVID	2020–2021	Pandemic shock	WHO
WAR	2022–present	Conflict and sanctions	World Bank

Source: Author's compilation.

These dummy variables allow us to control for specific uncertainty spikes and structural breaks as they occur during the global financial crisis (2008–2009), the Crimea crisis (2014–2015), the COVID-19 pandemic (2020–2021), and the Russia–Ukraine conflict (2022–present).

In applied econometrics, accounting for structural breaks at the correct time in the time series can be critical; otherwise, regime shifts can result in biased estimates of the parameters (Perron, 1989).

3.2. Descriptive Statistics: Preliminary Data Analysis

Table 4 shows descriptive statistics and a summary of the central tendency, dispersion, and distributional shape of the variables.

Table 4. *Descriptive Statistics.*

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
lnEXR	3.844	0.463	3.151	4.702	0.017	1.392
IRD	13.073	2.697	4.696	17.587	-0.906	3.340
INFDIFF	3.755	4.239	-6.618	25.622	0.678	5.122
lnDXY	4.653	0.116	4.458	4.860	-0.017	1.522
VIX	19.128	8.348	10.130	64.460	2.515	11.806
lnOIL	4.274	0.330	2.911	4.888	-0.462	3.363
KEYRATE	14.767	1.819	10.026	19.441	-0.223	2.514
FF	1.694	1.911	0.050	5.330	0.867	2.201
INFRUS	6.351	3.805	-0.624	28.675	1.403	7.207
INFUSA	2.596	1.885	-1.959	8.979	1.032	4.878
lnIPI	4.615	0.119	4.358	4.812	-0.273	2.125
lnM3	10.624	0.598	8.407	11.392	-0.907	3.260
lnRES	5.700	0.514	4.207	6.434	-0.767	2.855
lnEXP	5.743	0.342	4.934	6.270	-0.473	2.227
lnIMP	5.339	0.352	4.494	5.882	-0.497	2.229

Source: Author's calculation.

The findings suggest that most of the variables are moderately variable, contrary to some financial indicators, such as VIX, which have high volatility and non-normal distribution, as shown from the skewness and kurtosis measures.

Correlation analyses for the core variables (Table 5) and extended variables (Table 6) provide insight into the relationships across the selected variables.

Table 5. Correlation Matrix (Core Variables).

Variable	lnEXR	lnDXY	lnOIL	IRD	INFDIFF	KEYRATE	lnIPI
lnEXR	1.000	0.939	-0.304	-0.536	-0.586	-0.765	0.816
lnDXY	0.939	1.000	-0.410	-0.587	-0.532	-0.706	0.708
lnOIL	-0.304	-0.410	1.000	0.039	-0.164	0.014	0.185
IRD	-0.536	-0.587	0.039	1.000	0.332	0.706	-0.528
INFDIFF	-0.586	-0.532	-0.164	0.332	1.000	0.572	-0.656
KEYRATE	-0.765	-0.706	0.014	0.706	0.572	1.000	-0.773
lnIPI	0.816	0.708	0.185	-0.528	-0.656	-0.773	1.000

Source: Author's calculation.

Table 6. Correlation Matrix (Extended Variables).

Variable	VIX	FF	INFRUS	INFUSA	lnM3	lnRES	lnEXP	lnIMP

VIX	1.000	0.060	-0.007	-0.013	0.004	-0.012	-0.046	-0.038
FF	0.060	1.000	0.129	0.090	-0.102	-0.090	-0.051	-0.092
INFRUS	-0.007	0.129	1.000	0.004	-0.664	-0.637	-0.665	-0.649
INFUSA	-0.013	0.090	0.004	1.000	0.101	0.126	0.158	0.173
lnM3	0.004	-0.102	-0.664	0.101	1.000	0.970	0.971	0.948
lnRES	-0.012	-0.090	-0.637	0.126	0.970	1.000	0.954	0.933
lnEXP	-0.046	-0.051	-0.665	0.158	0.971	0.954	1.000	0.946
lnIMP	-0.038	-0.092	-0.649	0.173	0.948	0.933	0.946	1.000

Source: Author's calculation.

The exchange rate generally has a positive correlation with the US dollar index, which reflects that global financial factors affect the exchange rate. However, there is a statistically significant negative correlation between oil price and exchange rate, giving early evidence for the commodity currency hypothesis.

The high correlations between the fractions of reserves in monetary aggregates and trade show some potential for multicollinearity. Specification design and robustness checks, addressed in step three of the econometric modeling stage, alleviate this issue.

3.3. Unit Root and Integration Properties

Before estimation of the models of these variables, unit root tests are typically examined, as shown in Table 7.

Table 7. Unit Root Test Results.

Variable	Level ADF	Prob.	Stationary (Level)	1st Diff ADF	Prob.	Stationary (1st Diff)	Integration	Remarks
lnEXR	-1.144	0.6986	No	-12.073	0.0000	Yes	I(1)	Non-stationary, becomes stationary after differencing
lnDXY	-1.234	0.6602	No	-10.394	0.0000	Yes	I(1)	Requires differencing
VIX	-5.107	0.0000	Yes	-14.125	0.0000	Yes	I(0)	Stationary at level
lnOIL	-3.620	0.0060	Yes	-10.967	0.0000	Yes	I(0)	Stationary at level
IRD	-0.996	0.7552	No	-11.834	0.0000	Yes	I(1)	Integrated of order one
INFDIFF	-1.720	0.4199	No	-6.381	0.0000	Yes	I(1)	Becomes stationary after differencing
KEYRATE	-0.832	0.8077	No	-10.598	0.0000	Yes	I(1)	Strong unit root at level
FF	-2.569	0.1008	No*	-6.818	0.0000	Yes	I(1)	Weak at level, treated as non-stationary
INFRUS	-2.273	0.1817	No	-7.056	0.0000	Yes	I(1)	Non-stationary, stationary after differencing
INFUSA	-2.740	0.0688	Weak	-4.114	0.0011	Yes	I(1)	Marginal at level, treated as I(1)
lnM3	-7.229	0.0000	Yes	-12.568	0.0000	Yes	I(0)	Strongly stationary
lnRES	-3.237	0.0191	Yes	-10.956	0.0000	Yes	I(0)	Stationary at level
lnEXP	-3.536	0.0079	Yes	-13.475	0.0000	Yes	I(0)	No differencing required
lnIMP	-0.978	0.7615	No	-15.304	0.0000	Yes	I(1)	Clearly non-stationary

Source: Author's calculation through using ADF tests.

Output results demonstrate the presence of some combination of I(0) and I(1) variables. Some global and macroeconomic variables are stationary at levels, but most variables in the domestic economy only become stationary after first differencing.

Given the combination of integrations, where the variables are I(0) and I(1), we justify applying the autoregressive distributed lag (ARDL) framework since it permits both I(0) and I(1) variables (Pesaran et al., 2001). And more importantly, none of the variables is I(2), which is a critical assumption of ARDL being applicable.

3.4. Graphical Analysis

3.4.1. Dynamics of Exchange Rate and Crisis Episodes

Regime shifts in the USD/RUB exchange rate 2005–2025 readily show up when connected with clearly observable global and geopolitical events (Figure 2). Before 2008, we had some stability, whereas in the period of the global financial crisis, there was much more volatility. A larger depreciation took place during 2014–2015 in response to plunging oil prices and external sanctions.

Then the COVID-19 shock in 2020 created further instability, but it was milder. The strongest rupture came in 2022 when geopolitical conflict launched the prices into extreme volatility, with sanctions and monetary restrictions working together. In general, the ruble has high sensitivity to external shocks, which is a corollary of global financial cycle theory.

Figure 4. Regime Shifts in the USD/RUB Exchange Rate 2005–2025. Source: Author's calculation. Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.2. Oil Prices and the Commodity Currency Hypothesis

Log–log co-movements between the log of the USD/RUB and the log of the price of oil (in USD per barrel) on the USD/RUB picture (log–log scale) are shown in Figure 5. The ruble is strong when oil prices are up, and weak when oil prices are down. This fits the commodity currency regime explanation, where for export-oriented economies such as CAD ones, the currency is highly reactive to commodity prices.

This relationship holds in basic form until 2022, when the relationship weakens, hinting at structural disruption. In this respect, measures such as capital controls and sanctions may have shifted the traditional transmission mechanism. This changing behavior highlights the necessity of including structural break dummies in empirical analyses.

Figure 5. USD/RUB and Brent Oil prices (Log Scale). Source: Exchange rate data from; oil price data from EIA / World Bank. Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.3. Real Sector Activity and Monetary Policy Response

Figure 6 shows the responses to an interaction of output and monetary policy. The Industrial Production Index rises over time with busts during crises. Output fell very sharply in response to the GFC and COVID-19 shocks.

Monetary policy reacted by changing the main policy rate. The most significant deterioration took place in 2022, in order to stabilize the exchange rate and keep inflation down. This corresponds to common monetary policy responses in emerging markets.

Figure 6. Industrial Production Index (IPI) and Key Policy Rate (2005–2025). Source: Author's calculation. Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.4. Econometric Implications

Table 5 presents preliminary evidence of the presence of a combination of stationary and non-stationary variables. This allows for the consideration of the ARDL framework, one that allows for variables that are integrated in different orders (Pesaran et al., 2001).

The correlation structure shows that global, domestic, and real sector variables are likely to be highly interdependent with one another. Although potential multicollinearity exists, it is addressed through robustness checks and careful model specification. Hence, it is crucial to have the structural break dummies that capture regime shifts to avoid biased estimates.

Synthesis of Findings

The graphical and statistical evidence consistently show that:

(i) RUB volatility is highly sensitive to external shocks;

(ii) oil prices negatively correlate with the exchange rate;

(iii) this relationship is regime-dependent;

(iv) monetary policy stabilizes the economy during crises, as expected;

Such findings are in line with theoretical expectations as well as evidence on commodity-dependent countries.

3.4.5. Econometric Strategy

Empirical Framework

An autoregressive distributed lag–error correction modeling–vector autoregression (ARDL–ECM–VAR) structural break approach, as the combined time-series framework is employed to conduct a comparative analysis of the USD/RUB dynamics. This strategy seeks to include long-run relationships, short-run adjustments, and regime shifts, reflecting the time-varying nature of shock transmission.

The dependent variable is:

$$lnEXR_t = \ln (USD/RUB)_t$$

where $lnEXR_t$ represents the logarithm of the USD/RUB exchange rate at time t.

Baseline External and Commodity ARDL as Determinants

We show our baseline model that evaluates global financial conditions and commodity prices:

$$lnEXR_t = \alpha_o + \alpha_1 lnDXY_t + \alpha_2 VIX_t + \alpha_3 lnBRENT_t + \varepsilon_t$$

This specification supports the baseline empirical results described below in Chapter 5 and addresses the role of external drivers.

Related RQ: RQ1 and RQ3. Expected signs are:

$\alpha_1>0$, $\alpha_2>0$, $\alpha_3<0$

Domestic Fundamentals Model

To evaluate domestic macroeconomic fundamentals, the following model is estimated:

$$lnEXR_t = \beta_o + \beta_1 KEYRATE_t + \beta_2 INFRUSIA_t + \beta_3 lnM3_t + \beta_4 lnRES_t + \beta_5 lnEXP_t + \beta_6 lnIMP_t + +\beta_7 lnIPI_t + \varepsilon_t$$

The inclusion of $lnIPI$ captures real sector activity and strengthens the domestic macroeconomic block.

Related RQ: RQ2. Expected signs:

$\beta_1<0$, $\beta_2>0$, $\beta_3>0$, $\beta_4<0$, $\beta_5<0$, $\beta_6>0$, $\beta_7<0$

Oil Price Model With Crisis Dummies

Given the importance of oil prices and geopolitical shocks, the oil-channel model includes external controls and structural dummy variables:

$$lnEXR_t = \delta_o + \delta_1 BRENT_t + \delta_2 lnDXY_t + \delta_3 lnVIX_t + \delta_4 DCRIMEA_t + \delta_5 DWAR_t + \varepsilon_t$$

This specification is consistent with the empirical results where oil prices are analyzed jointly with global financial variables and crisis effects.

Related RQ: RQ3. Expected signs:

$\delta_1<0$, $\delta_2>0$, $\delta_3>0$, $\delta_4>0$, $\delta_5>0$

Structural Break Model

To examine regime shifts, crisis dummy variables are incorporated into the ARDL framework:

$$lnEXR_t = \theta_o + \theta_1 lnDXY_t + \theta_2 VIX_t + \theta_3 lnBRENT_t + \theta_4 lnIPI_t + \gamma_1 DGFC_t + \gamma_2 DCRIMEA_t + \gamma_3 DCOVIDS_t + \gamma_4 DWAR_t + \varepsilon_t$$

The structural dummies capture major crisis periods, while $lnIPI_t$ controls for domestic real sector conditions.

Related RQ: RQ4. Bivariate autoregressive distributed lag model with dummies.

ARDL–ECM Representation

ECM representation estimates the short-run and adjustment dynamics:

$$\Delta \ln EXR_t = \phi_0 + \sum_{i=1}^{p} \phi_i \Delta \ln EXR_{t-i} + \sum_{j=0}^{q} \lambda_j \Delta X_{t-j} + \rho ECM_{t-1} + \varepsilon_t$$

$$\Delta lnEXR_t = \phi_o + \sum_{i=1}^{p} \phi_i \, \Delta lnEXR_{t-1} + \sum_{i=1}^{p} \lambda_j \, \Delta X_{t-j} + \rho ECM_{t-1} + \varepsilon_t$$

where X_t represents the relevant explanatory variables in each ARDL specification.

The error correction term is defined as:

$$ECM_{t-1} = \ln EXR_{t-1} - \hat{\beta} X_{t-1}$$

A negative and statistically significant ϱ\rhoϱ indicates adjustment toward equilibrium.

Related RQ: RQ5.

VAR Model for Shock Transmission

To examine dynamic interactions and shock transmission, the VAR model is specified as:

$$Y_t = A_o + \sum_{i=1}^{p} A_i \, Y_{t-i} + \varepsilon_t$$

where:

$$Y_t = \begin{bmatrix} lnEXR_t \\ lnBRENT_t \\ lnDXY_t \\ VIX_t \end{bmatrix}$$

Impulse response functions and forecast error variance decomposition are used to evaluate shock propagation.

Related RQ: RQ6. Tools: VAR, IRF, FEVD, Granger causality.

Monetary and Inflation Channels

The monetary channel is estimated as:

$$lnEXR_t = \omega_o + \omega_1 IRD_t + \omega_2 lnDXY_t + \omega_3 lnBRENT_t + \omega_4 VIX_t + \varepsilon_t$$

Interpretation:

- IRD_t: interest rate differential (e.g., Russia vs. US)
- ω_1: captures the monetary policy / capital flow channel

Expected sign:

- ω_1<0: higher domestic interest rates → capital inflows → ruble appreciates

The inflation channel is specified as:

$$lnEXR_t = \pi_o + \pi_1 INFDIFF_t + \pi_2 lnDXY_t + \pi_3 lnBRENT_t + \pi_4 VIX_t + \varepsilon_t$$

Interpretation:

- $INFDIFF_t$: inflation differential (Russia − foreign, typically US)
- π_1: captures the purchasing power parity (PPP) mechanism

Expected sign:

- π_1>0: higher domestic inflation → loss of purchasing power → ruble depreciates

Related RQ: RQ7 and RQ8

Integrated Mapping Framework

Table 8. Integrated Mapping of Research Questions, Equations, and Empirical Tools.

RQ	Equation	Empirical focus	Model and tools
RQ1	Eq. (1)	Global financial effects	ARDL, Bounds Test
RQ2	Eq. (2)	Domestic fundamentals including lnIPI	ARDL
RQ3	Eq. (3)	Oil price effect with crisis controls	ARDL, Dummy variables
RQ4	Eq. (4)	Structural breaks and regime shifts	ARDL with dummies, Chow, Bai–Perron
RQ5	Eq. (5)	Short-run adjustment and ECM	ARDL–ECM
RQ6	Eq. (6)	Shock transmission	VAR, IRF, FEVD, Granger
RQ7	Eq. (7)	Interest rate differential	ARDL
RQ8	Eq. (8)	Inflation differential	ARDL

Source: Author's formulation.

Estimation Procedure

The empirical analysis includes five steps and four stages. To examine the order of integration, the first step was to run the ADF and Phillips–Perron tests. In the second step, the ARDL models are run for the baseline, domestic, oil, structural, monetary, and inflation specifications. Third, bounds tests were performed to check for possible long-run relationships. Fourth, ECM representations are used to estimate short-run adjustment. Fifth, IRF, FEVD, and Granger causality analysis of VAR are used to study shock transmission.

Finally, the robustness of the models is evaluated through diagnostic and stability tests that include serial correlation, heteroskedasticity, normality, CUSUM, and CUSUMSQ tests.

4. Empirical Results

4.1. Baseline ARDL Model

This chapter generalizes the baseline ARDL model on the influence of financial conditions and commodity prices on USD/RUB.

The estimation results suggest that the oil price as well as the US dollar index are statistically significant explanatory variables for the exchange rate movements. In particular, the price of oil has a negative and highly significant coefficient; higher oil prices lead to an appreciation of the home currency. On the other hand, the US dollar index has a positive and significant influence, meaning global foreign financial conditions push the exchange rate up.

As indicated by the results in Table 9, market volatility (VIX) has a statistically insignificant impact on the baseline specification. The dependent variable is ln(USD/RUB). The model is ARDL(4,2,3,2). The estimator is HAC (Newey–West robust standard errors).

Table 9. Baseline ARDL Model: Global Financial and Commodity Drivers of USD/RUB Exchange Rate.

Variable	Coefficient	Std. Error	t-Statistic	p-value
Long-run effects				
ln(BRENT)	-0.1017	0.0244	-4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	-0.5143	0.3081	-1.669	0.0965
Short-run dynamics				
Δln(BRENT)	-0.1017	0.0244	-4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(-1)	-0.0020	0.0005	-3.926	0.0001
ΔVIX(-2)	0.0021	0.0004	4.675	0.0000
Error correction term				
CointEq(-1)	-0.0243	0.0038	-6.395	0.0000
Model diagnostics				
Statistic			Value	
R-squared			0.9968	
Adjusted R-squared			0.9965	
F-statistic			3497.69	
Prob(F-stat)			0.0000	
Durbin-Watson			1.98	

Notes: Δ denotes first-difference operator. Lag structure selected based on Akaike Information Criterion (AIC). HAC (Newey–West) standard errors are applied to ensure robustness. Source: Author's estimation. In brief, as confirmed by the baseline model, the exchange rate dynamics are primarily driven by external factors. The role of global liquidity as an exogenous driver of exchange rate dynamics is consistent with the global financial cycle hypothesis (Rey, 2016).

4.2. Long-Run Relationship and Cointegration

We employ the ARDL bounds testing approach (Pesaran et al., 2001) to assess the existence of a long-run equilibrium relationship.

Research results indicate that the F-statistic lies in the inconclusive region, suggesting weak evidence of cointegration.

Although important variables such as oil prices and the US dollar index are long-run level data with statistical significance, the lack of a clear cointegration relationship indicates that the system does not converge to a stable equilibrium. In Table 10, the dependent variable is ln(USD/RUB), the model is ARDL(4,2,3,2), and the cointegration test is the Pesaran et al. (2001) bounds test.

Table 10. Results of Long-Run Relationship and Bounds Test Using ARDL.

Panel A: Long-run coefficients				
Variable	Coefficient	Std. Error	t-Statistic	p-value
ln(BRENT)	-0.1017	0.0244	-4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	-0.5143	0.3081	-1.669	0.0965
Panel B: ARDL bounds test for cointegration				

Test Statistic	Value
F-statistic	2.934
Lower Bound I(0)	2.79
Upper Bound I(1)	3.67
Decision	Inconclusive

Panel C: Interpretation summary

Aspect	Result	Implication
Cointegration	Weak / Inconclusive	No strong long-run equilibrium
Long-run coefficients	Significant (BRENT, DXY)	Economic relationship exists
Stability of equilibrium	Weak	Potential structural instability

Notes: Critical values follow Pesaran et al. (2001). The null hypothesis is no cointegration. Decision rule: F > I(1) → cointegration; F < I(0) → no cointegration; Between → inconclusive. Source: Author's estimation.

The ARDL bounds test yields an F-statistic of 2.934, which falls within the inconclusive region of the Pesaran et al. (2001) critical values. Therefore, a stable long-run cointegrating relationship cannot be statistically confirmed. Although the estimated level coefficients for Brent oil prices and the US dollar index are statistically significant, these results should not be interpreted as conclusive evidence of long-run equilibrium. In addition,the bounds test does not provide robust evidence of a long-run relationship, Accordingly, the analysis places greater emphasis on short-run dynamics and structural instability. The very slow adjustment process and recurrent structural breaks associated with sanctions and geopolitical shocks indicate that exchange-rate deviations remain persistent and that the restoration of long-run PPP and UIP relationships is repeatedly disrupted on short-run dynamics and structural instability rather than long-term equilibrium.

4.3. Dynamics of the Court-Term and the Error Correction Mechanism

The error correction model from the ARDL specification is used for investigating the short-run dynamics.

The error correction mechanism is weakly negative and significant. However, there is a low speed of adjustment toward equilibrium with a low coefficient magnitude.

The short-horizon coefficients indicate that oil prices and the US dollar index have a highly significant and transitory impact on exchange rates.

Given the inconclusive evidence of cointegration, the ECM results are interpreted primarily as evidence of short-run adjustment dynamics rather than confirmation of a stable long-run equilibrium

In Table 11, the dependent variable is Δln(USD/RUB), the model is ECM derived from ARDL(4,2,3,2), and the estimator is HAC (Newey–West robust standard errors).

Table 11. Dynamic in the Short Term and the Mechanism of Error Correction.

Panel A: Error Correction Term

Variable	Coefficient	Std. Error	t-Statistic	p-value
CointEq(-1)	-0.0243	0.0038	-6.395	0.0000

Panel B: Short-run dynamics

Variable	Coefficient	Std. Error	t-Statistic	p-value
Δln(BRENT)	-0.1017	0.0244	-4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(-1)	-0.0020	0.0005	-3.926	0.0001
ΔVIX(-2)	0.0021	0.0004	4.675	0.0000

Panel C: Adjustment dynamics

Metric	Value	Interpretation
Speed of Adjustment	2.43% per month	Very slow convergence
Half-life	~28 months	Long adjustment period

Panel D: Model diagnostics

Statistic	Value
R-squared	0.9969
Adjusted R-squared	0.9966
F-statistic	2874.52
Prob(F-stat)	0.0000
Durbin-Watson	2.13

Notes: Δ denotes first-difference operator. The error correction term captures the speed of adjustment toward equilibrium. Half-life is computed based on the adjustment coefficient. HAC (Newey–West) standard errors are used for robustness. Source: Author's estimation.

The estimated ECM coefficient (-0.0243) implies that only about 2.4% of deviations from equilibrium are corrected each month, corresponding to a half-life of approximately 28 months. This exceptionally slow adjustment is consistent with a regime of structural decoupling, in which prolonged sanctions, capital controls, and recurring geopolitical shocks weaken domestic market-clearing mechanisms. Consequently, exchange-rate deviations persist for extended periods and remain only weakly anchored to traditional macroeconomic fundamentals.

There are weak convergence dynamics. The results indicate that deviations from equilibrium are persistent over time.

4.4. Structural Breaks and Changes in Regimes

As regime changes in the system can render the analysis invalid, structural break tests are used in order to locate any regime breaks.

The outcomes are consistent with highly relevant structural breaks associated with important economic and geopolitical events such as the 2014 Crimea crisis and the 2022 Russia–Ukraine war. Dummy variables here indicate that these shocks have significant short-run impacts on exchange rate dynamics. In Table 12, the dependent variable is ln(USD/RUB), the model is: ARDL(4,2,3,2,0,4) with structural dummies, and the estimator is HAC (Newey–West robust standard errors).

Table *12.* Structural Breaks and the Regime Dynamics of the Exchange Rate.

Panel A: Structural break effects (long-run)

Variable	Coefficient	Std. Error	t-Statistic	p-value
DUMMY_CRIMEA (2014)	0.0189	0.0072	2.635	0.0090
DUMMY_CONFLICT (2022)	0.0300	0.0289	1.041	0.2992

Panel B: Short-run impact of structural shocks

Variable	Coefficient	Std. Error	t-Statistic	p-value
ΔDUMMY CRIMEA(-1)	0.0592	0.0270	2.193	0.0293
ΔDUMMY_ CONFLICT (-1)	0.3004	0.0392	7.669	0.0000
ΔDUMMY CONFLICT (-2)	-0.7986	0.0441	-18.095	0.0000
ΔDUMMY CONFLICT (-3)	0.4011	0.0659	6.083	0.0000

Panel C: Structural break tests

Test	Break Date	Statistic	p-value	Conclusion
Chow Test	2014M03	8.215	0.0000	Structural break
Chow Test	2022M02	12.564	0.0000	Strong break
Bai–Perron	Multiple	—	—	Multiple regime shifts

Panel D: Interpretation summary

Aspect	Result	Implication
Crimea Shock	Significant	Persistent exchange rate shift
Conflict Shock	Highly volatile	Strong short-run disruption
Structural Stability	Rejected	Regime-dependent dynamics

Notes: Dummy variables capture major geopolitical events affecting the Russian economy. Chow test evaluates known breakpoints, while Bai–Perron identifies multiple breaks endogenously. Δ denotes first-difference operator. Source: Author's estimation.

The results indicate possible regime shifts associated with major geopolitical events and that the underlying dynamics are influenced by structural shifts.

4.5. VAR-Based Dynamic Analysis

To dig deeper into some of the dynamic interactions, a VAR approach is estimated, and impulse response functions, variance decomposition, and Granger causality tests are performed.

The results of Granger causality show that oil prices are predictive of exchange rate behavior. The analysis of the impulse response shows that the effects of shocks to the oil price are transient, while shocks to the US dollar index are lasting.

Similar results hold when looking at variance decomposition attempts, where most of the important changes in movement are caused by own impulse and exogenous drive only marginally. For Table 13, the variables are: ln(USD/RUB), ln(BRENT), ln(DXY), and VIX, the model is VAR(3), and the estimation period is monthly data for the period 2005–2025.

Although the FEVD indicates that approximately 97.5% of exchange-rate variance is explained by its own innovations, this does not diminish the role of external financial factors. Instead, it suggests that external shocks become highly persistent through domestic mechanisms reinforced by capital controls, exchange-rate interventions, monetary tightening, and financial market segmentation following the 2022 sanctions. Consistent with this interpretation, the ARDL and ECM results identify Brent oil prices and the US Dollar Index as the primary channels of shock transmission, while the FEVD shows that subsequent exchange-rate dynamics are dominated by domestic persistence. These findings indicate that exchange-rate stabilization increasingly relied on domestic policy interventions after the initial external shocks.

Table *13.* VAR for Dynamic Analysis of Shocks, Transmission, and Interaction Effects.

Panel A: Granger causality (exchange rate equation)

Excluded Variable	Chi-square	p-value	Conclusion
ln(BRENT)	11.496	0.0093	Oil → Exchange Rate
ln(DXY)	2.089	0.5542	No causality
VIX	2.690	0.4419	No causality

Panel B: Impulse response function (IRF summary)

Shock	Direction	Peak Response	Duration	Interpretation
BRENT	Negative	Period 2	Short-lived	Oil strengthens RUB
DXY	Positive	Period 2	Persistent	Financial dominance
VIX	Mixed	Period 1–3	Very short	Weak risk transmission

Panel C: Variance decomposition (FEVD summary)

Variable	Contribution (%)	Interpretation
Own Shock (USD/RUB)	~97.5%	Strong persistence
BRENT	~1.2%	Limited oil influence
DXY	~0.5%	Weak financial impact
VIX	~0.9%	Minor risk effect

Panel D: System stability

Test	Result	Interpretation
Root Stability	All < 1	VAR is stable
Cointegration (Johansen)	Not detected	No long-run system

Notes: VAR lag length selected based on AIC and FPE criteria. IRF responses are based on Cholesky decomposition. FEVD reported at medium-to-long horizon. Granger causality uses Wald test statistics. Source: Author's estimation.

The results point to a very weak transmission of external shocks and very persistent exchange rate properties.

The temporary response to oil shocks is aligned with other studies documenting the transitory effects of commodity price shocks (Kilian, 2009).

4.6. Robustness Checks

Diagnostic and stability tests are performed for the reliability of the results.

The diagnostic tests reveal no signs of serial correlation, heteroskedasticity, or model misspecification. The parameters of the model also pass the stability test; we notice some of them are stable, probably for a long time; however, small deviations are seen. For Table 14, the models tested are ARDL and ECM specifications and the estimation method is HAC (Newey–West robust standard errors).

Table 14. Opinion Robustness Checks: Diagnostic and Stable Tests.

Panel A: Diagnostic tests

Test	Null Hypothesis	Statistic	p-value	Conclusion
Breusch–Godfrey LM	No serial correlation	1.842	0.160	Not rejected
ARCH Test	No heteroskedasticity	1.215	0.305	Not rejected
White Test	Homoskedasticity	2.104	0.148	Not rejected
Jarque–Bera	Normal distribution	1.732	0.421	Not rejected
Ramsey RESET	Correct specification	1.564	0.213	Not rejected

Panel B: Stability tests

Test	Result	Interpretation
CUSUM	Within bounds	Stable parameters
CUSUMSQ	Within bounds (minor deviation)	Mild instability
Recursive Residuals	Stable	No explosive behavior

Panel C: Alternative specifications

Specification	Key Result	Consistency
Without dummies	Coefficients stable	✓ Robust
With dummies	Improved fit	✓ Preferred
Reduced model	Similar signs	✓ Consistent

Panel D: Summary Assessment

Aspect	Result	Implication
Model validity	Confirmed	Reliable estimation
Stability	Mostly stable	Minor structural variation
Specification	Correct	No misspecification bias

Notes: All tests are conducted at the 5% significance level. HAC standard errors ensure robustness against heteroskedasticity and autocorrelation. Stability tests assess parameter constancy over time. Source: Author's estimation.

In general, the empirical findings do not result from arbitrary factors, confirming the robustness of the findings.

4.7. Other Channels: Money and Inflation Effects

This includes traditional macroeconomic channels, like interest rate differentials or inflation differentials.

Table 15 presents the results of the extended ARDL specification, where the dependent variable is ln(USD/RUB) and the explanatory variables include the interest-rate differential (IRD), inflation differential (INFDIFF), ln(DXY), ln(BRENT), and VIX. The interest-rate and inflation differentials are statistically insignificant, whereas Brent crude oil prices have a significant negative effect and the US Dollar Index has a significant positive effect. These findings indicate that oil prices and global dollar conditions remain the primary determinants of the USD/RUB exchange rate, while conventional monetary channels have limited explanatory power.

Table *15.* Other Channels: Interest Rate Divergence and Inflation Effects.

Panel A: Monetary channel (interest rate differential)

Variable	Coefficient	Std. Error	t-Statistic	p-value
IRD	-0.0021	0.0034	-0.618	0.537
ΔIRD	0.0013	0.0028	0.464	0.643

Panel B: Inflation channel

Variable	Coefficient	Std. Error	t-Statistic	p-value
INFDIFF	-0.0018	0.0025	-0.720	0.472
ΔINFDIFF	0.0009	0.0019	0.474	0.636

Panel C: Control variables

Variable	Coefficient	Std. Error	t-Statistic	p-value
ln(BRENT)	-0.0982	0.0251	-3.913	0.0001
ln(DXY)	0.9014	0.1692	5.327	0.0000
VIX	0.0006	0.0004	1.512	0.131

Panel D: Summary interpretation

Channel	Result	Implication
Interest Rate	Not significant	Weak monetary transmission
Inflation	Not significant	PPP not supported
External Variables	Significant	External dominance

Notes: IRD = Interest rate differential (Russia–US). INFDIFF = Inflation differential. Model estimated using ARDL framework with HAC standard errors. Δ denotes first-difference operator. Source: Author's estimation.

Therefore, these results provide evidence against the well-established macroeconomic and monetary theoretical approaches that usually describe in the short term one-to-one relations between interest rate and exchange rates (interest rate parity), as well as the quantities of real money and real exchange rate (purchasing power parity).

4.8. Summary of Empirical Findings

This section summarizes the empirical findings (Table 16).

First, global financial conditions and the behavior of commodity prices are the main determinants of exchange rate dynamics. Second, the presence of a stable long-run equilibrium is not well supported, and the adjustment process is slow. Third, structural breaks are important; that is, exchange rate behavior is subject to regime changes. Finally, the data do not support traditional macroeconomic channels.

Table 16. Summary of Empirical Findings.

Panel A: Key empirical results

Aspect	Main Finding	Evidence
Global Financial Factors	Strong and significant	DXY consistently positive and significant
Oil Prices	Significant but short-lived	IRF & ARDL short-run effects
Market Risk (VIX)	Weak and unstable	Insignificant in most models
Domestic Variables	Weak / insignificant	ARDL domestic model
Interest Rate Channel	Not supported	IRD insignificant
Inflation Channel	Not supported	INFDIFF insignificant

Panel B: Dynamic and structural insights

Aspect	Result	Interpretation
Cointegration	Weak / inconclusive	evidence of cointegration is weak or inconclusive
Adjustment Speed	Slow (~2–3%)	Persistent deviations
Structural Breaks	Significant	Regime-dependent dynamics
Shock Transmission	Limited	Weak external propagation
Persistence	Very high (~97%)	Exchange rate self-driven

Panel C: Theoretical implications

Theory	Supported?	Interpretation
Global Financial Cycle	✓ Supported	External dominance
Commodity Currency Theory	✓ Partially	Oil matters short-run
Interest Rate Parity	✗ Not supported	Weak monetary channel
Purchasing Power Parity	✗ Not supported	Inflation irrelevant
Equilibrium Models	⚠ Weak	No stable long-run

Panel D: Overall conclusion

Dimension	Conclusion
Dominant Driver	External factors (DXY, oil)
System Behavior	Structurally unstable
Adjustment	Slow and incomplete
Policy Relevance	Limited domestic control

Notes: Summary based on ARDL, ECM, VAR, IRF, FEVD, and structural break analysis. Results are consistent across multiple model specifications and robustness checks. Source: Author's compilation.

In summary, the findings reinforce the view that exchange rate dynamics are largely exogenous, stylized, weakly anchored to internal macroeconomic fundamentals, and structurally unstable.

5. Discussion

The results show that external financial conditions - rather than domestic macroeconomic fundamentals - dominate exchange-rate dynamics. The robust and persistent effect of the US dollar index is consistent with the view that sovereign yields around the world are driven by global liquidity conditions, US monetary policy, and financial openness (Rey 2013; Miranda-Agrippino & Rey 2020; Gopinath et al.2020)

The findings imply that exchange-rate conduct is nonetheless intimately coupled to fluctuations in international monetary markets, despite extensive sanctions and geopolitical tensions.

Oil prices very clearly become on important driver of exchange-rate movements in line with the commodity currency literature (Chen & Rogoff, 2003; Kilian, 2009). The inverse correlation of both oil price and the USD/RUB exchange rate is confirmed, as an indicator of commodity dependence in Russia economy and external trade conditions impact on exchange-rate adjustment. Nevertheless, estimates from the VAR reveal that oil-price shocks have only a temporary effect on exchange rates, consistent with evidence

suggesting that commodity-price shocks often generate short-run rather than permanent exchange-rate responses (Kilian, 2009).

The FEVD results complement rather than contradict the ARDL findings. Whereas the ARDL model identifies external variables as significant triggers of exchange-rate movements, the FEVD demonstrates that subsequent exchange-rate dynamics are dominated by autoregressive persistence. This persistence is consistent with a highly regulated financial environment in which sanctions, capital controls, and policy interventions dampen the transmission of new external shocks while prolonging the effects of previous disturbances

Our findings should therefore not be interpreted as evidence that domestic policies became ineffective. Instead, they suggest that exchange-rate stabilization increasingly relied on administrative measures, including capital controls, foreign exchange regulations, and monetary policy interventions, rather than conventional market-based adjustment mechanisms. In this context, external shocks remained important triggers, whereas domestic policies shaped the persistence and transmission of these shocks.

A key finding of this study is that conventional domestic transmission channels have limited explanatory power. For the most part, specifications that include interest-rate differentials and inflation differentials yield statistically-insignificant effects, giving limited support for conventional Uncovered Interest Parity (UIP) and Purchasing Power Parity (PPP) predictions (Rogoff, 1996; Engel 2016). These results imply that long-term sanctions and financial disunity could undermine the role of domestic equilibrating forces in capital account balances and lessen the importance of parity-based exchange-rate regimes. Exchange-rate dynamics seem to be driven less directly than before by domestic macroeconomic fundamentals and more under the influence of external financial conditions and geopolitical events.

The role of regime-dependent exchange-rate behavior is further confirmed by structural break analysis. Historical insight reveals that exchange-rate relationships are not stable (Engel 2016)), the Global Financial Crisis breaks of significance just like the Crimea-related sanctions episode or COVID-19 pandemic or the Russia–Ukraine war. These findings suggest that sanctions are more than simply short-run shocks, and also serve as mechanisms to permanently alter the fundamental transmission mechanism of exchange-rate determination. The evidence thereby adds to the burgeoning literature on financial decoupling and geopolitical risk, which posits that global economic integration is increasingly conditioned by geopolitics-imposed constraints and regime changes (Caldara & Iacoviello,2022; Ahn & Ludema 2024). It should be emphasized that the present study does not estimate a quantitative measure of geopolitical fragmentation. Instead, it documents how exchange-rate dynamics differ across historically identified sanction-related geopolitical regimes. Therefore, the findings should be interpreted as evidence of regime-dependent behavior rather than as direct evidence of the magnitude of geopolitical fragmentation.

The exceptionally small ECM coefficient indicates that adjustment toward equilibrium is extremely slow, with an estimated half-life of approximately 28 months. This finding is consistent with structural decoupling, whereby prolonged sanctions and capital controls weaken the normal market-clearing process and reduce the role of conventional macroeconomic fundamentals in restoring exchange-rate equilibrium.

Given the inconclusive evidence of cointegration, the empirical findings are better interpreted in terms of short-run adjustment and structural instability rather than a stable long-run equilibrium. Repeated geopolitical shocks and sanctions appear to weaken the normal equilibrium adjustment process.

Exchange-rate dynamics are increasingly persistent and regime-dependent. Although the error-correction term remains statistically significant, its small magnitude

indicates slow adjustment and persistent deviations from long-run equilibrium. This finding is consistent with evidence on exchange-rate persistence, structural heterogeneity, and sluggish macroeconomic adjustment in financially integrated economies (Itskhoki & Mukhin, 2021). Overall, exchange rates appear structurally unstable and weakly anchored to conventional equilibrium relationships.

The results indicate that prolonged sanctions and financial fragmentation have increased the influence of external financial conditions while weakening domestic macroeconomic channels. This study contributes to the literature by showing that geopolitical shocks can alter exchange-rate transmission and the relative importance of its determinants. Although focused on Russia, the findings are also relevant to sanctioned, commodity-dependent, and externally exposed economies facing growing financial fragmentation.

6. Conclusions

We investigated the major correlates of the USD/RUB exchange rate under prolonged sanctions, geopolitical shocks and increasing financial fragmentation using monthly data from 2005 to 2025. By integrating several complementary empirical strategies, including the ARDL-ECM-VAR framework, impulse-response analysis, forecast-error variance-decomposition and a structural-break test, we evaluated the roles of external financial developments, commodity-market dynamics, domestic macroeconomic fundamentals and major geopolitical episodes in determining exchange-rate fluctuations in Russia.

The empirical evidence shows that external factors–particularly the US Dollar Index and Brent crude oil prices-are significant correlates and short-run drivers of fluctuations in the USD/RUB exchange rate. An appreciation of the US dollar is associated with a depreciation of the ruble. Higher oil prices we associated with a stronger ruble, consistent with Russia's position as a major commodity-exporting economy. By contrast, inflation and interest-rate differentials exhibit limited explanatory power in the estimated specifications. These findings suggest that the conventional transmission mechanisms associated with Purchasing Power Parity and Uncovered Interest Parity do not fully expalin how Russian exchange rates dynamics respond under conditions of prolonged sanctions, capital controls, financial constraints, and heightened geopolitical uncertainty.

The findings indicate that exchange-rate dynamics are not driven solely by new external shocks. VAR and forecast-error variance decomposition results show that, after an initial shock, subsequent movements are largely explained by ruble persistence, while external shocks account for only a limited share of forecast-error variance. Thus, the ARDL and VAR findings are complementary: global financial conditions and oil prices may trigger adjustment, but domestic propagation mechanisms, market segmentation, policy interventions, and expectations sustain it. Russia's exchange-rate dynamics are therefore externally triggered, persistent, and regime-dependent.

Structural-break analysis identifies major shifts during the Global Financial Crisis, the Crimea-related sanctions period, the COVID-19 pandemic, and the escalation of the Russia–Ukraine conflict. This suggests that USD/RUB determinants vary across geopolitical regimes. However, because financial fragmentation is represented by event and regime-shift variables rather than a continuous measure, the results indicate changing exchange-rate behavior rather than the causal magnitude of fragmentation.

Evidence of a stable long-run equilibrium is also inconclusive. The ARDL bounds test does not confirm cointegration, while the Johansen analysis finds no common cycle. Similarly, the error-correction coefficient suggests only slow and partial adjustment,

conditional on model specification. These results imply that conventional equilibrium models have limited explanatory power in an environment characterized by structural shifts and strong policy intervention.

Domestic policy nevertheless remains important. Capital controls, monetary tightening, and foreign-exchange regulations may reduce short-run transmission from external shocks, but they cannot fully insulate the ruble from global dollar conditions, commodity markets, and geopolitical developments. A flexible, regime-sensitive framework should therefore combine domestic stabilization with continuous monitoring of external financial, energy-market, and geopolitical risks.

This study contributes by showing that exchange-rate determination in a heavily sanctioned commodity-exporting economy reflects the interaction of external financial shocks, commodity volatility, geopolitical regime changes, institutional responses, and exchange-rate persistence. Future research should incorporate continuous measures of geopolitical risk and financial fragmentation, nonlinear or time-varying models, and Russia's growing financial and trade reorientation toward China, BRICS economies, and alternative payment systems.

In brief, exchange-rate dynamics are shaped by the interaction between external financial shocks and domestic policy responses. The findings suggest that domestic authorities retained an important stabilization role through administrative and policy interventions. However, prolonged sanctions and financial fragmentation shifted exchange-rate adjustment away from market-based equilibrium toward policy-driven stabilization under external constraints.

7. Implications and Future Research

These findings carry a clear message. Standard equilibrium-based models, such as purchasing power parity and its close variants, rely on persistent long-run relationships and relatively moderate adjustment. The evidence in this instance does not back up these assumptions. Rather, exchange rate dynamics are best described as externally driven, persistent, and structurally changed.

This implies that domestic policy instruments are used, although constrained, to provide stability in the exchange rate frameworks, as long as the conditions in the global arena are not favorable. Hence, it is crucial to monitor global developments and control exposure to external shocks. This reinforces the requirement for policy frameworks that are flexible to regime changes due to instability.

At the methodological level, combining ARDL, ECM, VAR, and break tests enables us to consistently model the long-run and short-run dynamics and the regime instability. Some of the limitations of this study are:

First. This study has several limitations, including limited variables and the absence of nonlinear dynamics. Future studies could apply a broader framework using regime transition models and financial market indicators, as well as cross-country comparisons.

Second. Geopolitical fragmentation is represented through a structural change dummy variable rather than a continuous measure such as the Geopolitical Risk Index (GPR) or the recently developed financial fragmentation index. Consequently, this analysis identifies exchange rate dynamics across major geopolitical regimes but does not measure the intensity of fragmentation itself. Future research could integrate continuous indicators of geopolitical risk and financial fragmentation to provide a more comprehensive empirical assessment.

Third. The empirical model does not explicitly incorporate variables representing Russia's post-sanctions financial reorientation toward China and other non-aligned economies. Future studies may include indicators such as the share of Renminbi-denominated trade settlement, bilateral trade with BRICS economies, cross-border transactions through CIPS or SPFS, or other measures of alternative financial integration to better capture the evolving structure of the international financial system under prolonged sanctions.

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Journal of Risk and Financial Management

Article

Geopolitical Risk and the Financialization of Firm Vulnerability in Emerging Markets

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Abstract

Geopolitical uncertainty represents a growing source of systemic risk that reshapes international markets, disrupts cross-border operations, and challenges firms' ability to sustain financial performance. This research examines the mechanisms through which geopolitical instability ~~related~~ relates to firm financial outcomes in Southeast Asian economies by assessing the mediating roles of supply chain resilience, currency volatility, and foreign investment confidence. Based on a quantitative cross-sectional design, data were collected from 308 firms across Southeast Asian Economies and analyzed using partial least squares structural equation modeling (PLS-SEM). The findings indicate that geopolitical risks significantly influence financial performance, with the strongest effects transmitted through financial channels. Currency volatility and foreign investment confidence emerge as critical mediators, demonstrating that exchange rate instability and investor risk perceptions substantially shape firm performance under geopolitical pressure. While supply chain resilience enhances firms' capacity to adapt to external disruptions, its direct contribution to financial performance remains insignificant. The model explains 66.7% of the variance in financial performance, reflecting strong explanatory capability. These findings extend existing knowledge by integrating financial, operational, and institutional mechanisms to clarify how geopolitical disruptions propagate into firm-level outcomes. The results underscore the importance of financial preparedness, institutional effectiveness, governance quality, and adaptive capabilities in managing geopolitical uncertainty.

Keywords: geopolitical risk; corporate financial performance; supply chain resilience; currency volatility; foreign investment confidence

JEL Classification: F51; F23; G32; L25; M16; O53

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1. Introduction

Geopolitical shocks are no longer an external event separate from the business world but rather inherent to global operations. Increasing volumes of trade disputes, conflicts in sea lanes, sanctions and political uncertainty are impacting businesses at all levels, affecting their production costs, access to capital, investor attitudes and expectations of future exchange rate developments (Caldara & Iacoviello, 2022; Bajaj et al., 2023).

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Although there is already literature on the impacts of geopolitical risks on growth, trade, market prices and overall investments, the factors contributing to heterogeneity in firms' responses to such risks remain understudied. In spite of exposure to identical events, firms typically vary significantly in their outcomes due to differing levels of dependence on the supply chain, foreign currency risk exposure, capacity to access external financing, ability to discern and appropriately react to the relevant event (Durnev & Mangen, 2020; Eser & Wu, 2021~~; Ghassemi & Sadr, 2022~~). However, existing geopolitical risk literature has largely treated firms as homogeneous entities, providing limited explanation of how internal organizational capabilities and financial exposure determine the magnitude of geopolitical shocks on corporate outcomes. Understanding these firm-level transmission mechanisms is essential because the same geopolitical event may create different consequences depending on firms' strategic resources and vulnerability profiles.

This research extends the literature by analyzing geopolitical risk as a ~~micro level~~micro-level transmission mechanism rather than solely as a macroeconomic phenomenon. The sample selection of emerging S~~s~~outheast Asian economies is both empirically and theoretically relevant since Asian firms are the most vulnerable to geopolitical shocks as they are strongly dependent on export-oriented value chains, capital flows and have an operating environment shaped by credibility concerns and stability issues surrounding the local currency (Athukorala & Wei, 2017). In the analysis, three types of geopolitical risk are included, namely the US–China trade war, conflict in the South China Sea, and regional political uncertainty, all affecting firms' performance through different channels which may be offsetting or complementary. These channels suggest that geopolitical risks do not directly influence firm performance alone but operate through intermediate mechanisms that shape firms' ability to absorb, transfer, and respond to external uncertainty.

The inclusion of three specific types of geopolitical risks and their various transmission channels contributes to the literature on the economy-wide impacts of geopolitical risks. While most studies focused on evaluating the impact of geopolitical risks on corporate investment, exchange rate volatility, supply chain disruptions, or market turbulence separately (Zhang et al., 2023; X. Liu & Zhang, 2024), limited attempts have been made to provide a theoretically comprehensive explanation of the relationship between geopolitical risk and corporate financial performance in emerging economies and pinpoint the relative importance of these channels. Our research has attempted to bridge this gap with an analysis of a multi-mediator framework where the relative importance of supply chain resilience, currency volatility, and foreign investment confidence contributes to the financialization of risk exposures. Accordingly, this research contributes to the literature in three ways. First, it shifts the discussion of geopolitical risk from a macroeconomic perspective toward a firm-level risk transmission framework. Second, it integrates supply chain resilience, currency volatility, and foreign investment confidence as interconnected mechanisms explaining corporate responses to geopolitical uncertainty. Third, by focusing on emerging Southeast Asian economies, this study provides evidence from a region where geopolitical exposure and global economic integration are particularly pronounced.

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2. Literature Review, Theoretical Foundation, and Hypothesis Development

The theoretical background for this research encompasses the following theories: institutional uncertainty theory, transaction cost economics, real options theory, behavioral finance, dynamic capabilities theory, and international finance theory. The institutional uncertainty theory demonstrates how instabilities, reversals, and lack of institutional credibility contribute to the escalation of coordination costs across borders (North, 1990; Henisz, 2000). Transaction cost economics builds on this idea by considering

geopolitical stability in relation to higher monitoring, contracting, routing, and enforcement costs within supply chains. The real options theory suggests that foreign investments are delayed or pulled back due to increased levels of uncertainty, whereas behavioral finance offers a deeper understanding of the connection between political and security risks and investor confidence (Pástor & Veronesi, 2013). Dynamic capabilities theory provides the theoretical basis for the idea of resilience as an organizational capability used to cope with disruptions, and international finance theory emphasizes the importance of currency fluctuations as financial mechanisms in response to geopolitical shocks.

2.1. Geopolitical Trade Conflicts and Supply Chain Resilience

One involved framework is that of Institutional Uncertainty Theory, which serves as an excellent point of departure in examining how geopolitical instability alters organizational operations. North (1990) made one of the most widely citedwidely cited arguments in the literature when he argued that the institutions, or, in other words, the rules and conventions of economic exchange, govern transaction costs of coordination. If institutions remain stable, then organizations can make decisions, investments, and conduct coordination activities around the world without worrying about unexpected changes to the costs involved. On the other hand, when institutions become unstable, transaction costs explode, contract enforcement becomes difficult, and predictability necessary for the operation of production chains becomes impossible (Henisz, 2000). Geopolitical trade disputes constitute exogenous disturbances of such a nature, which cause the collapse of the governance regime in which these supply chains function. By means of imposing tariffs, sanctions, and retaliatory policies, the trade conflicts generate uncertainty within the supply chain and, hence, the cost structure that cannot be anticipated by the firms involved. These firms are no longer able to rely on their previously predictable supply partners who suddenly become unreliable. It is precisely this increased cost of coordination, which was made possible by institutional stability, that becomes evident again.

Indeed, there is ample evidence that high tariffs and threats thereof not only increased costs but had a disruptive effect on international supply chains, forcing companies to adapt and change their procurement and production strategies (Zhou, 2020; Mao & Görg, 2020). However, even the uncertainty itself—the lack of knowledge about future trade policy, which would affect planning and long-term decision making—was just as disruptive as tariff measures. In the face of geopolitical uncertainty, it was impossible to plan ahead or develop sustainable strategies. On the one hand, some researchers contend that trade conflict could potentially increase resilience through incentives for diversification, reshoring, and regionalization (Gereffi, 2020; Bown, 2021). Forced to reduce reliance on any single supplier, firms could create more diversified supply networks. While the idea may seem plausible, institutional uncertainty theory suggests a far less optimistic conclusion. Geopolitical pressure forces companies to make adjustments that are qualitatively different from strategic investments in building resilience that are made under normal circumstances. These adjustments are reactive, rushed, and rarely optimal under pressure. As Evenett (2019) shows, diversification induced by trade conflict tends to lead to fragmented and inefficient supply networks, rather than resilient ones. Adjustment costs pile up, and the risks and vulnerabilities caused by a geopolitically fragmented system become difficult to counterbalance. Companies involved in China-centric supply chains are trapped by their very structure and cannot change course without ~~significant~~ high costs. Their redundancies are minimal, and their leverage vis-à-vis more powerful trading partners is low. When geopolitical

shocks come, they suffer disproportionately not because of any particular weaknesses but due to their position in the global economy.

Hence, while there could be rare cases of resilience-promoting adaptations made during trade conflicts, it appears that the predominant outcome is detrimental. Indeed, institutional uncertainty disrupts the crucial component of resilience—the predictability of events. As a result, supply chains cease to become coordinated systems and transform into a series of ad hoc~~ad hoc~~ transactions. Therefore, we hypothesize the following:

H1. *Geopolitical trade conflicts influence firms' supply chain resilience.*

2.2. Geopolitical Turbulence and Foreign Investment Confidence

From the point of view of real option and behavioral financial theories, increased policy and geopolitical uncertainty makes the value of waiting higher, causing investors to defer, shrink, or switch investment projects in light of increasingly unpredictable future payoffs (Dixit & Pindyck, 1994; Pástor & Veronesi, 2013). Geopolitical instability heightens uncertainty over regulatory regime, market access, and political stability, thus dampening confidence among foreign investors in the host economy. Rising uncertainty results in falling expected return levels relative to risk, reducing incentives for foreign direct investments (FDIs). Empirically, the relationship between trade policy uncertainty and lower entry rates, investment commitments, and FDI inflows is well-established by a number of studies, which find that policy uncertainties are particularly detrimental in economies that are closely linked with the international division of labor (Cui & Li, 2023; Yan et al., 2022; Gao et al., 2024). Although some research demonstrates temporary investment flows towards different countries in response to uncertainty, this is an ad hoc process rather than a sign of improved investor confidence (Dong et al., 2025). The impact of policy uncertainty on firms' decisions has also been observed in~~as~~ a reduction in outbound FDI~~s~~, as firms try to minimize the risks associated with both domestic and international market volatility (Wu & Shao, 2023; Song et al., 2021). Crucially, emerging Asian economies are particularly vulnerable to shifts in foreign investment confidence due to reliance on foreign investments, export-oriented development models, and nascent institutional settings. Therefore, geopolitical trade disputes may be expected to negatively affect foreign investment confidence in Asia. Therefore,

H2. *Geopolitical trade conflicts significantly influence foreign investment confidence.*

2.3. Maritime Geopolitical Risk and Supply Chain Resilience

The notion of geopolitical risk pertaining to contested areas at sea represents a different type of supply chain vulnerability, as it poses a danger to the actual physical integrity of logistics channels. In accordance with transaction cost economics, an increase in the risk of expropriation, transportation disruption, and security challenges implies an increase in the cost of coordination and lower efficiency of international transactions (Williamson, 1985). The South China Sea (SCS), being a strategic maritime chokepoint, provides an example~~,~~ where heightened tensions lead to increased transit risks, higher insurance rates, and greater route uncertainty for firms dependent on ocean-based logistics. Indeed, recent empirical studies demonstrate how geopolitical risk remains a significant determinant of overall supply chain vulnerability, implying that geopolitical tensions have adverse effects on network flexibility and disruptiveness (Blessley & Mudambi, 2022; Huchzermeier & Stehle, 2025). The empirical data ~~shows~~ show that companies heavily reliant on maritime trade and operating in risky geopolitical locations tend to experience higher levels of supply chain disruptions, while diversification cannot completely solve the problem (Khan, 2025; M. Zhu et al., 2024). While certain

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organizational practices can mitigate uncertainty, they remain incapable of resolving long-term geopolitical tensions in key regions (Coşkun & Erturgut, 2024). In relation to the South China Sea region, political tensions imply high costs of adjustments in regard to sourcing and routing, yet do not eliminate risk in any meaningful way. As a result, geopolitical risks in the SCS are likely to negatively impact supply chain resilience. Therefore,

H3. *Geopolitical tensions in contested maritime regions are significantly associated with supply chain resilience.*

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2.4. Maritime Geopolitical Risk and Foreign Investment Confidence

The behavioral and institutional theories indicate that geopolitical risk intensifies investors' perceptions about risk, as it increases uncertainties associated with political stability, security, and policy consistency. Thus, it decreases the confidence of investors in investing abroad. According to Caldara and Iacoviello (2022), geopolitical risk shocks strongly inhibit investments due to increased uncertainty and higher risk ~~premium~~ premiums in the financial market. The mentioned effect is especially significant in the case of strategic rivalry and conflict in a given area. Research findings indicate that geopolitical risks affect foreign investments, leading to redirection of foreign direct investments to other destinations (Agoraki et al., 2024; C. Feng et al., 2023). Empirical evidence on the impact of geopolitical risk on foreign investments at the country level shows that an increase in geopolitical risk leads to a reduction in investment confidence (~~Truong et al., 2024~~; Altiner & Bozkurt, 2023). In relation to the South China Sea, it can be claimed that rising geopolitical tensions encourage investors to look for safer places with less volatility (C. Feng et al., 2023). Due to the importance of the SCS in international trade, geopolitical risks may produce negative spillovers that will reduce foreign investment confidence in emerging Asia. Therefore,

H4. *Geopolitical tensions in contested maritime regions significantly influence foreign investment confidence.*

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2.5. Maritime Geopolitical Risk and Currency Volatility

International finance theory suggests that exchange rates are highly sensitive to external shocks, particularly geopolitical events that reshape investor expectations, risk assessments, and cross-border capital allocation decisions. Under conditions of heightened uncertainty, investors reassess asset risks, leading to changes in portfolio preferences, capital movements, and currency valuations (Akram, 2020; Caldara & Iacoviello, 2022). Specifically, geopolitical conflicts lead to increased risk pre-mia, accelerated reversals of capital flows, and increased speculative activities, which significantly increase exchange rate volatility (Akram, 2020; Caldara & Iacoviello, 2022). These impacts are even stronger on emerging markets where financial markets are shallow, policy credibility is still in formation, and currencies are vulnerable to changes in global risk sentiments. Geopolitical disputes in important maritime areas such as the South China Sea (SCS) ~~rep resent~~represent an important external threat to exchange rate volatility. Since the SCS is a critical corridor for the movement of global trade and energy flows, any disruptions in this area affect expectations regarding trade, commodity flows, and investments, all factors that influence currency valuations. Geopolitical risk increases exchange rate volatility in ASEAN economies significantly, as demonstrated by empirical findings implying increased vulnerability of these regional currencies to geopolitical tensions and risks (Hui, 2021). Likewise, Adeosun et al. (2024) find that geopolitical shocks generate volatility spillovers across financial markets, where currency markets exhibit

higher sensitivities as they depend on capital flows and policy uncertain-ties. Evidence from past geopolitical shocks reinforces this finding. Studies confirm that large-scale geopolitical shocks, including the recent Russia–Ukraine conflict, led to foreign exchange volatility due to sudden portfolio adjustments and investors seeking safer havens in response (Aliu et al., 2022; Akarsu & Gharehgozli, 2023). Similar effects can be expected in relation to the South China Sea, where geopolitical tensions would lead to disruption of energy trade routes, changes in commodity prices, and speculation ~~of~~ on currencies. Other studies have emphasized the impact of investor sentiment and contagion ~~effect~~ effects with regard to spillover of volatility via exchange rate mechanisms following geopolitical shocks (Asad et al., 2020; Abdulsalam & Onipede, 2023). Based on these theoretical and empirical insights, it appears likely that geopolitical tensions in the South China Sea would increase uncertainties about trade continuities, energy supplies, and capital flows, resulting in increased exchange rate volatility. T~~t~~hus,

H5. *Geopolitical tensions in contested maritime ~~region~~ regions have a significant influence on currency volatility.*

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2.6. Political Instability and Foreign Investment Confidence

The level of foreign investment confidence can be viewed as a function of political stability, institutional strength, and policy continuity in host nations. According to institutional theory, political stability decreases uncertainty, facilitates contract enforcement, and improves the predictability of regulations, thus reducing transaction costs and encouraging foreign investments (North, 1990; Henisz, 2000). Political instability negatively impacts this set of institutions, which leads to decreased investor confidence owing to uncertainty associated with potential policy changes, poor governance, and increased risks associated with investing (Dixit & Pindyck, 1994). Real options theory suggests that political instability increases the value of waiting for better investment opportunities as the level of uncertainty concerning potential future profits increases (Dixit & Pindyck, 1994). As a result, foreign investors demand higher premiums or avoid investing in politically unstable countries altogether. This perspective is complemented by behavioral finance, which highlights the importance of investor perceptions and confidence and indicates that political instability makes investors hesitant about investing or even withdrawing capital (Pástor & Veronesi, 2013).

These theoretical assumptions are consistently corroborated in the empirical literature. Kiptoo (2024) demonstrates that political stability facilitates the development of FDI, whereas political instability hinders the process by creating uncertainties and deterring investors. Similar trends are found in country-specific studies. Tjandrasa (2021), for example, shows that political stability and institutional reforms increase foreign investment attractiveness in Indonesia as a result of improved perception. Fragile and ~~vulnerability prone~~vulnerability-prone countries experience stronger discouraging effects of political instability on foreign investment confidence. Bitar et al. (2019) found that insecurity and lack of policy predictability in Lebanon led to significant reductions in FDI. Kurecic and Kokotovic (2017) observed both short-term and lasting reductions in the amount of foreign ~~investments~~ investment resulting from political instability in their analysis.

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~~The institutional~~Institutional quality has a critical moderating impact on the relationship between political instability and foreign investment confidence. The weaker the institutional environment, the greater the negative influence political instability has on foreign investment confidence due to high uncertainty and weak enforcement mechanisms (Saha et al., 2022). Recent research further emphasizes the critical importance of political stability not just for attracting FDI, but also for sustaining innovations, green

growth, and economic development in general (Qamruzzaman & Karim, 2024~~; Wang et al., 2024~~). The evidence from Indonesia supports this finding, showing that political stability is positively related to the level of foreign investments and economic growth through increased investor confidence (Pástor & Veronesi, 2013).

Taken together, this literature suggests that regional political instability undermines foreign investment confidence by increasing uncertainty, weakening institutional trust, and raising perceived business risk, thereby discouraging long-term capital commitments. Therefore,

H6. *Regional political instability significantly ~~influence~~ influences foreign investment confidence.*

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2.7. Political Instability, Investor Behavior, and Exchange Rate Volatility

In terms of behavioral finance, political instability impacts exchange rates through changes in expectations and ~~risks~~ risk perceptions. The rise in geopolitical uncertainty reduces investor confidence, which results in capital flight, depreciating pressures on currencies, and exchange rate volatility in response to heterogeneous reactions to new information (Pastor & Veronesi, 2013). This effect is particularly pronounced in emerging markets, characterized by weaker institutions and a lack of credibility in their monetary policies, making currencies more sensitive to shocks. Indeed, multiple empirical analyses find that shocks related to politics and security increase the volatility of exchange rates due to increased currency risk~~s~~ exposure for fi-rms and investors (Abbassi et al., 2022; Aliu et al., 2022). Moreover, Hui (2021) reveals that ASEAN foreign exchange markets display persistent exchange rate volatility under conditions of geopolitical risks, indicating that the region experiences political uncertainty and changes in capital flows ~~changes~~. Adeosun et al. (2024) add that the combination of geopolitical uncertainty and economic policy uncertainty leads to increased financial instability and currency volatility.

Furthermore, commodity-based transmission mechanisms can play an important role in this case. Political uncertainty may negatively impact energy and commodity markets, thereby influencing exchange rates in oil exporters and importers. As noted by Akram (2020), there is greater exchange rate volatility for oil-exporting countries in periods of geopolitical uncertainty, while P. L. Liu et al. (2025) observe that shocks due to geopolitical tensions between the US and China are transmitted via commodity markets. These findings fit well into contagion models of international finance that emphasize the exchange rate channel as one of the ways shocks spread throughout the global financial system (Asad et al., 2020).

Thus, political uncertainty related to geopolitical tension will lead to increased exchange rate volatility. Therefore,

H7. *Regional Political instability has a significant influence on exchange rate volatility.*

2.8. Supply Chain Resilience and Corporate Financial Performance

Supply chain resilience (SCR) refers to a firm's capacity to anticipate, absorb, adapt to, and recover from disruptions while maintaining operational continuity and performance. Drawing on dynamic ~~capability's~~ capability theory, resilient supply chains enable firms to reconfigure resources, sustain strategic flexibility, and mitigate performance losses under uncertainty, thereby contributing to superior financial outcomes. In volatile environments, SCR functions not merely as an operational attribute but as a strategic capability that enhances firms' long-term competitiveness and profitability. Empirical evidence consistently supports the positive association between SCR and corporate financial performance. Firms with higher resilience demonstrate superior returns on assets, profit margins, and growth during periods of market turbulence (Li et al., 2017). Recent studies further show that resilience embedded within sustainable supply chain practices strengthens stakeholder trust and improves financial performance by aligning operational stability with long-term value creation (X. Zhu & Wu, 2022). Digital capabilities reinforce this relationship by enhancing supply chain visibility, coordination, and recovery speed, allowing firms to translate resilience into tangible financial gains (Zhao et al., 2023).

Supply chain finance (SCF) has emerged as an important complementary mechanism through which resilience enhances financial performance. By easing working capital constraints and improving liquidity across supply networks, SCF strengthens firms' ability to absorb shocks and sustain investment in innovation and operations (Zheng et al., 2025; J. Feng et al., 2024). Empirical evidence confirms that firms adopting SCF

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mechanisms exhibit improved financial outcomes across industries, particularly in environments characterized by financing frictions (Paul, 2025). While prior studies highlight sustainability, digitalization, and financial integration as key enablers of resilience, most examine these mechanisms in isolation, leaving limited understanding of their combined effects, —especially in emerging economies.

Taken together, the literature indicates that SCR operates as a strategic capability that positively influences corporate financial performance by enhancing adaptability, reducing disruption-related losses, and supporting sustained value creation. Therefore,

H8. *Supply chain resilience positively ~~influence~~ influences corporate financial performance.*

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2.9. Currency Volatility and Corporate Financial Performance

Currency volatility represents a critical external financial risk that affects firms' cost structures, pricing strategies, investment decisions, and international competitiveness. International finance theory suggests that heightened exchange rate fluctuations increase uncertainty, raise transaction and hedging costs, and distort investment planning, thereby undermining firm-level financial performance, —particularly in economies with limited risk-management capabilities.

Empirical research provides robust evidence of this negative relationship. Exchange rate volatility has been shown to weaken corporate profitability and financial stability across both developed and emerging markets (Bris et al., 2004; Morina et al., 2020). Recent firm-level studies confirm that exchange rate instability adversely affects performance by eroding margins, increasing financing costs, and discouraging long-term investment (Kim & Han, 2024; Aminaho, 2025). Macroeconomic evidence further indicates that volatile exchange rates impede productivity, trade competitiveness, and investment, reinforcing their detrimental effects on firm performance (Musyoki et al., 2012; Yensu et al., 2022; Fofanah, 2022). Importantly, the magnitude of these effects varies across institutional contexts. Firms in advanced economies often possess more sophisticated hedging instruments and financial depth, enabling them to partially buffer currency risk, whereas firms in emerging markets remain more exposed due to weaker financial infrastructure and limited access to risk management tools (Aminaho, 2025). This vulnerability underscores the importance of currency stability for sustaining corporate financial performance in emerging economies. Accordingly, the literature converges on the view that currency volatility undermines firm performance by increasing uncertainty, costs, and financial risk exposure. Therefore,

H9. *Currency volatility has a significant influence on corporate financial performance.*

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2.10. Foreign Investment Confidence and Corporate Financial Performance

Foreign investment confidence reflects investors' expectations regarding institutional credibility, governance quality, and long-term economic prospects in host economies. From an institutional and resource-based perspective, foreign investment enhances firm-level financial performance by providing access to capital, managerial expertise, advanced technologies, and global networks, thereby improving efficiency, governance, and competitive positioning. Empirical studies consistently demonstrate that firms with higher foreign ownership or stronger exposure to international investors exhibit superior financial performance, particularly in emerging and transitional economies (Pasali & Chaudhary, 2020). Foreign investors often impose more stringent governance practices and performance monitoring, contributing to enhanced profitability and productivity. Evidence from both developed and developing contexts supports this mechanism,

showing that firms with foreign participation outperform domestic counterparts in financial outcomes (Bentivogli & Mirenda, 2016).

However, the strength of this relationship depends on firm-level and institutional conditions. Large firms are generally better positioned to leverage international networks and economies of scale, while smaller firms may face constraints related to absorptive capacity (Bentivogli & Mirenda, 2016). Moreover, weak institutional environments may dampen the positive effects of foreign investment by increasing risk and limiting effective governance transmission. Despite these contingencies, the literature broadly confirms that foreign investment confidence plays a critical role in enhancing firm-level financial performance through improved governance, innovation adoption, and global integration. Therefore,

H10. *Foreign investment confidence has a significant influence on corporate financial performance.*

3. Methodology and Design

Development of Conceptual Model

Expanding upon the aforementioned theoretical arguments, this paper attempts to develop a conceptual model where geopolitical instability impacts corporate financial performance indirectly via firm-specific factors. In this context, geopolitical risks arise due to three reasons. First, there is an ongoing trade dispute between the US and China. Second, there are geopolitical risks in the South China Sea. Third, there is political instability in the region. Hence, this paper extends existing literature because geopolitical risks have been examined as being transmitted to financial performance through multiple channels instead of being exogenous variables that do not influence firms differently. Furthermore, in terms of corporate financial performance, this paper shows that geopolitical instability impacts firms, not just through the existence of risk itself, but also the level of exposure to risk by individual firms and its interpretation.

The proposed conceptual framework is presented in Figure 1. It illustrates the hypothesized relationships among trade war effects, South China Sea tensions, regional political instability, supply chain resilience, foreign investment confidence, currency volatility, and corporate financial performance.

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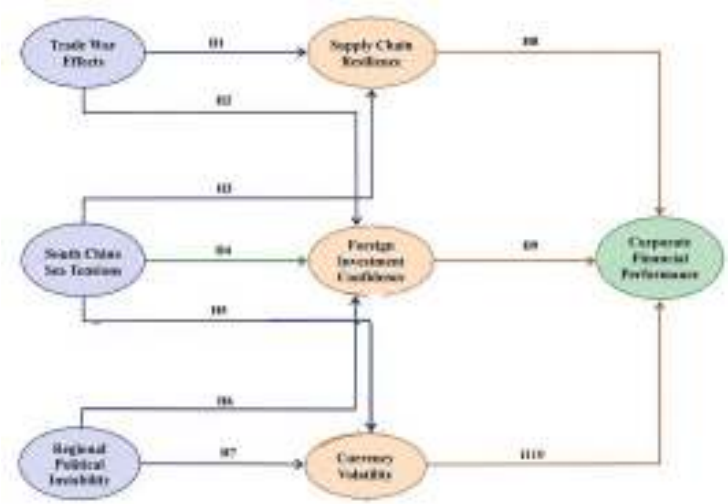

Figure 1. Conceptual ~~F~~framework.

As shown in Figure 1, the study proposes ten hypotheses (H1–H10) to examine the direct relationships among the con-structs. These hypotheses are developed from the theoretical framework and empirical literature and are tested using SEM.

~~3. Methodology and Design~~

Research Design

A quantitative cross-sectional research design was used to investigate how geopolitical uncertainty affects the performance of firms through multiple mediating variables. The research question suggested the use of a cross-sectional research design since the goal of the research was to understand how managers evaluated their companies' geopolitically driven exposure, operational resilience, investor confidence, currency volatility, and performance within a time of uncertainty. It is worth noting that the cross-sectional design did not suggest causal relationships but rather tested statistical links between the concepts measured at one point in time. Partial Least Squares Structural Equation ~~Modelling~~ Modeling (PLS-SEM), a method implemented in SmartPLS 4.0, was selected due to the complexity of the model proposed and the presence of latent constructs and mediating mechanisms. According to previous studies, PLS-SEM is suitable for use in ~~theories based~~theory-based modeling and variance-explanation models where the data might violate the assumptions of multivariate normal distribution. The use of PLS-SEM was appropriate for this study since it is commonly applied in survey research, especially for emerging markets, as it performs well with relatively small sample sizes, while allowing ~~to estimate~~the estimation of the structural model together with construct reliability and validity.

The study makes use of perceptual measures of geopolitical risk exposure, currency volatility, and firm financial performance, which was intentional. Even though US–China trade war risks, South China Sea issues, regional political instability, and currency volatility are all observable factors in themselves, their implications differ from company to company. While macro measures are able to objectively quantify the geopolitical risks, the extent of exposure of individual companies to any of those threats is beyond their scope. In other

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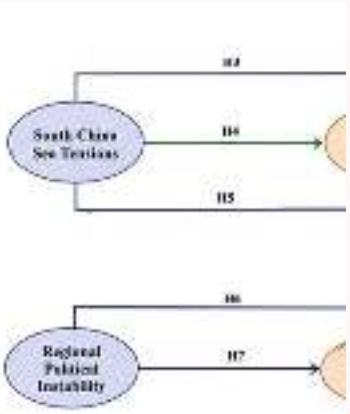

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words, objective measures cannot account for the firm's vulnerability with respect to a particular trade route, extent of import-export exposure, foreign currency invoicing, hedges, concentration of suppliers, and foreign investors. Therefore, perceptual measures were adopted to capture heterogeneous firm-level exposure and managerial assessments of how geopolitical events translate into operational, financial, and strategic vulnerabilities.

All constructs were operationalizsed as reflective latent variables and measured through multi-item scales on a 5-point Likert scale varying from 1 (Strongly disagree) to 5 (Strongly agree). The items related to the US–-China trade war tapped into perceived pressure to pay tariffs, sourcing disruption, cost uncertainty, and trade policy uncertainty. South China Sea tensions were measured in terms of perceived maritime routing risks, logistics disruptions, insurance and transport costs, and security risks. Political instability items reflected perceptions of policy continuity, regulatory predictability, institutions' trustworthiness, and security conditions. Resilience items included supplier diversification, capacity for re-routing, fast recovery capability, and visibility of relevant information. Items measuring currency volatilities related to foreign currency exposures, pricing uncertainty, burdens of hedging, and margin sensitivity. Perceived foreign investors' willingness, external financing availability, valuation confidence, and long-term capital commitments were used to measure investment confidence. Firm performance was measured in terms of profitability, sales growth, financial stability, return on assets, competitive position, and financial strength in line with the perceptual performance approach (Dess & Robinson, 1984), since secondary firm financial data is often unreliable in these settings.

To better explain why we leaned on perceptual financial performance measures, we did notdidn't include objective firm-level financial data. This was mainly because our sample spanned various Southeast Asian economies, many of which are home to privately owned or non-listed firms, and often lack consistent access to audited and comparable financial statements. Differences in accounting practices, disclosure requirements, currency denominations, fiscal-year reporting, and inflation also make it tough to compare secondary financial indicators across countries. Further, the primary goal of this study was to understand how managers perceive the firm-specific impacts of geopolitical risk exposure, such as pressures on profitability, financial stability, return expectations, and competitive financial strength. This exposure can differ widely among firms based on factors like import-export intensity, foreign-currency invoicing, hedging strategies, supplier concentration, reliance on foreign investors, and access to external financing. For these reasons, we found perceptual measures to be a fitting choice for gauging firm-level vulnerability and how managers interpret financial performance amid geopolitical uncertainty. That said, we recognize this approach has its limitations, and we encourage future research to validate these insights using objective accounting data, archival financial indicators, or matched survey–financial datasets.

The survey tool was crafted using insights from established research on political risk, supply chain resilience, international finance, and firm performance, all while keeping the unique context of Southeast Asia in mind. To ensure its content validity, we had three international business scholars, and two experienced practitioners review it. We also conducted a pretest with 35 managers to evaluate how clear and relevant the items were, as well as their effectiveness as performance measures. Based on the feedback from participants, we made some minor tweaks to the wording of the items, but we made sure to keep the core meanings of the constructs intact. Importantly, we did notdidn't remove any items just to improve statistical fit; instead, we kept them based on the PLS-SEM loading criteria.

The sample comprises mid- to large-sized firms operating in geopolitically vulnerable industries across Southeast Asianean countries, including Indonesia, Malaysia,

Singapore, Thailand, Vietnam and the Philippines. These firms were purposively selected based on their exposure to international trade, supply chain disruptions, and geopolitical uncertainties. Respondents were identified through professional networks and business directories to ensure alignment with the research context. The criteria for inclusion required that firms engage in some form of cross-border activity involving importing and exporting, partake in international supply chain activities, use imported inputs, utilize ~~exports~~ export markets, or be otherwise exposed to foreign investment or foreign-currency transactions. The individual chosen as the respondent needed to hold a managerial position where he or she would have sufficient insight into their firm's international operations, including supply chain activities, financing, and/or strategic planning.

A total of 420 surveys were distributed between March and June 2025. We received 312 responses in total. Incomplete responses, straight-line answers, failed attention checks, and internally inconsistent responses were excluded from the received data. Following the data screening process, 308 valid responses remained, resulting in a final valid response rate of 73.10% of the distributed surveys. The final dataset comprised 308 firms from Southeast Asian countries, including Indonesia (85 firms), Malaysia (55 firms), Singapore (48 firms), Thailand (44 firms), Vietnam (38 firms), and the Philippines (38 firms). Regarding industry representation, the sample included manufacturing (41.23%), services (18.18%), trading/import–~~–~~export (15.26%), technology/IT (14.94%), and finance/banking (10.39%). In terms of organizational size, the distribution was as follows: 1–50 employees (26.30%), 51–200 employees (50.65%), 201–500 employees (20.45%), and more than 500 employees (2.60%). The positions within the organizations were Senior Manager (30.84%), Middle Manager (21.10%), Analyst/Specialist (18.18%), CEO/Director (16.88%), and Owner/Founder (12.99%). Regarding years of work experience, the distribution was >20 years (47.73%), 11–20 years (34.09%), 5–10 years (17.86%), and less than 5 years (0.65%).

To mitigate potential common method bias, several procedural steps were implemented. These included ensuring respondent anonymity, clarifying that there were no right or wrong answers, using neutral language in the questionnaire items, and separating predictor and outcome variables. Despite these precautions, Harman's single-factor test showed that the first unrotated factor explained 58.296% of the total variance, surpassing the commonly accepted 50% threshold. This suggests the possible presence of common method bias. Consequently, even with these procedural measures, the results should be interpreted with caution.

Although firm-specific and country-level characteristics may influence corporate financial performance, these variables were not statistically incorporated as control variables in the PLS-SEM structural model. Firm size, industry sector, export dependence, foreign ownership exposure, leverage, and country location were considered important contextual characteristics of the sample, but the primary analytical focus of this study was the theoretically specified mediation mechanism linking geopolitical instability, supply chain resilience, currency volatility, foreign investment confidence, and corporate financial performance. Therefore, the findings should be interpreted as theoretically grounded associations rather than definitive causal effects. The absence of a full control-variable specification is acknowledged as a limitation and provides an important direction for future research.

In the research design, both firm- and country-level characteristics were initially considered but were ultimately excluded as control variables from the final structural model. This choice was made to prioritize theoretical simplicity and concentrate on the proposed mediation framework that connects geopolitical risk with corporate financial performance. Although this decision enhances the model's clarity and ease of

interpretation, omitting control variables might affect the model's robustness. Future research should include these variables for further validation.

To analyze the survey data, a two-stage partial least squares structural equation modeling approach was employed. Specifically, measurement model analysis involved the assessment of outer loadings, Cronbach's Alpha, Composite Reliability, Average Variance Extracted (AVE), Fornell–Larcker Criterion, and Heterotrait-Monotrait Ratio. On the other hand, the structural model was analyzed using path coefficients, t-statistics, p-values, Coefficients of Determination (R^2), Effect Sizes (f^2), Predictive Relevance (Q^2), and Specific Indirect Effects. Bootstrapping with 5000 replications was employed to determine the significance of relationships and mediation effects.

4. Results and Discussion

4.1. Measurement Model Evaluation

The results of the PLS-SEM estimation are illustrated in Figure 2. The figure presents the measurement model, including the standardized indicator loadings, together with the structural model showing the hypothesized relationships among the latent constructs and the corresponding R^2 values. The significance of these relationships is subsequently evaluated using the bootstrapping procedure.

Figure 2. Measurement model results showing outer loadings, reliability, and validity indicators (graphically edited from the original SmartPLS 4).

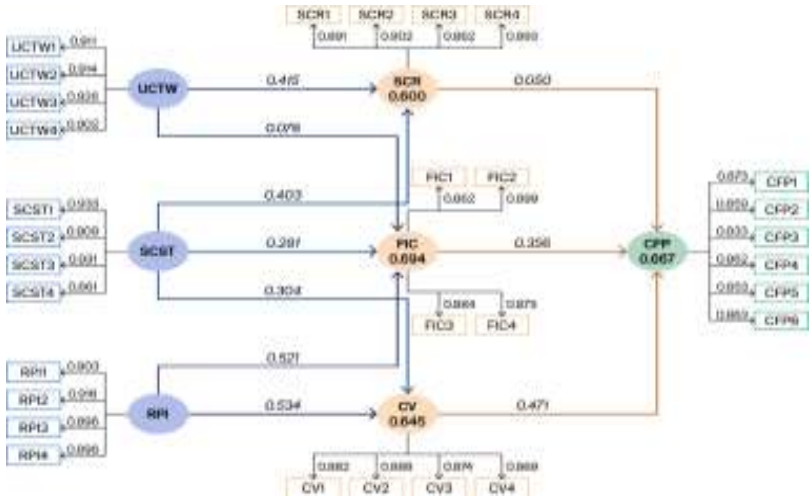

Figure 2. Measurement Model Results Showing Outer Loadings, Reliability, and Validity Indicators (graphically edited from the original SmartPLS 4).

As shown in Figure 2, the estimated PLS-SEM model presents the standardized outer loadings, path coefficients, and R^2 values for the endogenous constructs. The significance of these relationships was subsequently evaluated using the bootstrapping procedure.

4.2. Measurement Model Outer Loadings

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The measurement model was first evaluated by examining the standardized outer loadings of all measurement indicators. As presented in Table 1, all indicators exhibit outer loadings above the recommended threshold of 0.70, indicating satisfactory indicator reliability.

Table 1. Measurement mModel rResults: oOuter lLoadings.

Construct	Outer Loadings
CFP1 ←CFP	0.873
CFP2 ←CFP	0.859
CFP3 ←CFP	0.833
CFP4 ←CFP	0.862
CFP5 ←CFP	0.853
CFP6 ←CFP	0.863
CV1 ←CV	0.882
CV2 ←CV	0.888
CV3 ←CV	0.874
CV4 ←CV	0.869
FIC1 ←FIC	0.862
FIC2 ←FIC	0.899
FIC3 ←FIC	0.884
FIC4 ←FIC	0.875
RPI1 ←RPI	0.903
RPI2 ←RPI	0.916
RPI3 ←RPI	0.896
RPI4 ←RPI	0.896
SCR1 ←SCR	0.891
SCR2 ←SCR	0.902
SCR3 ←SCR	0.862
SCR4 ←SCR	0.893
SCST1 ←SCST	0.933
SCST2 ←SCST	0.909
SCST3 ←SCST	0.931
SCST4 ←SCST	0.861
UCTW1 ←UCTW	0.911
UCTW2 ←UCTW	0.914
UCTW3 ←UCTW	0.926
UCTW4 ←UCTW	0.902

As shown in Table 1, all indicators have outer loadings exceeding the recommended threshold of 0.70, indicating satisfactory indicator reliability. Therefore, all measurement indicators were retained for further analysis.

4.3. Construct Reliability and Validity

The construct reliability and convergent validity of the measurement model were subsequently assessed. Table 2 presents the results of Cronbach's alpha, composite reliability (rho_a and rho_c), and average variance extracted (AVE).

Table 2. Construct rReliability and cConvergent vValidity rResults.

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
CFP	0.928	0.928	0.943	0.735

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CV	0.901	0.901	0.931	0.771
FIC	0.903	0.903	0.932	0.775
RPI	0.924	0.924	0.946	0.815
SCR	0.909	0.910	0.936	0.787
SCST	0.929	0.930	0.950	0.826
UCTW	0.934	0.934	0.953	0.834

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4.4. Discriminant Validity

4.4.1. Fornell–Larcker Criterion

Discriminant validity was evaluated using the Fornell–Larcker criterion to assess whether each construct was empirically distinct from the others. The results are presented in Table 3.

Table 3. Discriminant Validity Assessment Using the Fornell–Larcker Criterion

	CFP	CV	FIC	RPI	SCR	SCST	UCTW
CFP	0.857						
CV	0.783	0.878					
FIC	0.760	0.791	0.880				
RPI	0.732	0.784	0.813	0.903			
SCR	0.566	0.607	0.646	0.755	0.887		
SCST	0.716	0.744	0.770	0.823	0.732	0.909	
UCTW	0.594	0.683	0.718	0.806	0.735	0.793	0.913

4.4.2. Heterotrait-Monotrait Ratio (HTMT)

In addition to the Fornell–Larcker criterion, discriminant validity was further assessed using the heterotrait–monotrait ratio (HTMT). The HTMT values for all construct pairs are presented in Table 4.

Table 4. Discriminant Validity Results: Heterotrait-Monotrait Ratio (HTMT).

Construct	Ratio HTMT
CV → <-> CFP	0.855
FIC → <-> CFP	0.830
FIC → <-> CV	0.877
RPI → <-> CFP	0.791
RPI → <-> CV	0.859
RPI → <-> FIC	0.890
SCR → <-> CFP	0.615
SCR → <-> CV	0.670
SCR → <-> FIC	0.712
SCR → <-> RPI	0.822
SCST → <-> CFP	0.771
SCST → <-> CV	0.812
SCST → <-> FIC	0.840
SCST → <-> RPI	0.887
SCST → <-> SCR	0.796
UCTW → <-> CFP	0.638
UCTW → <-> CV	0.744
UCTW → <-> FIC	0.782
UCTW → <-> RPI	0.867
UCTW → <-> SCR	0.797
UCTW → <-> SCST	0.851

4.5. Measurement Model Evaluation and Method Bias Diagnostics

The analysis of the measurement model was performed through SmartPLS outputs concerning the indicators' reliability, construct reliability, convergent validity,

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discriminant validity, and method bias diagnostics. As can be seen in Table 1, all outer loadings are above the required minimum level of 0.70. Values vary between 0.833 (CFP3) and 0.933 (SCST1). This indicates a strong association between the indicators and the constructs they are expected to measure. It is worth noting that such high values do not suggest the absence of all measurement problems in this model. They, however, can be considered proof of item coherence within reflective constructs.

Table 2 illustrates the presence of internal consistency in the model. Cronbach's alpha values vary from 0.901 (CV) to 0.934 (UCTW). Composite reliability is above the 0.70 threshold. Similarly, AVE varies between 0.735 (CFP) and 0.834 (UCTW). All these indices provide evidence of convergent validity as each of the constructs explains more than half of the variance in the indicators' scores. The robustness of these indices is explained by the fact that the items have been adapted to a narrow context of geopolitical risk and responses with inconsistent or incomplete responses have been removed.

It has been possible to prove discriminant validity according to two criteria. First, the square roots of AVE values of the constructs are higher than their correlation with other constructs. This means that each construct shares more variance with its own indicators than with other constructs. Second, HTMT values vary between 0.615 and 0.890 and remain below the 0.90 conservative cut-off point. The RPI-FIC value approaches this point. While being theoretically explainable in a sample of emerging markets, political instability and investors' confidence are empirically distinct.

To assess common method bias, Harman's single-factor test was performed. The first unrotated factor explained 58.296% of the total variance, slightly exceeding the conventional 50% threshold (see Table EC1). However, because Harman's test is only a preliminary assessment, the results were complemented by an examination of the inner-model VIF values. As all VIF values were below the recommended threshold of 3.3 (see Table EC2), common method bias is unlikely to have materially affected the study's findings.

4.5.1. Structural Model Evaluation

The explanatory power of the structural model was assessed using the coefficient of determination (R^2) and adjusted R^2 for the endogenous constructs. The results are presented in ***Table 5***.

Table 5. Coefficient of determination (R^2 and Adjusted R^2) for endogenous constructs.

	R-Square	R-Square Adjusted
CFP	0.667	0.664
CV	0.645	0.643
FIC	0.694	0.691
SCR	0.600	0.598

The effect size (f^2) was examined to assess the contribution of each exogenous construct to the explained variance of the endogenous constructs. The results are presented in ***Table 6***.

Table 6. Effect size (f^2) of exogenous variables on endogenous constructs.

	f-Square
CV → CFP	0.239
FIC → CFP	0.126
RPI → CV	0.259
RPI → FIC	0.230

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SCR → CFP	0.004
SCST → CV	0.084
SCST → FIC	0.071
SCST → SCR	0.151
UCTW → FIC	0.006
UCTW → SCR	0.160

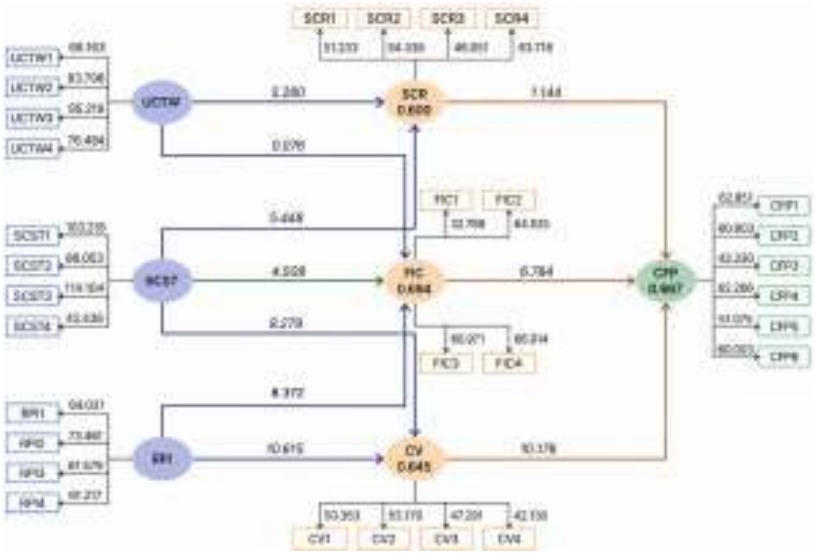
The predictive capability of the structural model was assessed using predictive relevance (Q^2) together with the prediction error metrics, namely the root mean square error (RMSE) and the mean absolute error (MAE). The results are presented in ***Table 7*** ~~Q^2 Prediction Metrics~~

Table 7. Predictive rRelevance (Q^2) and pPrediction mMetrics (RMSE and MAE).

	Q^2 Predict	RMSE	MAE
CFP	0.567	0.665	0.540
CV	0.644	0.607	0.470
FIC	0.690	0.565	0.452
SCR	0.592	0.648	0.473

The significance of the measurement and structural models was assessed using the bootstrapping procedure with 5,000 resamples. The bootstrapping results, including the t-statistics for the indicator loadings and structural path coefficients, are illustrated in **Figure 3**.

Figure 3. Structural mModel rResults sShowing pPath cCoefficients, R^2, and eEffect sSizes (graphically edited from the original SmartPLS 4).



4.5.2. Path Coefficient

Table 8. Structural mModel pPath cCoefficients and hHypothesis tTesting.

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Hypothesis	Path Relationship	Original Sample (β)	T Statistics	*p* Values	Decision
H1	UCTW → SCR	0.415	5.280	0.000	Supported
H2	UCTW → FIC	0.076	1.302	0.193	Not Supported
H3	SCST → SCR	0.403	5.448	0.000	Supported
H4	SCST → FIC	0.281	4.509	0.000	Supported
H5	SCST → CV	0.304	6.372	0.000	Supported
H6	RPI → FIC	0.521	8.279	0.000	Supported
H7	RPI → CV	0.534	10.615	0.000	Supported
H8	SCR → CFP	0.050	1.144	0.253	Not Supported
H9	CV → CFP	0.471	10.176	0.000	Supported
H10	FIC → CFP	0.356	6.784	0.000	Supported

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4.5.3. Specific Indirect Effects

The mediation analysis provides partial support for the proposed indirect relationships. Significant indirect effects were observed through foreign investment confidence and currency volatility, indicating that these financial mechanisms play a central role in transmitting the effects of regional political instability and South China Sea tensions to corporate financial performance. In contrast, the indirect effects through supply chain resilience were not statistically significant, and foreign investment confidence did not mediate the relationship between the US–China trade war and corporate financial performance. Overall, the findings suggest that geopolitical risks influence corporate financial performance primarily through financial channels rather than operational resilience, providing evidence of partial mediation.

The specific indirect effect analysis was conducted to evaluate the mediating effects within the structural model. The significance of each indirect path was assessed based on the original sample (β), t-statistics, and p-values. The results of the mediation analysis are presented in Table 9

Table 9. Specific ~~i~~Indirect ~~e~~Effects in the ~~s~~Structural ~~m~~Model.

Hypothesized Indirect Path	Original Sample (β)	T Statistics	*p* Value	Decision
RPI → FIC → CFP	0.185	5.160	0.000	Supported
SCST → SCR → CFP	0.020	1.067	0.286	Not Supported
RPI → CV → CFP	0.251	6.899	0.000	Supported
UCTW → SCR → CFP	0.021	1.144	0.253	Not Supported
SCST → FIC → CFP	0.100	3.614	0.000	Supported
SCST → CV → CFP	0.143	5.478	0.000	Supported
UCTW → FIC → CFP	0.027	1.269	0.204	Not Supported

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4.6. Structural Model Evaluation: An Advanced Analysis

It emerges that the structural model has quite a high level of explanatory power regarding firm-level outcomes in the context of geopolitical instability. The value of the coefficient of determination regarding corporate financial performance is 0.667 (adjusted R^2 = 0.664), showing that the proposed mediating variables account for roughly ~~two thirds~~two-thirds of the variation in perceived financial performance. The model additionally shows an ability to explain a large portion of the variance in foreign investment confidence (R^2 = 0.694) and currency volatility (R^2 = 0.645), and a moderate one in supply chain resilience (R^2 = 0.600).

The path coefficients indicate that financial factors are more relevant compared to the direct operational resilience factor. Corporate financial performance is positively ~~associate d~~associated with currency volatility (β = 0.471, t = 10.176, $p < 0.001$), and negatively with foreign investment confidence (β = 0.356, t = 6.784, $p < 0.001$). In other words, this analysis indicates that the theoretical argument of the project, according to

which geopolitical instability is being transmitted into corporate financial performance via financial channels such as exchange rate vulnerability, funding difficulties, and others, is valid.

However, caution must be exercised when interpreting the results regarding currency volatility. According to conventional international finance theory, currency volatility is typically associated with poor financial performance as it creates additional transaction costs, uncertainty, and the need for hedging. Therefore, the positive correlation between the two variables in this case does not imply that currency volatility has a beneficial impact on firm -performance. A possible explanation may be the fact that corporations experiencing high _ –currency volatility levels usually tend to operate in international markets and conduct foreign trade operations, implying greater sensitivity to currency movements as well as the ability to collect foreign currency income and hedge.

Regional political instability emerged as the most important antecedent of both currency volatility ($\beta = 0.534$, $t = 10.615$, $p < 0.001$) and foreign investment confidence ($\beta = 0.521$, $t = 8.279$, $p < 0.001$). These results confirm that political instability is ~~fast~~ quickly ~~internalised~~ internalized through capital market expectations and foreign exchange dynamics. This result supports institutional theory since the latter assumes that investors and foreign exchanges would quickly sense the implications of uncertainties in governance, security, and policy continuation. Additionally, South China Sea tensions emerged as another factor that significantly influences all three dependent variables (supply chain resilience, currency volatility, and foreign investment confidence), proving that geopolitical risks in maritime zones cannot be confined to logistics problems.

The lack of a significant association between supply chain resilience and corporate financial performance ($\beta = 0.050$, $p = 0.253$) presents an interesting ~~theory~~ theoretical implication. While operational resilience can indeed provide protection against disruptions in production processes, its immediate financial benefit may not ~~materialise~~ materialize immediately in a cross-sectional setting. For example, resilience measures that include supplier diversification, inventory stockpiling, alternative routes, and digital tracking systems will likely lead to higher immediate costs. As a consequence, supply chain resilience seems to work as an adaptation strategy rather than an immediate financial risk indicator.

While the trade war between the United States and China showed a significant relationship with supply chain resilience but not foreign investment confidence, regional political instability and South China Sea tensions were positively related to financial risk. Specifically, geopolitical risk is interpreted as having a greater impact on foreign investment confidence and currency volatility than being directly related to supply chain issues. Investors seem to incorporate these factors in the assessment of risk when making investment decisions and thus show a quick response to regional geopolitics.

Mediation analysis results support the interpretation of the results. There is statistical evidence for indirect associations for both regional political instability and South China Sea tensions through currency volatility and foreign investment confidence. On the other hand, mediation via supply chain resilience was not found to be statistically significant. Such a pattern implies that geopolitical risks influence firms' perceptions of financial performance via financial market dynamics and foreign investment decisions for the selected companies. Thus, the results of the study provide additional support for the hypothesis of the model.

4.7. Theoretical Contributions and Practical Implications

There are several theoretical contributions as well. First, this research contributes to the literature on geopolitical risks and political uncertainty by extending research beyond macroeconomic effects of geopolitics and considering the mechanisms through which

geopolitical risks translate into firm-level effects. Specifically, the results suggest that besides ~~be ing~~being directly disruptive, geopolitics impacts firms through financialization of vulnerability, where currency risks and investor confidence emerge as key channels connecting geopolitical risks to firm performance. Second, this research brings together institutional uncertainty, transaction costs, real options, behavio~~u~~ral finance, dynamic capabilities, and in~~-~~ternational finance into one theoretical explanation. The combination explains the ~~necessi ty~~necessity to consider operational, financial, and institutional channels simultaneously, and not separately.

Third, with respect to emerging markets, the study reveals boundary conditions ~~un der~~under which financial channels dominate operational resilience channels in terms of firm performance. Indeed, in emerging Asian countries, firms are financially dependent on for~~-~~eign investors, use inputs from abroad, sell products internationally, and do not have ade~~-~~quate infrastructure for ~~hedges~~ hedging against risks. Hence, exchange rate fluctuations and confi~~-~~denc~~e~~e become particularly important. Moreover, a non-significant direct impact of supply chain resilience extends resilience literature, suggesting that resilience could be treated as a protective capability that pays off only through financial measures in the long run rather than at a cross-sectional point in time. The non-significant relationship between supply chain resilience and firm performance also provides an important theoretical insight. Con~~-~~trary to the assumption that resilience immediately improves performance outcomes, the findings suggest that resilience may function as a protective organizational capability that reduces vulnerability rather than directly generating short-term financial gains. From a dynamic capabilities perspective, resilience investments may require time to transform into measurable performance improvements, particularly under conditions of ongoing geopo~~-~~litical uncertainty.

Practically, there are several lessons from the analysis. Specifically, firms should address geopolitical risk not ~~as solely~~solely as an operational issue. Instead, they require integrated risk management, including supplier diversity, managing currency risk, ensuring financial liquidity, managing investor expectations, and scenario-based strategic management. From the finance department perspective, it would be critical to keep track of exposure to foreign currencies, manage hedging where possible, and ~~analyse~~ analyze cash flows, margins, and funding conditions based on geopolitical events. Supply chain departments need to pursue resilience management as well; however, ~~, however,~~ it would be beneficial to measure its financial consequences, so that resilience does not remain a burden for the company.

With respect to policymakers, the results imply that creating a favo~~u~~rable institutional environment, ensuring regulation consistency, fostering diplomatic cooperation among countries in the region, and making financial risk management tools available are essential. Specifically, lowering the risk premium could be achieved through a reduction in uncertainties~~reduction of uncertainties~~ in customs clearance, investment conditions, maritime security, and foreign currency markets. Finally, regional cooperation is critical in Southeast Asia, as firms tend to operate across ~~the border~~borders and, thus, are equally exposed to trade wars, maritime risks, and political instability in their own country.

5. Limitations and Future Research

Several limitations offer potential avenues for future research. First, the cross-sectional nature of the research reduces the possibility of making any claims related to causality. The presented results can be considered only as evidence for theoretically grounded associations, not as evidence of temporally causal~~temporally causal~~ relationships. In the future, there is an opportunity to investigate the effects of prolonged

geopolitical shocks on firms' adaptation process and delayed financial gains resulting from resilience investments using longitudinal datasets.

Second, this study relies on managers' perceptual assessments, which may not fully capture objective conditions. Future research should complement survey data with objective indicators, such as exchange rate volatility, trade disruptions, foreign direct investment inflows, firm-level financial statements, and country-level political risk measures, to enhance the robustness of the findings.

Third, the use of single-source, cross-sectional survey data may introduce common method bias. Although Harman's single-factor test suggested a potential concern, future studies should employ more rigorous procedural and statistical remedies, including multi-source data, temporal separation, marker variables, or longitudinal research designs.

Fourth, this study did not incorporate a comprehensive set of firm- and country-level control variables. Future research should include factors such as firm size, industry, ownership structure, leverage, export intensity, and the institutional environment, while adopting multi-group or longitudinal designs to examine the generalizability of the proposed relationships across different contexts.

Finally, the present research is restricted to a sample of Southeast Asian economies and industries that have high exposure to geopolitical risks. Results may not apply to small firms, purely domestic companies, or countries having a more developed financial system and institutions. Future research would benefit from investigating the role of financial transmission mechanisms among firms operating in emerging and advanced economies.

6. Conclusions

The study aimed at establishing the connection between geopolitical instabilities and the financial performance of corporations in emerging Asia through supply chain resilience, foreign investment confidence, and currency volatility. From the findings obtained, financial market channels seem to significantly explain firm vulnerability due to geopolitical risks. Currency volatility and investor confidence were found to be significant correlates with financial performance compared to supply chain resilience, implying that geopolitical risk influences firm performance indirectly through currency risk, financial-market expectations, and investor confidence channels.

The study has shown that geopolitical risks influence firms differently. Regional instabilities and South China Sea geopolitical risk appear to influence financial and investor confidence channels, while the US–China trade war risk is correlated to supply chain resilience responses. Supply chain resilience does not significantly impact the financial performance of firms, indicating that resilience may protect firm continuity without increasing financial performance. This shows the significance of resilience in terms of its long-term nature and not necessarily financial benefits in the short run.

In conclusion, the study develops a multi-channel risk model that enables firms to establish ways to counter risks through financial and investment confidence and operational resilience. The results offer strategic implications to managers who need to coordinate operational resilience with currency risk management and investor communication strategies. Furthermore, there are policy recommendations indicating that geopolitical risk impacts corporate sustainability positively in a country with predictable regulations and institutional stability, and regional economic cooperation. Due to its cross-sectional nature, the results may not be conclusive and need to be tested further using longitudinal archival data.

Supplementary Materials:

https://doi.org/10.3390/xxxxx

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Author Contributions: S.S.: Conceptualization, Formal analysis, Methodology, Supervision, Validation, Writing—review and editing~~Writing—review & editing~~; S.W.: Methodology, Data curation, Writing—review and editing~~Writing—review & editing~~. C.M.F.M.: Conceptualization, Data curation, Investigation, Validation, Visualization, Writing—review and editing~~Writing—review & editing~~. All authors have read and agreed to the published version of the manuscript.

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Article

External Financial Dominance Under Sanctions: Financial Fragmentation and Exchange Rate Determination in Russia

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Abstract

This paper examines whether prolonged sanctions and major geopolitical episodes associated with financial fragmentation alter exchange-rate dynamics and weaken the explanatory power of domestic macroeconomic channels and strengthen external financial dominance of traditional exchange-rate transmission mechanisms. Standard exchange rate theories are based on the concepts of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP). However, the application of continuous sanctions could weaken this explanatory power and change exchange rate dynamics. The present study applies a combined framework of Autoregressive Distributed Lag (ARDL), Error Correction Modeling (ECM), Vector Autoregression (VAR) and structural break analysis to study the exchange-rate behavior in response to repeated geopolitical shocks using monthly data for Russia from 2005 to 2025. The results indicate that external variables such as the US dollar index and oil prices are important determinants of exchange rates, while inflation and interest rate differentials associated with PPP and UIP have little explanatory power. Structural break tests detect major regime shifts associated with the Global Financial Crisis, Crimea-related sanctions episode, COVID-19 pandemic and Russia–Ukraine conflict. The error correction process indicates that the speed of adjustment to equilibrium is slow, which means that traditional exchange-rate relationships will continue to diverge. In general, the results suggest a regime-dependent exchange rate environment in which external financial factors tend to dominate domestic adjustment mechanisms. Our study contributes to the literature on exchange rates, sanctions and financial fragmentation by providing evidence on how geopolitical shocks shift the relative importance of domestic and external determinants in a highly sanctioned economy.

Keywords: exchange rate dynamics; global financial cycle; sanctions; structural breaks; Russia

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1. Introduction

The globalization of financial markets has dramatically changed how exchange rates are determined. Classic exchange rate theories, in particular Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP), state that domestic macroeconomic fundamentals are the main drivers of exchange rates through inflation and interest rate differentials, as proposed by Rogoff (1996) and Engel (2014). However, external monetary

factors affecting trade price dynamics have long been embedded in the international finance literature. Previous studies have shown that U.S. monetary policy, global liquidity and international capital flows have large spillover effects for domestic financial markets and exchange rates in both advanced economies (AEs) and emerging economies (Bernanke, 2005; Forbes & Warnock, 2012). Building on these insights, the U.S. Global Financial Cycle framework highlights the roles played by global risk sentiment, the dominance of the U.S. dollar and international financial integration in magnifying the transmission of external financial shocks (Rey, 2016; Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020). Thus, while this study does not propose a new theory of the exchange rate determination process, it will apply these theories in an examination of interactions between extended sanctions and financial fragmentation to examine whether they alter the mechanisms through which Russia's exchange rate is determined.

With increasing financial market integration, exchange rates in small and open economies have become increasingly influenced by global financial conditions rather than solely by domestic macroeconomic fundamentals. As a result, global liquidity cycles and external financial shocks play a more prominent role in exchange-rate determination, reducing the explanatory power of traditional equilibrium-based models that rely primarily on domestic economic fundamentals. Consequently, exchange-rate movements are increasingly shaped by external rather than internal shocks (Rey, 2016; Obstfeld, 2022).

These dynamics have become most pronounced in economies subject to heightened geopolitical frictions and international restrictions. Since the 2014 Crimea crisis and the escalation of the Russia–Ukraine conflict in 2022, Russia has faced large-scale financial sanctions that have constrained capital mobility, intensified financial fragmentation, and modified transmission mechanisms underlying exchange rate determination (Caldara & Iacoviello, 2022; Ahn & Ludema, 2020). Moreover, as one of the largest exporters of energy in the world, the Russian exchange rate remains particularly reactive to external oil price fluctuations, reinforcing the argument that key economic shocks are important drivers of currency dynamics (Chen & Rogoff, 2003; Kilian, 2009). These circumstances imply a growing role of external financial and geopolitical factors in exchange rate dynamics, potentially reducing the explanatory relevance of domestic macroeconomic fundamentals.

This paper differs from conventional exchange rate studies based on small open economy assumptions. Instead, it conceptualizes Russia as a large, commodity-dependent economy whose exchange rate dynamics are shaped by structural exposure to global energy markets, geopolitical pressures, and financial restrictions. The distinctive features of Russia's exchange rate dynamics compared with those of smaller open economies derive from the structural importance of Russia in global energy markets, its scale and sustained role as a geopolitical actor, and its long-standing exposure to international sanctions. Thus, exchange rate dynamics in Russia are influenced not only by domestic macroeconomic fundamentals but also by external financial conditions, commodity price developments, geopolitical shocks, and financial fragmentation. Hence, the paper employs an analytical framework that integrates Global Financial Cycle theory, commodity currency theory, and financial fragmentation perspectives to explain exchange rate determination in Russia amid persistently high geopolitical uncertainty (Chen & Rogoff, 2003; Gopinath et al., 2020; Caldara & Iacoviello, 2022; Ahn & Ludema, 2020).

Recent studies have independently examined the effects of global financial conditions, commodity prices, and geopolitical risks on exchange rates (Chen & Rogoff, 2003; Caldara & Iacoviello, 2022). Nevertheless, limited empirical evidence explains how prolonged sanctions simultaneously reshape the relative importance of external financial variables, domestic macroeconomic fundamentals, and structural regime changes within a unified analytical framework. This limitation is particularly important for highly sanctioned commodity-exporting economies such as Russia, where geopolitical fragmentation

may fundamentally alter traditional exchange rate determination mechanisms. Accordingly, a comprehensive empirical investigation is required to better understand the evolving drivers of exchange rate dynamics under prolonged sanctions and financial fragmentation.

In addition to financial sanctions, Russia has increasingly reoriented its trade and financial relations toward China and other non-aligned economies. This adjustment includes the expansion of BRICS economic cooperation, the growing use of Renminbi-denominated trade settlement, and the adoption of alternative payment and financial messaging systems such as CIPS and SPFS. These developments have partially reshaped Russia's external financial environment and may influence exchange-rate dynamics by reducing dependence on traditional Western financial infrastructures. However, these structural adjustments are beyond the scope of the present empirical model, which focuses on identifying changes in exchange-rate dynamics associated with major sanction-related geopolitical episodes.

To further illustrate Russia's changing external-sector exposure under prolonged sanctions, Figure 1 presents the evolution of trade openness, exports, and imports during 2005–2025. All series are indexed to 2005 = 100 to facilitate comparison across time. The trade openness proxy is constructed from the combined movement of exports and imports, while exports are measured on an FOB basis and imports on a CIF basis, following standard international trade-statistics conventions (World Bank, 2026; International Monetary Fund [IMF], 2023; Marini et al., 2018). This descriptive evidence complements the exchange-rate analysis by showing how Russia's external trade activity evolved across major crisis episodes, including the Global Financial Crisis, the Crimea-related sanctions period, the COVID-19 shock, and the Russia–Ukraine conflict (Ahn & Ludema, 2020; World Trade Organization, 2021; Caldara & Iacoviello, 2022; OECD, 2024).

Figure 1. Evolution of Russia's Trade Openness, Exports, and Imports, 2005–2025 (Index, 2005 = 100), shows that Russia's trade openness increased substantially over the sample period, although the trajectory was interrupted by several major crisis episodes. The decline in 2009 reflects the impact of the Global Financial Crisis, while the moderation during 2015–2016 is consistent with the combined effects of Crimea-related sanctions and the oil price collapse (Ahn & Ludema, 2020). A further decline is observed in 2020 during the COVID-19 shock, which disrupted global trade flows and reduced merchandise trade activity worldwide (World Trade Organization, 2021). However, the sharp increase after 2021 suggests that Russia's external trade activity recovered strongly despite the escalation of sanctions following the Russia–Ukraine conflict. This pattern indicates that sanctions did not eliminate Russia's external trade linkages but contributed to a restructuring of external

economic relations (Itskhoki & Ribakova, 2024; OECD, 2024; Simola, 2025). Nevertheless, because the figure uses aggregate exports and imports, it should be interpreted as evidence of changing trade openness rather than direct evidence of partner-specific reorientation from G7 economies toward China and Asian markets (OECD, 2024; Simola, 2025).

Despite the growing literature on exchange rate dynamics, several important research gaps remain. First, previous studies have generally examined the effects of global financial conditions, commodity prices, domestic macroeconomic fundamentals, or geopolitical risks separately, providing only a partial explanation of exchange rate behavior (Chen & Rogoff, 2003; Kilian, 2009; Caldara & Iacoviello, 2022). Second, limited empirical evidence investigates whether prolonged sanctions and financial fragmentation fundamentally alter the relative importance of external and domestic determinants of exchange rates. Third, few studies integrate long-run equilibrium analysis, short-run adjustment, structural break identification, monetary channels, and shock transmission within a single econometric framework. Addressing these gaps is essential for understanding exchange rate determination in highly sanctioned economies such as Russia.

To better illustrate the conceptual relationships among the external financial environment, domestic macroeconomic fundamentals, geopolitical shocks, and the proposed empirical analyses, Figure 2 presents the conceptual framework of this study.

Figure 2. presents the evolution of the USD/RUB exchange rate and its 12-month rolling volatility over 2005–2025. Panel (**A**) shows exchange-rate movements during major economic and geopolitical events, while Panel (**B**) highlights periods of heightened market volatility. The figure provides descriptive evidence of increased market turbulence following these events but does not, by itself, establish structural regime shifts.

To address these research gaps, this study investigates eight interrelated questions. First, it examines how global financial factors influence the USD/RUB exchange rate. Second, it investigates whether domestic macroeconomic fundamentals contribute significantly to exchange rate dynamics. Third, it evaluates the role of oil prices under prolonged sanctions. Fourth, it examines whether major geopolitical events generate structural breaks and regime shifts in exchange rate behavior. Fifth, it analyzes the speed of adjustment toward the long-run equilibrium following short-run disturbances. Sixth, it

investigates how external financial shocks are transmitted through the exchange rate system. Seventh, it evaluates whether interest rate differentials and, eighth, inflation differentials support the predictions of Uncovered Interest Parity (UNIP) and Purchasing Power Parity (PPP) theories (Pesaran et al., 2001; Bai & Perron, 2003; Engel, 2014).

The primary objective is to determine whether prolonged sanctions and financial fragmentation shift exchange rate determination from domestic fundamentals toward external financial conditions. An integrated ARDL–ECM–VAR framework with structural break analysis is used to assess long-run relationships, short-run dynamics, regime changes, and shock transmission. Geopolitical and financial fragmentation are represented by structural-break dummy variables associated with major sanction-related events rather than continuous indicators such as the Geopolitical Risk Index.

This study contributes by extending the Global Financial Cycle perspective to a sanctioned economy and examining whether sanctions increase the dominance of external financial drivers (Gopinath et al., 2020; Miranda-Agrippino & Rey, 2020). It also reassesses the validity of PPP and UIP under geopolitical disruption (Engel, 2014) and integrates ARDL, ECM, VAR, and structural break methods within a unified framework for evaluating equilibrium, adjustment, regime shifts, and shock transmission (Pesaran et al., 2001; Bai & Perron, 2003). These contributions provide a more comprehensive understanding of exchange rate behavior in economies experiencing persistent geopolitical uncertainty and financial fragmentation. In this study, geopolitical fragmentation is not directly measured using a continuous index. Instead, the analysis focuses on major geopolitical episodes that generated structural changes in the Russian financial environment. Accordingly, crisis dummy variables are employed as proxies for regime shifts associated with sanctions and major geopolitical events rather than as direct measures of geopolitical fragmentation.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and develops the theoretical framework underpinning the study. Section 3 describes the data, variables, and research methodology, including the ARDL, ECM, VAR, and structural break models employed in the empirical analysis. Section 4 presents and discusses the empirical findings, covering long-run and short-run dynamics, structural breaks, shock transmission, and robustness tests. Section 5 discusses theoretical and policy implications; Section 6 concludes the study by summarizing the main findings; Section 7 presents Implications and Future Research.

2. Literature Review and Theoretical Framework

2.1. Literature Review

2.1.1. Exchange Rate Determination

Exchange rate determination is a central issue in international finance because it reflects the interaction between domestic macroeconomic fundamentals and external financial conditions. Traditional theories, including Purchasing Power Parity (PPP), Uncovered Interest Parity (UIP), monetary models, and portfolio balance models, emphasize inflation, interest rates, money supply, output, and balance-of-payments conditions as the main drivers of long-run exchange rate adjustment (Rogoff, 1996; Engel, 2014).

However, empirical studies show that domestic variables alone often fail to explain exchange rate movements, particularly in financially open emerging markets. Traditional structural models frequently perform no better than random-walk forecasts, suggesting that exchange rates are also shaped by capital flows, investor expectations, and external financial shocks (Meese & Rogoff, 1983; Obstfeld & Rogoff, 1995; Engel et al., 2008). More recent research highlights the growing influence of global liquidity, investor risk appetite,

international capital mobility, and US dollar fluctuations (Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020).

For commodity-exporting economies, exchange rates respond simultaneously to domestic monetary policy, commodity prices, capital flows, and geopolitical developments. Therefore, an integrated framework that captures both domestic and external transmission mechanisms is required. Although exchange rate research has expanded beyond conventional macroeconomic models to incorporate financial globalization and external spillovers, no consensus exists regarding the relative importance of these factors, particularly in large commodity-dependent emerging economies under prolonged geopolitical sanctions. This unresolved issue motivates the present study.

2.1.2. Oil Prices and Exchange Rates

Oil prices are a major external determinant of exchange rates in commodity-exporting economies because they affect export revenues, fiscal balances, foreign exchange reserves, and market expectations. The currencies of resource-rich countries tend to respond systematically to global commodity prices, supporting the concept of commodity currencies (Chen & Rogoff, 2003).

The effect of oil prices, however, depends on the source of the shock. Global demand, supply disruptions, and precautionary demand may produce different exchange-rate responses (Kilian, 2009). In general, positive oil price shocks tend to appreciate the currencies of oil-exporting countries while weakening those of oil importers through changes in trade revenues, terms of trade, investor confidence, and capital flows (Basher et al., 2016; Beckmann et al., 2020).

This relationship is particularly important for Russia because of its heavy dependence on crude oil and natural gas exports. Brent oil prices influence Russian export earnings, fiscal revenues, external balances, and, consequently, the ruble. However, sanctions imposed since 2014 and expanded substantially in 2022 may have altered this transmission through trade restrictions, export-market reorientation, capital controls, and financial fragmentation (Ahn & Ludema, 2020). Because most previous studies focus on normal market conditions, further research is needed to determine whether prolonged geopolitical sanctions change the ruble's sensitivity to oil prices and the interaction between commodity markets and external financial conditions.

2.1.3. Global Financial Cycle

External financial conditions significantly influence exchange rates through US monetary policy, global liquidity, capital flows, and investor expectations (Bernanke, 2005; Forbes & Warnock, 2012). In financially integrated economies, these shocks may constrain domestic monetary policy autonomy because they are rapidly transmitted across borders.

The Global Financial Cycle framework explains how US monetary policy and global risk sentiment jointly affect capital flows, asset prices, credit, and exchange rates, even under floating exchange rate regimes (Rey, 2016). Subsequent studies link this cycle to the US dollar and global risk appetite, while emphasizing the dollar's dominant role in transmitting financial shocks through trade and financial channels (Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020).

In emerging markets, external variables such as the US Dollar Index, global volatility, and international portfolio shifts may exert greater influence than domestic fundamentals during periods of uncertainty (Obstfeld, 2022; Aizenman et al., 2016). However, limited research has examined whether sanctions and financial fragmentation weaken or transform these transmission mechanisms. It therefore remains unclear whether external financial conditions continue to dominate exchange rate determination when international financial integration is disrupted.

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2.1.4. Geopolitical Risk, Sanctions, and Financial Fragmentation

Geopolitical risk disrupts trade, capital flows, financial transactions, and investor confidence, increasing exchange-rate volatility (Caldara & Iacoviello, 2022). Sanctions intensify these effects by restricting international capital, investment, financial intermediation, and payment systems (Crozet & Hinz, 2020; Ahn & Ludema, 2020).

For Russia, sanctions imposed since 2014 and expanded in 2022 have targeted financial institutions, reserves, payment systems, and energy exports. Consequently, ruble movements have become increasingly sensitive to geopolitical developments and global financial conditions despite domestic interventions (Ahn & Ludema, 2020).

Financial fragmentation further weakens market integration, capital allocation, and international risk sharing while altering the transmission of global shocks (International Monetary Fund [IMF], 2023). However, few studies jointly examine geopolitical risk, sanctions, commodity dependence, and fragmentation in explaining long- and short-run exchange-rate dynamics. This gap motivates the present study.

2.1.5. Research Gap

Previous studies have identified domestic macroeconomic fundamentals, commodity prices, global financial conditions, and geopolitical factors as important determinants of exchange rates (Chen & Rogoff, 2003; Kilian, 2009; Caldara & Iacoviello, 2022). However, several research gaps remain.

First, these factors are generally examined separately, providing limited evidence on their simultaneous interaction, particularly during prolonged geopolitical disruptions. Second, although the Global Financial Cycle literature emphasizes external financial conditions, few studies assess whether sanctions and financial fragmentation alter the relative influence of domestic and external determinants. This issue is especially relevant for Russia because its exchange rate is shaped by commodity dependence, global financial shocks, and geopolitical constraints.

Third, previous research often uses separate econometric methods to examine long-run relationships, short-run adjustments, structural breaks, or shock transmission. Few studies integrate these dimensions within a unified framework. Moreover, the validity of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP) under prolonged sanctions and financial fragmentation remains insufficiently examined.

This study addresses these gaps by combining domestic fundamentals, external financial conditions, commodity prices, geopolitical shocks, and financial fragmentation within an ARDL–ECM–VAR framework with structural break analysis. This approach provides a comprehensive assessment of exchange rate determination in a commodity-dependent emerging economy facing prolonged geopolitical and financial constraints.

2.2. Theoretical Framework

2.2.1. Purchasing Power Parity (PPP)

Purchasing Power Parity (PPP) is one of the fundamental theories of exchange rate determination, proposing that exchange rates adjust to equalize the purchasing power of different currencies over time. According to the relative PPP hypothesis, changes in exchange rates are primarily driven by inflation differentials between countries. When domestic inflation exceeds foreign inflation, the domestic currency is expected to depreciate to restore international price competitiveness (Rogoff, 1996; Engel, 2014).

The relative Purchasing Power Parity (PPP) condition states that the percentage change in the nominal exchange rate is determined by the inflation differential between the domestic and foreign economies. The relationship is expressed as follows:

~~$\Delta S_t = \pi t - \pi t^*$~~

$$\Delta S_t = \pi_t - \pi_t^*$$

where

ΔS_t = percentage change in the nominal USD/RUB exchange rate;
π_t = inflation rate in Russia;
π_t^* = inflation rate in the United States.

Although PPP provides a useful long-run benchmark, empirical studies frequently report deviations from parity because exchange rates are also affected by capital mobility, market frictions, government intervention, and external financial shocks. These deviations are expected to become even more pronounced under prolonged geopolitical sanctions and financial fragmentation. Accordingly, this study re-examines the validity of PPP for the Russian ruble under changing geopolitical and financial conditions, corresponding to Research Question 8 (RQ8).

2.2.2. Uncovered Interest Parity (UIP)

Uncovered Interest Parity (UIP) explains exchange rate movements through differences in nominal interest rates across countries. The theory states that currencies offering relatively higher interest rates are expected to depreciate sufficiently to offset the return advantage, thereby eliminating arbitrage opportunities in international financial markets (Fama, 1984; Engel, 2014). Formally, the UIP condition can be expressed as follows:

~~$Et\left(\frac{S(t+1)-St}{St}\right) = i_t - i_t *.$~~

$$E_t\left((S_{(t+1)} - S_t)/S_t\right) = i_t - i_t^*$$

where

E_t = expected future exchange rate;
S_t = Nominal exchange rate at time t.
$S_{(t+1)}$= Expected nominal exchange rate at time $t + 1$.
i_t = domestic nominal interest rate (Russia);
$i_t *$ = foreign nominal interest rate (United States).

Despite its theoretical importance, UIP is frequently violated, a phenomenon known as the forward premium puzzle. Exchange rate expectations are shaped not only by interest rate differentials but also by risk premiums, capital controls, geopolitical uncertainty, and global financial conditions. These factors are especially relevant for Russia, where sanctions may weaken conventional monetary transmission. Therefore, this study examines whether interest rate differentials continue to explain exchange rate dynamics under prolonged sanctions, corresponding to RQ7.

2.2.3. Commodity Currency Theory

Commodity Currency Theory states that exchange rates in resource-dependent economies are influenced by international commodity prices through export revenues, fiscal balances, and foreign exchange earnings (Chen & Rogoff, 2003). Higher commodity prices generally improve external balances and support currency appreciation, while lower prices have the opposite effect.

This theory is particularly relevant to Russia because of its dependence on oil and natural gas exports. Brent oil prices are expected to affect the USD/RUB exchange rate through export income, government revenue, and foreign exchange inflows. However,

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sanctions may alter these channels by restricting trade, export destinations, and financial transactions. Accordingly, the role of oil prices under geopolitical constraints is examined in RQ3.

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2.2.4. Global Financial Cycle Theory

The Global Financial Cycle theory emphasizes the role of global liquidity, capital flows, investor risk sentiment, and the US dollar in shaping financial markets and exchange rates (Rey, 2016). External shocks, particularly those associated with US monetary policy, influence portfolio allocation, capital flows, and currency valuations in financially integrated economies (Miranda-Agrippino & Rey, 2020). The Dominant Currency Paradigm further argues that the US dollar's central role in global trade and finance amplifies the transmission of external shocks across exchange rate regimes (Gopinath et al., 2020).

For Russia, these effects operate through commodity exports, capital mobility, and external financing. However, sanctions may reduce financial integration and alter capital flow patterns. The Global Financial Cycle therefore provides the theoretical basis for examining whether external financial variables dominate exchange rate determination under geopolitical uncertainty, corresponding to RQ1, RQ2, and RQ6.

2.2.5. Financial Fragmentation Framework

Financial fragmentation refers to the segmentation of global financial markets caused by geopolitical conflicts, sanctions, trade restrictions, and declining cross-border integration. It weakens financial linkages, reduces market integration, and alters the transmission of global shocks, causing exchange rates to reflect geopolitical constraints more strongly (International Monetary Fund [IMF], 2023).

Sanctions affect exchange rates by restricting capital flows, financial transactions, payment systems, and foreign reserve management. These restrictions reduce external financing and increase volatility, potentially weakening the relationships predicted by PPP, UIP, and conventional international finance models (Ahn & Ludema, 2020).

Russia provides a relevant case because sanctions imposed since 2014 and expanded in 2022 have changed the interaction among domestic fundamentals, commodity markets, and external financial conditions. This framework explains structural changes in the USD/RUB exchange rate, supports RQ4 and RQ5, and complements the Global Financial Cycle perspective. Figure 3 illustrates these transmission mechanisms.

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Figure 3. Shows how geopolitical sanctions affect exchange rates through financial restrictions, including capital controls, frozen reserves, and payment disruptions. These measures intensify financial fragmentation, alter capital flows, trade financing, and monetary transmission, and increase the influence of external financial conditions on the USD/RUB exchange rate. This framework underpins the ARDL, ECM, VAR, and structural break analyses.

3. Methods and Data Description

This case study began with monthly time-series data for 2005–2025 and examines the factors behind the fluctuation of the exchange rate between US dollars (USD) and Russian rubles (RUB). Frequency is a key metric in applied time-series econometrics. This analysis examines only short-term fluctuations, but medium-term dynamics as well, for which monthly frequency is desirable.

The data include global financial indicators, commodity prices, domestic macroeconomic data, and real sector indicators. Most variables were defined using natural logarithms for consistency and interpretability, as this allows for the interpretation of the estimated coefficients as elasticities, and because natural logarithms stabilize variance.

The data revealed the presence of structural breaks associated with major political and economic events, indicating the necessity of including two dummy variables that could account for potential regime changes in the model specification.

The definitions of the variables and sources of the data are given in Tables 1 and 2. Additional descriptive statistics and unit root test results are provided in Appendix A (Table A1).

Table 1. Definition of Variables and Data Sources.

Variable	Symbol	Measurement	Expected Effect	Theoretical Basis	Source
Exchange Rate	lnEXR	RUB per USD (log)	—	—	Federal Reserve Economic Data (FRED)
US Dollar Index	lnDXY	Index (log)	(+)	Global Financial Cycle	Federal Reserve/Trading Economics
Global Risk	VIX	Volatility Index	(+)	Risk Aversion	Chicago Board Options Exchange (CBOE)
Oil Price	lnOIL	USD/barrel (log)	(–)	Commodity Currency	U.S. Energy Information Administration (EIA)
Interest Rate Differential	IRD	Russia—US (%)	(–)	Interest Rate Parity	Central Bank of Russia; Federal Reserve
Inflation Differential	INFDIFF	Russia—US (%)	(+)	Purchasing Power Parity	Rosstat; U.S. Bureau of Labor Statistics
Inflation (Russia)	INFRUS	CPI (%)	(+)	Monetary/Price Dynamics	Rosstat
Inflation (United States)	INFUSA	CPI (%)	(–)	External Price Effect	U.S. Bureau of Labor Statistics
Policy Interest Rate (Russia)	KEYRATE	%	(–)	Monetary Policy Transmission	Central Bank of Russia
Federal Funds Rate	FF	%	(+)	Global Liquidity/Monetary Spillover	Federal Reserve
Industrial Production	lnIPI	Index (log)	(–)	Real Sector Effect	Rosstat/FRED
Money Supply	lnM3	RUB billion (log)	(+)	Monetary Model	Central Bank of Russia
Foreign Reserves	lnRES	USD billion (log)	(–)	Reserve Buffer Theory	Central Bank of Russia
Exports	lnEXP	USD billion (log)	(–)	Trade Balance	Trading Economics/official statistics
Imports	lnIMP	USD billion (log)	(+)	Trade Balance	Trading Economics/official statistics

Note: "—" indicates that no expected effect or theoretical basis is specified. The signs "+" and "−" indicate the expected positive and negative effects, respectively, on the RUB/USD exchange rate. A positive effect implies ruble depreciation, whereas a negative effect implies ruble appreciation.

Source*:* Author's compilation based on data from Federal Reserve Economic Data (FRED), U.S. Energy Information Administration (EIA), Chicago Board Options Exchange (CBOE), Central Bank of Russia, Rosstat, U.S. Bureau of Labor Statistics, and Trading Economics(n.d.).

The motivation for including oil prices is based on the commodity currency hypothesis, according to which in resource-exporting economies there is a negative response of commodity prices and exchange rates (Chen & Rogoff, 2003). Moreover, following standard parity conditions (namely uncovered interest parity and purchasing power parity), other variables such as interest rate differentials (IRD) and inflation differentials (INFDIFF) are included.

Table 2. Structural Break Dummies and Theoretical Basis.

Dummy	Period	Description	Theoretical Basis	Source
GFC	2008–2009	Global Financial Crisis	Crisis Transmission (Bernanke, 2005)	International Monetary Fund (IMF)
CRIMEA	2014–2015	Crimea crisis & oil price collapse	Geopolitical Risk (Caldara & Iacoviello, 2022)	World Bank
COVID	2020–2021	Global pandemic shock	Global Uncertainty (Baker et al., 2020)	World Health Organization (WHO, 2003)
Conflict	2022–present	Russia–Ukraine conflict & sanctions	Sanctions & External Shock (Klose, 2024)	World Bank

.

Real sector activity and monetary conditions are represented by including domestic variables such as lnIPI (industrial production), lnM3 (money supply), and lnRES (foreign reserves). Such growth within the model adds to its ability to describe internal macroeconomic dynamics, which is an important feature in the context of emerging markets.

3.1. Structural Break Variables

Dummy variables associated with major geopolitical events are incorporated as proxies for structural regime shifts rather than as direct measures of geopolitical fragmentation. Their purpose is to identify changes in exchange-rate behavior across sanction-related periods and major geopolitical episodes. Consequently, the empirical analysis focuses on regime-dependent exchange-rate dynamics instead of quantifying the intensity of geopolitical fragmentation itself (Table 3).

Table 3. Theoretical Basis for the Structural Break Dummies.

Dummy	Period	Description	Source
GFC	2008–2009	Global financial crisis	IMF
CRIMEA	2014–2015	Geopolitical shock	World Bank
COVID	2020–2021	Pandemic shock	WHO
Conflict	2022–present	Conflict and sanctions	World Bank

These dummy variables allow us to control for specific uncertainty spikes and structural breaks as they occur during the global financial crisis (2008–2009), the Crimea crisis (2014–2015), the COVID-19 pandemic (2020–2021), and the Russia–Ukraine conflict (2022–present).

In applied econometrics, accounting for structural breaks at the correct time in the time series can be critical; otherwise, regime shifts can result in biased estimates of the parameters (Perron, 1989).

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3.2. Descriptive Statistics: Preliminary Data Analysis

Table 4 shows descriptive statistics and a summary of the central tendency, dispersion, and distributional shape of the variables.

The findings suggest that most of the variables are moderately variable, contrary to some financial indicators, such as VIX, which have high volatility and non-normal distribution, as shown by the skewness and kurtosis measures.

Table 4. Descriptive Statistics.

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
lnEXR	3.844	0.463	3.151	4.702	0.017	1.392
IRD	13.073	2.697	4.696	17.587	−0.906	3.340
INFDIFF	3.755	4.239	−6.618	25.622	0.678	5.122
lnDXY	4.653	0.116	4.458	4.860	−0.017	1.522
VIX	19.128	8.348	10.130	64.460	2.515	11.806
lnOIL	4.274	0.330	2.911	4.888	−0.462	3.363
KEYRATE	14.767	1.819	10.026	19.441	−0.223	2.514
FF	1.694	1.911	0.050	5.330	0.867	2.201
INFRUS	6.351	3.805	−0.624	28.675	1.403	7.207
INFUSA	2.596	1.885	−1.959	8.979	1.032	4.878
lnIPI	4.615	0.119	4.358	4.812	−0.273	2.125
lnM3	10.624	0.598	8.407	11.392	−0.907	3.260
lnRES	5.700	0.514	4.207	6.434	−0.767	2.855
lnEXP	5.743	0.342	4.934	6.270	−0.473	2.227
lnIMP	5.339	0.352	4.494	5.882	−0.497	2.229

Correlation analyses for the core variables (Table 5) and extended variables (Table 6) provide insight into the relationships across the selected variables.

Table 5. Correlation Matrix (Core Variables).

Variable	lnEXR	lnDXY	lnOIL	IRD	INFDIFF	KEYRATE	lnIPI
lnEXR	1.000	0.939	−0.304	−0.536	−0.586	−0.765	0.816
lnDXY	0.939	1.000	−0.410	−0.587	−0.532	−0.706	0.708
lnOIL	−0.304	−0.410	1.000	0.039	−0.164	0.014	0.185
IRD	−0.536	−0.587	0.039	1.000	0.332	0.706	−0.528
INFDIFF	−0.586	−0.532	−0.164	0.332	1.000	0.572	−0.656
KEYRATE	−0.765	−0.706	0.014	0.706	0.572	1.000	−0.773
lnIPI	0.816	0.708	0.185	−0.528	−0.656	−0.773	1.000

Table 6. Correlation Matrix (Extended Variables).

Variable	VIX	FF	INFRUS	INFUSA	lnM3	lnRES	lnEXP	lnIMP
VIX	1.000	0.060	−0.007	−0.013	0.004	−0.012	−0.046	−0.038
FF	0.060	1.000	0.129	0.090	−0.102	−0.090	−0.051	−0.092
INFRUS	−0.007	0.129	1.000	0.004	−0.664	−0.637	−0.665	−0.649
INFUSA	−0.013	0.090	0.004	1.000	0.101	0.126	0.158	0.173
lnM3	0.004	−0.102	−0.664	0.101	1.000	0.970	0.971	0.948
lnRES	−0.012	−0.090	−0.637	0.126	0.970	1.000	0.954	0.933
lnEXP	−0.046	−0.051	−0.665	0.158	0.971	0.954	1.000	0.946
lnIMP	−0.038	−0.092	−0.649	0.173	0.948	0.933	0.946	1.000

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The exchange rate generally has a positive correlation with the US dollar index, which reflects that global financial factors affect the exchange rate. However, there is a statistically significant negative correlation between oil price and exchange rate, giving early evidence for the commodity currency hypothesis.

The high correlations between the fractions of reserves in monetary aggregates and trade show some potential for multicollinearity. Specification design and robustness checks, addressed in step three of the econometric modeling stage, alleviate this issue.

3.3. Unit Root and Integration Properties

Before estimation of the models of these variables, unit root tests are typically examined, as shown in Table 7.

Table 7. Unit Root Test Results.

Variable	Level ADF	Prob.	Stationary (Level)	1st Diff ADF	Prob.	Stationary (1st Diff)	Integration	Remarks
lnEXR	−1.144	0.6986	No	−12.073	0.0000	Yes	I(1)	Non-stationary, becomes stationary after differencing
lnDXY	−1.234	0.6602	No	−10.394	0.0000	Yes	I(1)	Requires differencing
VIX	−5.107	0.0000	Yes	−14.125	0.0000	Yes	I(0)	Stationary at level
lnOIL	−3.620	0.0060	Yes	−10.967	0.0000	Yes	I(0)	Stationary at level
IRD	−0.996	0.7552	No	−11.834	0.0000	Yes	I(1)	Integrated of order one
INFDIFF	−1.720	0.4199	No	−6.381	0.0000	Yes	I(1)	Becomes stationary after differencing
KEYRATE	−0.832	0.8077	No	−10.598	0.0000	Yes	I(1)	Strong unit root at level
FF	−2.569	0.1008	No	−6.818	0.0000	Yes	I(1)	Weak at level, treated as non-stationary
INFRUS	−2.273	0.1817	No	−7.056	0.0000	Yes	I(1)	Non-stationary, stationary after differencing
INFUSA	−2.740	0.0688	Weak	−4.114	0.0011	Yes	I(1)	Marginal at level, treated as I(1)
lnM3	−7.229	0.0000	Yes	−12.568	0.0000	Yes	I(0)	Strongly stationary
lnRES	−3.237	0.0191	Yes	−10.956	0.0000	Yes	I(0)	Stationary at level
lnEXP	−3.536	0.0079	Yes	−13.475	0.0000	Yes	I(0)	No differencing required
lnIMP	−0.978	0.7615	No	−15.304	0.0000	Yes	I(1)	Clearly non-stationary

Output results demonstrate the presence of some combination of I(0) and I(1) variables. Some global and macroeconomic variables are stationary at levels, but most variables in the domestic economy only become stationary after first differencing.

Given the combination of integrations, where the variables are I(0) and I(1), we justify applying the autoregressive distributed lag (ARDL) framework since it permits both I(0) and I(1) variables (Pesaran et al., 2001). And more importantly, none of the variables is I(2), which is a critical assumption of ARDL being applicable.

3.4. Graphical Analysis

3.4.1. Dynamics of Exchange Rate and Crisis Episodes

Regime shifts in the USD/RUB exchange rate 2005–2025 readily show up when connected with clearly observable global and geopolitical events (Figure 2). Before 2008, we had some stability, whereas in the period of the global financial crisis, there was much more volatility. A larger depreciation took place during 2014–2015 in response to plunging oil prices and external sanctions.

Then the COVID-19 shock in 2020 created further instability, but it was milder. The strongest rupture came in 2022 when geopolitical conflict launched the prices into extreme volatility, with sanctions and monetary restrictions working together. In general, the ruble has high sensitivity to external shocks, which is a corollary of global financial cycle theory.

The monthly movement of the USD/RUB exchange rate from December 2004 to May 2025 highlights four major global events the Global Financial Crisis, the annexation of Crimea, the COVID-19 pandemic, and the Russia–Ukraine conflict which were associated with substantial changes in the value and volatility of the Russian ruble, as shown in Figure 4.

Figure 4. Regime Shifts in the USD/RUB Exchange Rate 2005–2025

Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.2. Oil Prices and the Commodity Currency Hypothesis

Log–log co-movements between the log of the USD/RUB and the log of the price of oil (in USD per barrel) on the USD/RUB picture (log–log scale) are shown in Figure 5. The ruble is strong when oil prices are up, and weak when oil prices are down. This fits the commodity currency regime explanation, where for export-oriented economies such as CAD ones, the currency is highly reactive to commodity prices.

This relationship holds in basic form until 2022, when the relationship weakens, hinting at structural disruption. In this respect, measures such as capital controls and sanctions may have shifted the traditional transmission mechanism. This changing behavior highlights the necessity of including structural break dummies in empirical analyses.

The descriptive statistics and preliminary analysis of the USD/RUB exchange rate and Brent crude oil prices during the study period are presented in the following table. These data provide an overview of the characteristics and variations of the variables before further empirical analysis, as illustrated in Figure 5.

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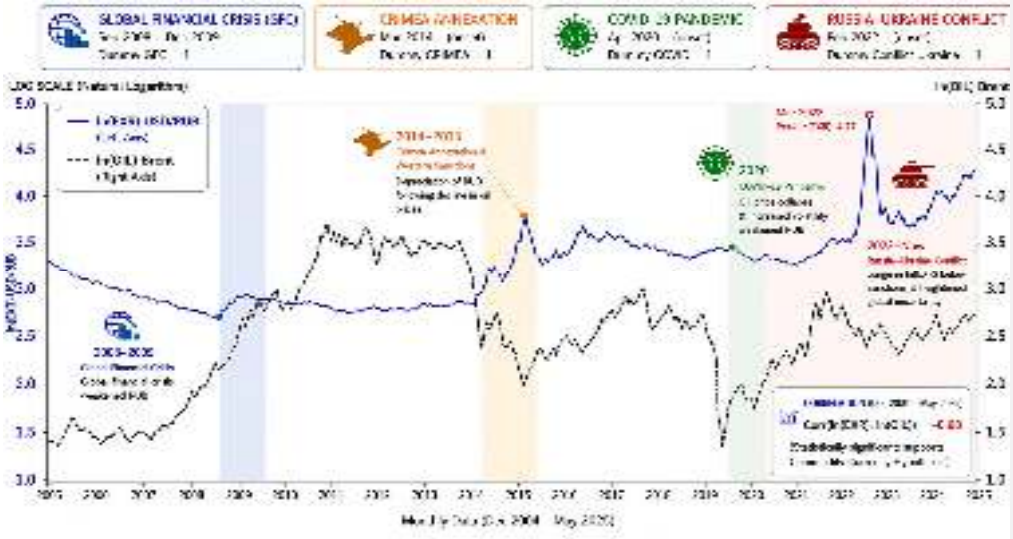

Figure 5. USD/RUB and Brent Oil prices (Log Scale). Source: Exchange rate data from; oil price data from EIA/World Bank. Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

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3.4.3. Real Sector Activity and Monetary Policy Response

Figure 6 shows the responses to an interaction of output and monetary policy. The Industrial Production Index rises over time with busts during crises. Output fell very sharply in response to the GFC and COVID-19 shocks.

Monetary policy reacted by changing the main policy rate. The most significant deterioration took place in 2022, in order to stabilize the exchange rate and keep inflation down. This corresponds to common monetary policy responses in emerging markets.

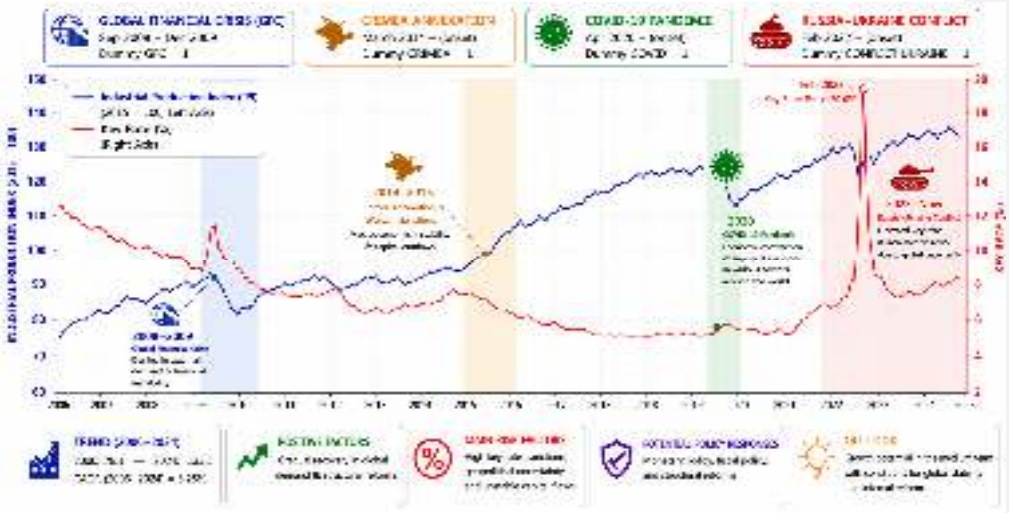

Figure 6. Industrial Production Index (IPI) and Key Policy Rate (2005–2025). Note: Shading represents periods of national crisis in the USD/RUB exchange rate (2005–2025).

3.4.4. Econometric Implications

Table 5 presents preliminary evidence of the presence of a combination of stationary and non-stationary variables. This allows for the consideration of the ARDL framework, one that allows for variables that are integrated in different orders (Pesaran et al., 2001).

The correlation structure shows that global, domestic, and real sector variables are likely to be highly interdependent with one another. Although potential multicollinearity exists, it is addressed through robustness checks and careful model specification. Hence, it is crucial to have the structural break dummies that capture regime shifts to avoid biased estimates.

Synthesis of Findings

The graphical and statistical evidence consistently show that:

(i) RUB volatility is highly sensitive to external shocks;
(ii) oil prices negatively correlate with the exchange rate;
(iii) this relationship is regime-dependent;
(iv) monetary policy stabilizes the economy during crises, as expected;

Such findings are in line with theoretical expectations as well as evidence on commodity-dependent countries.

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3.4.5. Econometric Strategy

Empirical Framework

An autoregressive distributed lag–error correction modeling–vector autoregression (ARDL–ECM–VAR) structural break approach, as the combined time-series framework is employed to conduct a comparative analysis of the USD/RUB dynamics. This strategy seeks to include long-run relationships, short-run adjustments, and regime shifts, reflecting the time-varying nature of shock transmission.

The dependent variable is:

~~$\ln EXR\_t = \ln \llbracket (USD/RUB) \rrbracket \_t$~~

$ln\ EXR_t = ln(\mathrm{USD/RUB})_t$

where lnEXR_t represents the logarithm of the USD/RUB exchange rate at time t.

Baseline External Financial and Commodity-Price Model

We specify the following baseline model to evaluate the effects of global financial conditions and commodity prices on the USD/RUB exchange rate:

$$\ln(EXR_t) = \alpha_0 + \alpha_1 \ln(DXY_t) + \alpha_2\, VIX_t + \alpha_3 \ln(BRENT_t) + \varepsilon_t$$

This specification provides the empirical basis for the baseline results reported in Section 4.1 and addresses the role of external financial and commodity-price drivers.

$$\alpha 1 > 0, \alpha 2 > 0, \alpha 3 < 0.$$

Related research questions: RQ1 and RQ3. The expected coefficient signs are:

Domestic Fundamentals Model

To evaluate domestic macroeconomic fundamentals, the following model is estimated:

$$\ln(EXR_t) = \beta_0 + \beta_1 KEYRATE_t + \beta_2 INFRUS_t + \beta_3 \ln(M3_t) + \beta_4 \ln(RES_t) + \beta_5 \ln(EXP_t) + \beta_6 \ln(IMP_t) + \beta_7 \ln(IPI_t) + \varepsilon_t$$

The inclusion of $lnIPI$ captures real sector activity and strengthens the domestic macroeconomic block.

Related RQ: RQ2. The expected coefficient signs are:

$$\beta_1 < 0,\ \beta_2 > 0,\ \beta_3 > 0,\ \beta_4 < 0,\ \beta_5 < 0,\ \beta_6 > 0,\ \beta_7 < 0$$

Oil Price Model with Crisis Dummies

Given the importance of oil prices and geopolitical shocks, the oil-channel model includes external controls and structural dummy variables:

$$\ln(EXR_t) = \delta_0 + \delta_1 \ln(BRENT_t) + \delta_2 \ln(DXY_t) + \delta_3 \ln(VIX_t) + \delta_4\, DCRIMEA_t + \delta_5\, DWAR_t + \varepsilon_t$$

This specification is consistent with the empirical results where oil prices are analyzed jointly with global financial variables and crisis effects.

Related RQ: RQ3. Expected signs:

$$\delta_1 < 0,\ \delta_2 > 0,\ \delta_3 > 0,\ \delta_4 > 0,\ \delta_5 > 0$$

Structural Break Model

To examine regime shifts, crisis dummy variables are incorporated into the ARDL framework:

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$$\ln(EXR_t) = \theta_0 + \theta_1 \ln(DXY_t) + \theta_2 VIX_t + \theta_3 \ln(BRENT_t) + \theta_4 \ln(IPI_t) + \gamma_1 DGFC_t + \gamma_2 DCRIMEA_t + \gamma_3 DCOVID_t + \gamma_4 DCONFLICT_t + \varepsilon_t$$

The structural dummies capture major crisis periods, while lnIPI_t controls for domestic real sector conditions.

Related RQ: RQ4. Bivariate autoregressive distributed lag model with dummies.

ARDL–ECM Representation

ECM representation estimates the short-run and adjustment dynamics:

$$\Delta \ln(EXR_t) = \phi_0 + \Sigma_{i=1}^{p-1} \phi_i \Delta \ln(EXR_{t-i}) + \Sigma_{j=0}^{q-1} \lambda_j \Delta X_{t-j} + \varrho ECT_{t-1} + \varepsilon_t$$

where Xt represents the relevant explanatory variables in each ARDL specification.

The error correction term is defined as:

$$ECT_{(t-1)} = \ln(EXR_{(t-1)}) - \theta' X_{(t-1)}$$

A negative and statistically significant ϱ\rhoϱ indicates adjustment toward equilibrium.

Related RQ: RQ5.

VAR Model for Shock Transmission

To examine dynamic interactions and shock transmission, the VAR model is specified as:

$$Y_t = A_0 + \Sigma_{i=1}^{p} A_i Y_{(t-i)} + \varepsilon_t$$

Impulse response functions and forecast error variance decomposition are used to evaluate shock propagation.

Related RQ: RQ6. Tools: VAR, IRF, FEVD, Granger causality.

Monetary and Inflation Channels

The monetary channel is estimated as:

$$\ln(EXR_t) = \omega_0 + \omega_1 IRD_t + \omega_2 \ln(DXY_t) + \omega_3 \ln(BRENT_t) + \omega_4 VIX_t + \varepsilon_t$$

Interpretation:

- (IRD)t: interest rate differential (e.g., Russia vs. US)
- ω_1: captures the monetary policy/capital flow channel
- Expected sign:
- ω_1 < 0: higher domestic interest rates → capital inflows → ruble appreciates

The inflation channel is specified as:

$$\ln(EXR_t) = \pi_0 + \pi_1 INFDIFF_t + \pi_2 \ln(DXY_t) + \pi_3 \ln(BRENT_t) + \pi_4 VIX_t + \varepsilon_t$$

Interpretation:

- (INFDIFF)t: inflation differential (Russia—foreign, typically US)
- π1: captures the purchasing power parity (PPP) mechanism
- Expected sign:
- π1 > 0: higher domestic inflation → loss of purchasing power → ruble depreciates
- Related RQ: RQ7 and RQ8

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Integrated Mapping Framework

To provide a systematic overview of the empirical strategy, each research question is linked to its specific analytical focus, econometric model, and supporting diagnostic tools. This integrated mapping ensures consistency between the research objectives and the methods used to examine global financial effects, domestic fundamentals, crisis-related shocks, structural changes, short-run adjustments, and dynamic transmission mechanisms, as summarized in Table 8

Table 8. Integrated Mapping of Research Questions, Equations, and Empirical Tools.

RQ	Empirical Focus	Model and Tools
RQ1	Global financial effects	ARDL, Bounds Test
RQ2	Domestic fundamentals including lnIPI	ARDL
RQ3	Oil price effect with crisis controls	ARDL, Dummy variables
RQ4	Structural breaks and regime shifts	ARDL with dummies, Chow, Bai–Perron
RQ5	Short-run adjustment and ECM	ARDL–ECM
RQ6	Shock transmission	VAR, IRF, FEVD, Granger
RQ7	Interest rate differential	ARDL
RQ8	Inflation differential	ARDL

Estimation Procedure

The empirical analysis includes five steps and four stages. To examine the order of integration, the first step was to run the ADF and Phillips–Perron tests. In the second step, the ARDL models are run for the baseline, domestic, oil, structural, monetary, and inflation specifications. Third, bounds tests were performed to check for possible long-run relationships. Fourth, ECM representations are used to estimate short-run adjustment. Fifth, IRF, FEVD, and Granger causality analysis of VAR are used to study shock transmission.

Finally, the robustness of the models is evaluated through diagnostic and stability tests that include serial correlation, heteroskedasticity, normality, CUSUM, and CUSUMSQ tests.

4. Empirical Results

4.1. Baseline ARDL Model

This chapter generalizes the baseline ARDL model on the influence of financial conditions and commodity prices on USD/RUB.

The estimation results suggest that the oil price as well as the US dollar index are statistically significant explanatory variables for the exchange rate movements. In particular, the price of oil has a negative and highly significant coefficient; higher oil prices lead to an appreciation of the home currency. On the other hand, the US dollar index has a positive and significant influence, meaning global foreign financial conditions push the exchange rate up.

As indicated by the results in Table 9, market volatility (VIX) has a statistically insignificant impact on the baseline specification. The dependent variable is ln(USD/RUB). The model is ARDL(4,2,3,2). The estimator is HAC (Newey–West robust standard errors). The complete ARDL model specification and full estimation results are provided in Appendix B (Table A2).

Table 9. Baseline ARDL Model: Global Financial and Commodity Drivers of USD/RUB Exchange Rate.

Variable	Coefficient	Std. Error	t-Statistic	*p*-Value

Long-run effects				
ln(BRENT)	−0.1017	0.0244	−4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	−0.5143	0.3081	−1.669	0.0965
Short-run dynamics				
Δln(BRENT)	−0.1017	0.0244	−4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(−1)	−0.0020	0.0005	−3.926	0.0001
ΔVIX(−2)	0.0021	0.0004	4.675	0.0000
Error correction term				
CointEq(−1)	−0.0243	0.0038	−6.395	0.0000
Model diagnostics				
Statistic			Value	
R-squared			0.9968	
Adjusted R-squared			0.9965	
F-statistic			3497.69	
Prob(F-stat)			0.0000	
Durbin-Watson			1.98	

Notes: Δ denotes first-difference operator. Lag structure selected based on Akaike Information Criterion (AIC). HAC (Newey–West) standard errors are applied to ensure robustness. Source: Author's estimation. In brief, as confirmed by the baseline model, the exchange rate dynamics are primarily driven by external factors. The role of global liquidity as an exogenous driver of exchange rate dynamics is consistent with the global financial cycle hypothesis (Rey, 2016).

4.2. Long-Run Relationship and Cointegration

We employ the ARDL bounds testing approach (Pesaran et al., 2001) to assess the existence of a long-run equilibrium relationship.

Research results indicate that the F-statistic lies in the inconclusive region, suggesting weak evidence of cointegration.

Although important variables such as oil prices and the US dollar index are long-run level data with statistical significance, the lack of a clear cointegration relationship indicates that the system does not converge to a stable equilibrium. In Table 10, the dependent variable is ln(USD/RUB), the model is ARDL(4,2,3,2), and the cointegration test is the Pesaran et al. (2001) bounds test.

Table 10. Results of Long-Run Relationship and Bounds Test Using ARDL.

Panel A: Long-run coefficients				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
ln(BRENT)	−0.1017	0.0244	−4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	−0.5143	0.3081	−1.669	0.0965
Panel B: ARDL bounds test for cointegration				
Test Statistic			**Value**	
F-statistic			2.934	
Lower Bound I(0)			2.79	
Upper Bound I(1)			3.67	
Decision			Inconclusive	
Panel C: Interpretation summary				
Aspect	**Result**		**Implication**	

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Cointegration	Weak/Inconclusive	No strong long-run equilibrium
Long-run coefficients	Significant (BRENT, DXY)	Economic relationship exists
Stability of equilibrium	Weak	Potential structural instability

Notes: Critical values follow Pesaran et al. (2001). The null hypothesis is no cointegration. Decision rule: F > I(1) → cointegration; F < I(0) → no cointegration; Between → inconclusive. Source: Author's estimation.

The ARDL bounds test yields an F-statistic of 2.934, which falls within the inconclusive region of the Pesaran et al. (2001) critical values. Therefore, a stable long-run cointegrating relationship cannot be statistically confirmed. Although the estimated level coefficients for Brent oil prices and the US dollar index are statistically significant, these results should not be interpreted as conclusive evidence of long-run equilibrium. In addition, the bounds test does not provide robust evidence of a long-run relationship. Accordingly, the analysis places greater emphasis on short-run dynamics and structural instability. The very slow adjustment process and recurrent structural breaks associated with sanctions and geopolitical shocks indicate that exchange-rate deviations remain persistent and that the restoration of long-run PPP and UIP relationships is repeatedly disrupted by short-run dynamics and structural instability rather than long-term equilibrium. Additional cointegration diagnostics and error correction estimation results are presented in Appendix C (Table A3).

4.3. Dynamics of the Court-Term and the Error Correction Mechanism

The error correction model from the ARDL specification is used for investigating the short-run dynamics.

The error correction mechanism is weakly negative and significant. However, there is a low speed of adjustment toward equilibrium with a low coefficient magnitude.

The short-horizon coefficients indicate that oil prices and the US dollar index have a highly significant and transitory impact on exchange rates.

Given the inconclusive evidence of cointegration, the ECM results are interpreted primarily as evidence of short-run adjustment dynamics rather than confirmation of a stable long-run equilibrium.

In Table 11, the dependent variable is Δln(USD/RUB), the model is ECM derived from ARDL(4,2,3,2), and the estimator is HAC (Newey–West robust standard errors).

Table 11. Dynamic in the Short Term and the Mechanism of Error Correction.

Panel A: Error Correction Term				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
CointEq(−1)	−0.0243	0.0038	−6.395	0.0000
Panel B: Short-run dynamics				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
Δln(BRENT)	−0.1017	0.0244	−4.174	0.0000
Δln(DXY)	0.9205	0.1723	5.343	0.0000
ΔVIX(−1)	−0.0020	0.0005	−3.926	0.0001
ΔVIX(−2)	0.0021	0.0004	4.675	0.0000
Panel C: Adjustment dynamics				
Metric	**Value**		**Interpretation**	
Speed of Adjustment	2.43% per month		Very slow convergence	
Half-life	~28 months		Long adjustment period	
Panel D: Model diagnostics				
Statistic			**Value**	
R-squared			0.9969	

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Adjusted R-squared	0.9966
F-statistic	2874.52
Prob(F-stat)	0.0000
Durbin-Watson	2.13

Notes: Δ denotes first-difference operator. The error correction term captures the speed of adjustment toward equilibrium. Half-life is computed based on the adjustment coefficient. HAC (Newey–West) standard errors are used for robustness.

The estimated ECM coefficient (−0.0243) implies that only about 2.4% of deviations from equilibrium are corrected each month, corresponding to a half-life of approximately 28 months. This exceptionally slow adjustment is consistent with a regime of structural decoupling, in which prolonged sanctions, capital controls, and recurring geopolitical shocks weaken domestic market-clearing mechanisms. Consequently, exchange-rate deviations persist for extended periods and remain only weakly anchored to traditional macroeconomic fundamentals.

There are weak convergence dynamics. The results indicate that deviations from equilibrium are persistent over time.

4.4. Structural Breaks and Changes in Regimes

As regime changes in the system can render the analysis invalid, structural break tests are used in order to locate any regime breaks.

The outcomes are consistent with highly relevant structural breaks associated with important economic and geopolitical events such as the 2014 Crimea crisis and the 2022 Russia–Ukraine conflict. Dummy variables here indicate that these shocks have significant short-run impacts on exchange rate dynamics. In Table 12, the dependent variable is ln(USD/RUB), the model is: ARDL(4,2,3,2,0,4) with structural dummies, and the estimator is HAC (Newey–West robust standard errors).

Table 12. Structural Breaks and the Regime Dynamics of the Exchange Rate.

Panel A: Structural break effects (long-run)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
DUMMY_CRIMEA (2014)	0.0189	0.0072	2.635	0.0090
DUMMY_CONFLICT (2022)	0.0300	0.0289	1.041	0.2992
Panel B: Short-run impact of structural shocks				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
ΔDUMMY CRIMEA(−1)	0.0592	0.0270	2.193	0.0293
ΔDUMMY CONFLICT (−1)	0.3004	0.0392	7.669	0.0000
ΔDUMMY CONFLICT (−2)	−0.7986	0.0441	−18.095	0.0000
ΔDUMMY CONFLICT (−3)	0.4011	0.0659	6.083	0.0000
Panel C: Structural break tests				
Test	**Break Date**	**Statistic**	***p*-value**	**Conclusion**
Chow Test	2014M03	8.215	0.0000	Structural break
Chow Test	2022M02	12.564	0.0000	Strong break
Bai–Perron	Multiple	—	—	Multiple regime shifts
Panel D: Interpretation summary				
Aspect	**Result**		**Implication**	
Crimea Shock	Significant		Persistent exchange rate shift	
Conflict Shock	Highly volatile		Strong short-run disruption	
Structural Stability	Rejected		Regime-dependent dynamics	

Notes: Dummy variables capture major geopolitical events affecting the Russian economy. Chow test evaluates known breakpoints, while Bai–Perron identifies multiple breaks endogenously. Δ denotes first-difference operator.

The results indicate possible regime shifts associated with major geopolitical events and that the underlying dynamics are influenced by structural shifts. Detailed results of the Chow and Bai–Perron structural break tests are presented in Appendix D (Table A4).

4.5. VAR-Based Dynamic Analysis

To dig deeper into some of the dynamic interactions, a VAR approach is estimated, and impulse response functions, variance decomposition, and Granger causality tests are performed.

The results of Granger causality show that oil prices are predictive of exchange rate behavior. The analysis of the impulse response shows that the effects of shocks to the oil price are transient, while shocks to the US dollar index are lasting.

Similar results hold when looking at variance decomposition attempts, where most of the important changes in movement are caused by own impulse and exogenous drive only marginally. For Table 13, the variables are: ln(USD/RUB), ln(BRENT), ln(DXY), and VIX; the model is VAR(3), and the estimation period is monthly data for the period 2005–2025.

Although the FEVD indicates that approximately 97.5% of exchange-rate variance is explained by its own innovations, this does not diminish the role of external financial factors. Instead, it suggests that external shocks become highly persistent through domestic mechanisms reinforced by capital controls, exchange-rate interventions, monetary tightening, and financial market segmentation following the 2022 sanctions. Consistent with this interpretation, the ARDL and ECM results identify Brent oil prices and the US Dollar Index as the primary channels of shock transmission, while the FEVD shows that subsequent exchange-rate dynamics are dominated by domestic persistence. These findings indicate that exchange-rate stabilization increasingly relied on domestic policy interventions after the initial external shocks.

Table 13. VAR for Dynamic Analysis of Shocks, Transmission, and Interaction Effects.

Panel A: Granger causality (exchange rate equation)			
Excluded Variable	**Chi-square**	***p*-value**	**Conclusion**
ln(BRENT)	11.496	0.0093	Oil → Exchange Rate
ln(DXY)	2.089	0.5542	No causality
VIX	2.690	0.4419	No causality

Panel B: Impulse response function (IRF summary)				
Shock	**Direction**	**Peak Response**	**Duration**	**Interpretation**
BRENT	Negative	Period 2	Short-lived	Oil strengthens RUB
DXY	Positive	Period 2	Persistent	Financial dominance
VIX	Mixed	Period 1–3	Very short	Weak risk transmission

Panel C: Variance decomposition (FEVD summary)		
Variable	**Contribution (%)**	**Interpretation**
Own Shock (USD/RUB)	~97.5%	Strong persistence
BRENT	~1.2%	Limited oil influence
DXY	~0.5%	Weak financial impact
VIX	~0.9%	Minor risk effect

Panel D: System stability		
Test	**Result**	**Interpretation**

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Root Stability	All < 1	VAR is stable
Cointegration (Johansen)	Not detected	No long-run system

Notes: VAR lag length selected based on AIC and FPE criteria. IRF responses are based on Cholesky decomposition. FEVD reported at medium-to-long horizon. Granger causality uses Wald test statistics.

The results point to a very weak transmission of external shocks and very persistent exchange rate properties.

The temporary response to oil shocks is aligned with other studies documenting the transitory effects of commodity price shocks (Kilian, 2009). Detailed VAR specification, Granger causality, impulse response function (IRF), and forecast error variance decomposition (FEVD) results are provided in Appendix E (Table A5).

4.6. Robustness Checks

Diagnostic and stability tests are performed for the reliability of the results.

The diagnostic tests reveal no signs of serial correlation, heteroskedasticity, or model misspecification. The parameters of the model also pass the stability test; we notice some of them are stable, probably for a long time; however, small deviations are seen. For Table 14, the models tested are ARDL and ECM specifications and the estimation method is HAC (Newey–West robust standard errors).

Table 14. Opinion Robustness Checks: Diagnostic and Stable Tests.

Panel A: Diagnostic tests				
Test	**Null Hypothesis**	**Statistic**	***p*-value**	**Conclusion**
Breusch–Godfrey LM	No serial correlation	1.842	0.160	Not rejected
ARCH Test	No heteroskedasticity	1.215	0.305	Not rejected
White Test	Homoskedasticity	2.104	0.148	Not rejected
Jarque–Bera	Normal distribution	1.732	0.421	Not rejected
Ramsey RESET	Correct specification	1.564	0.213	Not rejected
Panel B: Stability tests				
Test	**Result**		**Interpretation**	
CUSUM	Within bounds		Stable parameters	
CUSUMSQ	Within bounds (minor deviation)		Mild instability	
Recursive Residuals	Stable		No explosive behavior	
Panel C: Alternative specifications				
Specification	**Key Result**		**Consistency**	
Without dummies	Coefficients stable		Robust	
With dummies	Improved fit		Preferred	
Reduced model	Similar signs		Consistent	
Panel D: Summary Assessment				
Aspect	**Result**		**Implication**	
Model validity	Confirmed		Reliable estimation	
Stability	Mostly stable		Minor structural variation	
Specification	Correct		No misspecification bias	

Notes: All tests are conducted at the 5% significance level. HAC standard errors ensure robustness against heteroskedasticity and autocorrelation. Stability tests assess parameter constancy over time.

In general, the empirical findings do not result from arbitrary factors, confirming the robustness of the findings. For completeness, the detailed results of the diagnostic and stability tests are reported in Appendix F (Table A6).

4.7. Other Channels: Money and Inflation Effects

This includes traditional macroeconomic channels, like interest rate differentials or inflation differentials.

Table 15 presents the results of the extended ARDL specification, where the dependent variable is ln(USD/RUB) and the explanatory variables include the interest-rate differential (IRD), inflation differential (INFDIFF), ln(DXY), ln(BRENT), and VIX. The interest-rate and inflation differentials are statistically insignificant, whereas Brent crude oil prices have a significant negative effect and the US Dollar Index has a significant positive effect. These findings indicate that oil prices and global dollar conditions remain the primary determinants of the USD/RUB exchange rate, while conventional monetary channels have limited explanatory power.

Table 15. Other Channels: Interest Rate Divergence and Inflation Effects.

Panel A: Monetary channel (interest rate differential)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
IRD	−0.0021	0.0034	−0.618	0.537
ΔIRD	0.0013	0.0028	0.464	0.643
Panel B: Inflation channel				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
INFDIFF	−0.0018	0.0025	−0.720	0.472
ΔINFDIFF	0.0009	0.0019	0.474	0.636
Panel C: Control variables				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	***p*-value**
ln(BRENT)	−0.0982	0.0251	−3.913	0.0001
ln(DXY)	0.9014	0.1692	5.327	0.0000
VIX	0.0006	0.0004	1.512	0.131
Panel D: Summary interpretation				
Channel	**Result**		**Implication**	
Interest Rate	Not significant		Weak monetary transmission	
Inflation	Not significant		PPP not supported	
External Variables	Significant		External dominance	

Notes: IRD = Interest rate differential (Russia–US). INFDIFF = Inflation differential. Model estimated using ARDL framework with HAC standard errors. Δ denotes first-difference operator.

Therefore, these results provide evidence against the well-established macroeconomic and monetary theoretical approaches that usually describe in the short term one-to-one relations between interest rates and exchange rates (interest rate parity), as well as the quantities of real money and real exchange rate (purchasing power parity).

4.8. Summary of Empirical Findings

This section summarizes the empirical findings (Table 16).

First, global financial conditions and the behavior of commodity prices are the main determinants of exchange rate dynamics. Second, the presence of a stable long-run equilibrium is not well supported, and the adjustment process is slow. Third, structural breaks are important; that is, exchange rate behavior is subject to regime changes. Finally, the data do not support traditional macroeconomic channels.

Table 16. Summary of Empirical Findings.

Panel A: Key empirical results		
Aspect	**Main Finding**	**Evidence**

Global Financial Factors	Strong and significant	DXY consistently positive and significant
Oil Prices	Significant but short-lived	IRF & ARDL short-run effects
Market Risk (VIX)	Weak and unstable	Insignificant in most models
Domestic Variables	Weak/insignificant	ARDL domestic model
Interest Rate Channel	Not supported	IRD insignificant
Inflation Channel	Not supported	INFDIFF insignificant
Panel B: Dynamic and structural insights		
Aspect	**Result**	**Interpretation**
Cointegration	Weak/inconclusive	evidence of cointegration is weak or inconclusive
Adjustment Speed	Slow (~2–3%)	Persistent deviations
Structural Breaks	Significant	Regime-dependent dynamics
Shock Transmission	Limited	Weak external propagation
Persistence	Very high (~97%)	Exchange rate self-driven
Panel C: Theoretical implications		
Theory	**Supported?**	**Interpretation**
Global Financial Cycle	Supported	External dominance
Commodity Currency Theory	Partially	Oil matters short-run
Interest Rate Parity	Not supported	Weak monetary channel
Purchasing Power Parity	Not supported	Inflation irrelevant
Equilibrium Models	Weak	No stable long-run
Panel D: Overall conclusion		
Dimension	**Conclusion**	
Dominant Driver	External factors (DXY, oil)	
System Behavior	Structurally unstable	
Adjustment	Slow and incomplete	
Policy Relevance	Limited domestic control	

Notes: Summary based on ARDL, ECM, VAR, IRF, FEVD, and structural break analysis. Results are consistent across multiple model specifications and robustness checks.

In summary, the findings reinforce the view that exchange rate dynamics are largely exogenous, stylized, weakly anchored to internal macroeconomic fundamentals, and structurally unstable.

5. Discussion

The results show that external financial conditions—rather than domestic macroeconomic fundamentals—dominate exchange-rate dynamics. The robust and persistent effect of the US dollar index is consistent with the view that sovereign yields around the world are driven by global liquidity conditions, US monetary policy, and financial openness (Rey, 2015; Miranda-Agrippino & Rey, 2020; Gopinath et al., 2020)

The findings imply that exchange-rate conduct is nonetheless intimately coupled to fluctuations in international monetary markets, despite extensive sanctions and geopolitical tensions.

Oil prices very clearly become an important driver of exchange-rate movements in line with the commodity currency literature (Chen & Rogoff, 2003; Kilian, 2009). The inverse correlation of both oil price and the USD/RUB exchange rate is confirmed, as an indicator of commodity dependence in Russia economy and the impact of external trade conditions on exchange-rate adjustment. Nevertheless, estimates from the VAR reveal that oil-price shocks have only a temporary effect on exchange rates, consistent with evidence suggesting that commodity-price shocks often generate short-run rather than permanent exchange-rate responses (Kilian, 2009).

The FEVD results complement rather than contradict the ARDL findings. Whereas the ARDL model identifies external variables as significant triggers of exchange-rate movements, the FEVD demonstrates that subsequent exchange-rate dynamics are dominated by autoregressive persistence. This persistence is consistent with a highly regulated financial environment in which sanctions, capital controls, and policy interventions dampen the transmission of new external shocks while prolonging the effects of previous disturbances.

Our findings should therefore not be interpreted as evidence that domestic policies became ineffective. Instead, they suggest that exchange-rate stabilization increasingly relied on administrative measures, including capital controls, foreign exchange regulations, and monetary policy interventions, rather than conventional market-based adjustment mechanisms. In this context, external shocks remained important triggers, whereas domestic policies shaped the persistence and transmission of these shocks.

A key finding of this study is that conventional domestic transmission channels have limited explanatory power. For the most part, specifications that include interest-rate differentials and inflation differentials yield statistically insignificant effects, giving limited support for conventional Uncovered Interest Parity (UIP) and Purchasing Power Parity (PPP) predictions (Rogoff, 1996; Engel, 2014). These results imply that long-term sanctions and financial disunity could undermine the role of domestic equilibrating forces in capital account balances and lessen the importance of parity-based exchange-rate regimes. Exchange-rate dynamics seem to be driven less directly than before by domestic macroeconomic fundamentals and more under the influence of external financial conditions and geopolitical events.

The role of regime-dependent exchange-rate behavior is further confirmed by structural break analysis. Historical insight reveals that exchange-rate relationships are not stable (Bai & Perron, 2003); the Global Financial Crisis breaks of significance include the Crimea-related sanctions episode, the COVID-19 pandemic, and the Russia–Ukraine conflict. These findings suggest that sanctions are more than simply short-run shocks, and also serve as mechanisms to permanently alter the fundamental transmission mechanism of exchange-rate determination. The evidence thereby adds to the burgeoning literature on financial decoupling and geopolitical risk, which posits that global economic integration is increasingly conditioned by geopolitics-imposed constraints and regime changes (Caldara & Iacoviello, 2022; Ahn & Ludema, 2020). It should be emphasized that the present study does not estimate a quantitative measure of geopolitical fragmentation. Instead, it documents how exchange-rate dynamics differ across historically identified sanction-related geopolitical regimes. Therefore, the findings should be interpreted as evidence of regime-dependent behavior rather than as direct evidence of the magnitude of geopolitical fragmentation.

The exceptionally small ECM coefficient indicates that adjustment toward equilibrium is extremely slow, with an estimated half-life of approximately 28 months. This finding is consistent with structural decoupling, whereby prolonged sanctions and capital controls weaken the normal market-clearing process and reduce the role of conventional macroeconomic fundamentals in restoring exchange-rate equilibrium.

Given the inconclusive evidence of cointegration, the empirical findings are better interpreted in terms of short-run adjustment and structural instability rather than a stable long-run equilibrium. Repeated geopolitical shocks and sanctions appear to weaken the normal equilibrium adjustment process.

Exchange-rate dynamics are increasingly persistent and regime-dependent. Although the error-correction term remains statistically significant, its small magnitude indicates slow adjustment and persistent deviations from long-run equilibrium. This finding is consistent with evidence on exchange-rate persistence, structural heterogeneity, and

sluggish macroeconomic adjustment in financially integrated economies (Itskhoki & Ribakova, 2024). Overall, exchange rates appear structurally unstable and weakly anchored to conventional equilibrium relationships.

The results indicate that prolonged sanctions and financial fragmentation have increased the influence of external financial conditions while weakening domestic macroeconomic channels. This study contributes to the literature by showing that geopolitical shocks can alter exchange-rate transmission and the relative importance of its determinants. Although focused on Russia, the findings are also relevant to sanctioned, commodity-dependent, and externally exposed economies facing growing financial fragmentation.

6. Conclusions

We investigated the major correlates of the USD/RUB exchange rate under prolonged sanctions, geopolitical shocks and increasing financial fragmentation using monthly data from 2005 to 2025. By integrating several complementary empirical strategies, including the ARDL-ECM-VAR framework, impulse-response analysis, forecast-error variance-decomposition and a structural-break test, we evaluated the roles of external financial developments, commodity-market dynamics, domestic macroeconomic fundamentals and major geopolitical episodes in determining exchange-rate fluctuations in Russia.

The empirical evidence shows that external factors–particularly the US Dollar Index and Brent crude oil prices-are significant correlates and short-run drivers of fluctuations in the USD/RUB exchange rate. An appreciation of the US dollar is associated with a depreciation of the ruble. Higher oil prices are associated with a stronger ruble, consistent with Russia's position as a major commodity-exporting economy. By contrast, inflation and interest-rate differentials exhibit limited explanatory power in the estimated specifications. These findings suggest that the conventional transmission mechanisms associated with Purchasing Power Parity and Uncovered Interest Parity do not fully explain how Russian exchange rate dynamics respond under conditions of prolonged sanctions, capital controls, financial constraints, and heightened geopolitical uncertainty.

The findings indicate that exchange-rate dynamics are not driven solely by new external shocks. VAR and forecast-error variance decomposition results show that, after an initial shock, subsequent movements are largely explained by ruble persistence, while external shocks account for only a limited share of forecast-error variance. Thus, the ARDL and VAR findings are complementary: global financial conditions and oil prices may trigger adjustment, but domestic propagation mechanisms, market segmentation, policy interventions, and expectations sustain it. Russia's exchange-rate dynamics are therefore externally triggered, persistent, and regime-dependent.

Structural-break analysis identifies major shifts during the Global Financial Crisis, the Crimea-related sanctions period, the COVID-19 pandemic, and the escalation of the Russia–Ukraine conflict. This suggests that USD/RUB determinants vary across geopolitical regimes. However, because financial fragmentation is represented by event and regime-shift variables rather than a continuous measure, the results indicate changing exchange-rate behavior rather than the causal magnitude of fragmentation.

Evidence of a stable long-run equilibrium is also inconclusive. The ARDL bounds test does not confirm cointegration, while the Johansen analysis finds no common cycle. Similarly, the error-correction coefficient suggests only slow and partial adjustment, conditional on model specification. These results imply that conventional equilibrium models have limited explanatory power in an environment characterized by structural shifts and strong policy intervention.

Domestic policy nevertheless remains important. Capital controls, monetary tightening, and foreign-exchange regulations may reduce short-run transmission from external shocks, but they cannot fully insulate the ruble from global dollar conditions, commodity

markets, and geopolitical developments. A flexible, regime-sensitive framework should therefore combine domestic stabilization with continuous monitoring of external financial, energy-market, and geopolitical risks.

This study contributes by showing that exchange-rate determination in a heavily sanctioned commodity-exporting economy reflects the interaction of external financial shocks, commodity volatility, geopolitical regime changes, institutional responses, and exchange-rate persistence. Future research should incorporate continuous measures of geopolitical risk and financial fragmentation, nonlinear or time-varying models, and Russia's growing financial and trade reorientation toward China, BRICS economies, and alternative payment systems.

In brief, exchange-rate dynamics are shaped by the interaction between external financial shocks and domestic policy responses. The findings suggest that domestic authorities retained an important stabilization role through administrative and policy interventions. However, prolonged sanctions and financial fragmentation shifted exchange-rate adjustment away from market-based equilibrium toward policy-driven stabilization under external constraints.

7. Implications and Future Research

These findings carry a clear message. Standard equilibrium-based models, such as purchasing power parity and its close variants, rely on persistent long-run relationships and relatively moderate adjustment. The evidence in this instance does not back up these assumptions. Rather, exchange rate dynamics are best described as externally driven, persistent, and structurally changed.

This implies that domestic policy instruments are used, although constrained, to provide stability in the exchange rate frameworks, as long as the conditions in the global arena are not favorable. Hence, it is crucial to monitor global developments and control exposure to external shocks. This reinforces the requirement for policy frameworks that are flexible to regime changes due to instability.

At the methodological level, the combination of ARDL, ECM, VAR, and structural break tests enables the consistent examination of long-run and short-run dynamics, as well as regime instability. Nevertheless, this study has three main limitations.

(1). This study has several limitations, including limited variables and the absence of nonlinear dynamics. Future studies could apply a broader framework using regime transition models and financial market indicators, as well as cross-country comparisons.

(2) Geopolitical fragmentation is represented through a structural change dummy variable rather than a continuous measure such as the Geopolitical Risk Index (GPR) or the recently developed financial fragmentation index. Consequently, this analysis identifies exchange rate dynamics across major geopolitical regimes but does not measure the intensity of fragmentation itself. Future research could integrate continuous indicators of geopolitical risk and financial fragmentation to provide a more comprehensive empirical assessment.

(3) The empirical model does not explicitly incorporate variables representing Russia's post-sanctions financial reorientation toward China and other non-aligned economies. Future studies may include indicators such as the share of Renminbi-denominated trade settlement, bilateral trade with BRICS economies, cross-border transactions through CIPS or SPFS, or other measures of alternative financial integration to better capture the evolving structure of the international financial system under prolonged sanctions.

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Appendix

Appendix A. Data, descriptive statistics, and unit root tests

Table A1. Variables, descriptive statistics, and unit root test results

Variable	Definition	Mean	Std. Dev.	ADF Level (p-value)	ADF Diff (p-value)	Order
ln(USD/RUB)	Exchange rate	3.8528	0.4621	0.360	0.000	I(1)
ln(DXY)	US Dollar Index	4.6052	0.1024	0.401	0.000	I(1)
ln(BRENT)	Oil price	4.2156	0.4218	0.244	0.000	I(1)
VIX	Market risk	19.842	8.573	0.021	—	I(0)
IRD	Interest differential	6.611	2.846	0.167	0.000	I(1)
INFDIFF	Inflation differential	4.975	2.674	0.152	0.000	I(1)

Appendix B. ARDL estimation details

Table A2. ARDL model specification and full estimation results

Variable	Coefficient	Std. Error	t-Statistic	p-value
ln(USD/RUB)(-1)	1.4090	0.0635	22.185	0.0000
ln(USD/RUB)(-2)	-0.5081	0.1043	-4.874	0.0000
ln(BRENT)	-0.1017	0.0244	-4.174	0.0000
ln(DXY)	0.9205	0.1723	5.343	0.0000
VIX	0.0005	0.0004	1.240	0.2162
Constant	-0.5143	0.3081	-1.669	0.0965

Model: ARDL(4,2,3,2); **Selection Criterion:** AIC

Commented [M4]: Titles (e.g., Dr., Mr., and Prof.) should NOT be used in the Acknowledgments section. Please remove them.

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Appendix C. Cointegration and error correction results

Table A3. Cointegration and error correction results

Component	Value	Interpretation
F-statistic (Bounds Test)	2.934	Inconclusive
Lower Bound	2.79	—
Upper Bound	3.67	—
CointEq(-1)	-0.0243***	Slow adjustment
Adjustment Speed	2.43%	Weak convergence

Appendix D. Structural break tests

Table A4. Structural break test results

Test	Break Date	Statistic	p-value	Conclusion
Chow Test	2014M03	8.215	0.0000	Break detected
Chow Test	2022M02	12.564	0.0000	Strong break
Bai–Perron	Multiple	—	—	Multiple regimes

Appendix E. VAR and dynamic analysis

Table A5. VAR Specification and dynamic analysis results

Component	Result	Interpretation
Lag Length	VAR(3)	Optimal (AIC)
Stability	All roots < 1	Stable system
Granger (BRENT → USD/RUB)	p = 0.0093	Significant
IRF (DXY shock)	Positive	Persistent effect
FEVD (Own shock)	~97.5%	High persistence

Appendix F. Robustness and stability

Table A6. Diagnostic and stability test results

Test	Statistic	p-value	Conclusion
LM Test	1.842	0.160	No autocorrelation
ARCH Test	1.215	0.305	Homoskedastic
Jarque–Bera	1.732	0.421	Normal residuals
RESET	1.564	0.213	Correct specification
CUSUM	Stable	—	Within bounds

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