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How Trade War Shocks Shape Reserve Accumulation? Evidence from MENA Countries

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Abstract:

The study examines the effects of trade war tensions, exchange rate volatility, and financial depth on foreign exchange reserves in 14 MENA countries from 2000 to 2024. Using the Panel Vector Error Correction Model (PVECM), the analysis captures both short-run dynamics and long-run equilibrium relationships. Stationarity and cointegration tests confirm that all variables are integrated at the 1 level and exhibit a stable long-term relationship. The PVECM results show that none of the key variables significantly affect FER in the short term. In the long term, however, TWI demonstrates a positive and significant impact, indicating that prolonged global trade tensions encourage MENA countries to increase reserve accumulation as a precautionary response to external uncertainty. Conversely, FD exerts a negative and significant long-term effect, suggesting that deeper financial markets may reduce reserve holdings through greater foreign currency demand and increased financial openness. Meanwhile, ERV shows a negative long-term relationship with FER but lacks statistical significance in either the long or short term, indicating that exchange rate fluctuations do not directly drive reserve adjustment behavior in MENA economies. These findings highlight the importance for policymakers to strengthen external resilience and manage financial sector development carefully to ensure foreign exchange reserve stability amid intensifying global geopolitical tensions.

Keywords: *Foreign Exchange Rate, Trade War, Exchange Rate Volatility, Financial Depth*

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1. Introduction

Global trade tensions have intensified since the escalation of the US–China trade war, which began in 2018 when the Trump administration imposed tariffs of up to 25% on more than US$34 billion of Chinese goods, later expanding to over US$370 billion, to which China responded with tariffs on more than US$110 billion of US products (CRS, 2018; Xu Zhang, 2020). These escalating protectionist measures disrupted international trade stability, contributing to a decline in world trade volume growth from 4.6% in 2017 to just 2.7% in 2019, according to the WTO (Gurría et al., 2019).

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Although the Biden administration adopted a more diplomatic tone, structural rivalry continues through the CHIPS and Science Act 2022, restrictions on strategic technology exports, and the inclusion of over 600 Chinese firms on the Entity List by 2024 (Umoru et al., 2025). Persistent geopolitical frictions have heightened global uncertainty, intensified financial market volatility, and increased exchange rate instability, particularly in developing and emerging economies (Fajgelbaum & Amit Khandelwal, 2021; Sanyal, 2025). This environment has prompted countries to accumulate foreign exchange reserves as precautionary buffers against external shocks, consistent with the Buffer-Stock Theory, which posits that reserves function as insurance to maintain macroeconomic and currency stability during periods of turbulence (Hamdani & Belfencha, 2024; Shrivastava & Jash, 2025).

A growing body of empirical literature highlights the crucial role of external uncertainty in driving reserve accumulation. Ali and Ismail (2025) find evidence that Economic Policy Uncertainty (EPU) positively influences reserve accumulation in BRIC economies as a defensive response to sudden stops and capital reversal risks. Similarly, Mumtaz and Ruch (2025) show that global macroeconomic uncertainty exerts significant negative effects on output and investment, particularly in emerging markets. Apaitan (2022) notes that increases in global uncertainty significantly reduce long-term investment and portfolio inflows in Thailand. Furthermore, Kaveh-Yazdy and Zarifzadeh (2023) review modern uncertainty measurement techniques, demonstrating improvements in risk assessment accuracy through text-based EPU indices. Collectively, these studies confirm that foreign exchange reserves serve as stabilizing instruments during external distress primarily through the exchange rate stabilization channel, capital flow management, and macroeconomic support. However, despite extensive research on Asia and BRIC economies, studies integrating global trade uncertainty, exchange rate volatility, and structural domestic factors remain limited.

Research specifically focusing on the Middle East and North Africa (MENA) context remains scarce, despite the region's high exposure to external shocks due to dependence on energy exports and imports of food and capital goods. Large fluctuations in oil prices from US$86 per barrel in 2018, falling to US$35 in 2020, and rising again above US$80 in 2022 have generated significant pressures on current account balances and currency stability . Severe currency depreciation episodes, such as the Turkish Lira crisis and the more than 50% depreciation of the Egyptian Pound since 2022, illustrate the region's vulnerability. Portfolio capital inflows to MENA emerging markets declined more than 35% in 2019, contributing to substantial reductions in foreign reserves, for example in Egypt (from US$45 billion to US$33 billion) and Tunisia (from US$9.4 billion to US$7.8 billion). Additionally, accelerating global energy transition policies and carbon border adjustment mechanisms such as the EU CBAM present new long-term external risks for carbon-intensive exporters. These dynamics suggest that governance effectiveness, fiscal balance, financial depth, and green trade exposure may significantly influence reserve performance yet empirical evidence integrating these dimensions remains absent (Cui & Jiang, 2025; Wang et al., 2025).

Despite substantial existing research, several critical gaps persist. First, most prior studies analyze EPU or global economic uncertainty in the context of Asia or BRIC economies, whereas comprehensive studies on the MENA region are limited. Second, there is a lack of empirical models that simultaneously examine trade war intensity, exchange rate volatility, governance effectiveness, financial depth, and green trade exposure in explaining foreign reserve accumulation. Third, existing studies have not adequately explored governance effectiveness as a moderating mechanism within the Buffer-Stock framework. Therefore, this study aims to analyze the impact of global trade war intensity on foreign exchange reserve accumulation in MENA countries from 2000 to 2024 and to examine the mediating role of exchange rate volatility. This research contributes to the literature by providing a more holistic model that incorporates structural, financial, and green policy dimensions, thereby extending Buffer-Stock Theory in the context of rising geopolitical conflict and green economic transition. The findings are expected to provide policy implications for strengthening external resilience, improving governance effectiveness, and designing sustainable reserve management strategies.

2. Theoretical Background

Buffer-Stock Theory

The Buffer-Stock Theory of International Reserves was first introduced by Heller (1966) through his article Optimal International Reserves in the Economic Journal. Heller defines foreign exchange reserves as a buffer stock used by countries to smooth external imbalances and protect the economy from unexpected external shocks. In this view, foreign exchange reserves are not merely an instrument of international liquidity, but a stabilization buffer that enables countries to maintain the smooth operation of international transactions amid uncertain global conditions (Rath, 2025).

Further theoretical development was carried out by Frenkel and Jovanovic (1981), who conceptualized foreign exchange reserves as a precautionary stock of foreign assets that functions to minimize adjustment costs when random external shocks occur. This perspective was reinforced by Ben-Bassat & Gottlieb, (1992), who view foreign exchange reserves as a form of self-insurance against the risk of sudden stops, exchange rate volatility, and trade disruptions. Overall, buffer-stock theory positions foreign exchange reserves as a key instrument for maintaining exchange rate stability, balance of payments, and macroeconomic resilience when external risks rise.

The core concept of this theory is that the demand for foreign exchange reserves increases as global uncertainty increases. When risks in international trade, geopolitical pressures, or global market volatility intensify, countries tend to build up their reserves to reduce potentially costly adjustment processes. Thus, reserve accumulation is considered a rational response to external risk exposure (Benigno et al., 2022; Dominguez, 2012).

The Buffer-Stock Theory provides a strong conceptual foundation for explaining how the intensity of the global trade war influences the accumulation of foreign exchange reserves in MENA countries. Trade conflicts, such as the U.S.–China rivalry, represent a clear form of external uncertainty shock that can increase exchange rate volatility, disrupt cross-border trade, suppress capital flows, and trigger global economic instability. Consistent with buffer-stock theory, countries facing such external risks will be inclined to increase their reserves as a mitigation strategy.

Moreover, the presence of exchange rate volatility as a mediating variable is in line with Frenkel and Jovanovic (1981), who emphasized that foreign exchange reserves are used to dampen exchange rate pressures. In other words, the intensity of a trade war can increase exchange rate volatility, and through this channel the need for foreign exchange reserves rises. Additional variables such as trade openness, capital flows, current account balance, fiscal balance, financial depth, and governance effectiveness are all determinants of reserve accumulation that align with the buffer-stock framework, as these factors influence a country's exposure to external risks and its buffering capacity (Heller, 1966). Therefore, the Buffer-Stock Theory serves not only as the main grand theory of this study but also comprehensively explains the relationship between trade war intensity, exchange rate volatility, and foreign exchange reserve accumulation in MENA countries.

3. Methodology

This research design employs a quantitative approach using panel data to analyze the relationship between foreign exchange reserves, trade war, exchange rate, and financial development in MENA countries during the period 2000–2024 (Sekaran & Bougie, 2016). The research population includes all countries classified as part of the Middle East and North Africa (MENA) region. The sample selection was conducted using purposive sampling, which is a selection technique based on data availability and completeness (Creswell, 2018). The criteria used include:

a. Availability of research variables in MENA country reports
b. Availability of annual data on foreign exchange reserves, exchange rates, trade openness, and current account balances. Fiscal Balance, Financial Depth, Governance Effectiveness, and Green Trade Exposure consistently throughout the research period (2000-2024).
c. The Trade War variable is categorized as a dummy variable where 0 is for the period without trade wars (2000-2017) and 1 is for the period with trade wars (2018-2024).

Based on these criteria, 14 countries were selected as research samples covering the years 2000-2024. Table 1 shows the list of countries in this study:

Table 1
Research Sample

No.	Countries	No.	Countries
1	Bahrain	8	Qatar
2	Iraq	9	Saudi Arabia
3	Israel	10	Algeria
4	Jordan	11	Egypt
5	Kuwait	12	Libya
6	Lebanon	13	Morocco
7	Oman	14	Tunisia

Source: Researcher (2025)

The data used is secondary data sourced from the World Bank which includes the main variables of foreign exchange reserves, trade war intensity, exchange rate volatility, and a number of control variables such as trade openness, capital flows, current account balance, fiscal balance, financial depth, governance effectiveness, and energy transition indicators (Creswell, 2018). Table 2 shows the operational definitions of the variables in this study :

Table 2
Operational Definition of Variables

Variable	Definition	Measurement / Formula
Dependent Variable *Foreign Exchange Reserves* (FER)	Stock of total international reserves, including gold, held by the central bank as buffer assets.	Total Reserves (incl. gold) / GDP × 100%
Independent Variabel *Trade War Intensity* (X1)	Degree of exposure of MENA countries to the US–China trade war, measured through tariff exposure or Trade Policy Uncertainty index.	Trade-Weighted Tariff Exposure Index or TPU Index
Exchange Rate Volatility / ERV (X2)	Degree of fluctuation in nominal exchange rate as a reflection of external shocks.	Standard deviation of monthly log-difference in exchange rate (12-month window)
Financial Depth / FD (X3)	Development level of the financial sector reflecting liquidity and intermediation.	M2 / GDP × 100%
Trade Openness / TO (C1)	Integration level of an economy with global markets.	(Exports + Imports) / GDP × 100%
Capital Flows / CF (C2)	Net inflows of foreign capital into domestic economy.	Net Capital Inflows / GDP × 100%

Current Account Balance / CAB (C3)	Net balance of current account transactions representing trade in goods, services, income, and transfers.	CAB / GDP × 100%
Fiscal Balance / FB (C4)	Difference between government revenues and expenditures relative to GDP.	Fiscal Balance / GDP × 100%
Governance Effectiveness / GE (C5)	Quality of governance in formulating and implementing policies.	WGI Governance Effectiveness Score (−2.5 to +2.5)
Green Transition Exposure / GTX (C6)	Degree of exposure to global energy transition, affecting external vulnerability.	Fossil fuel rents (% GDP)

Resource : Research (2025)

The analytical method used is the Panel Vector Error Correction Model (Panel VECM), which allows the researcher to examine both short-run and long-run relationships among the study variables. Before estimating the model, stationarity testing is conducted using a panel unit root test, followed by a cointegration test to ensure the presence of a long-run relationship (Widarjono, 2023). After that, the Panel VECM is estimated to observe short-run adjustment dynamics through the error correction term, as well as the direct influence of the explanatory variables on foreign exchange reserves. Additional analyses such as the impulse response function (IRF) and variance decomposition are also conducted to examine how foreign exchange reserves respond to shocks in trade war, exchange rate, and financial development.
After the long-run relationship is established, the Panel VECM model is formulated as follows:
The stages of the Panel VECM analysis in this study consist of several steps:

a. Stationarity Test (Unit Root Test)
   All variables are tested for stationarity levels using panel tests such as LLC, IPS, and Fisher-ADF/PP. The purpose of this testing is to determine whether each variable is I(0) or I(1). Panel VECM requires that the variables be integrated of order one (I(1)).
b. Panel Cointegration Test
   After confirming that all variables are I(1), a cointegration test is conducted using the Pedroni, Kao, or Westerlund methods to determine whether there is a long-run relationship between foreign exchange reserves and the explanatory variables.
c. Optimal Lag Selection
   The optimal lag length is selected based on information criteria such as the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC). An appropriate lag is necessary to ensure the VECM model is stable and free from misspecification.

d. Panel VECM Model Estimation
   If cointegration exists, the Panel VECM is estimated. The error correction term (ECT) is used to observe the speed of adjustment toward long-run equilibrium, while the differencing coefficients (Δ) describe the short-run relationships among variables.
e. IRF and Variance Decomposition Analysis
   The Impulse Response Function (IRF) is used to observe how foreign exchange reserves respond to shocks in trade war, exchange rate, and financial development. Variance decomposition is used to determine the extent to which each independent variable contributes to explaining changes in foreign exchange reserves..

4. Empirical Findings/Result

Stationarity Test

The unit root or stationarity test is conducted as an initial step in the analysis to identify the characteristics of time-series data, particularly to assess the stability of the data over time (Pratama et al., (2025). The Augmented Dickey–Fuller (ADF) test is used to evaluate whether the data are stationary. The data are considered stationary when the null hypothesis (H0) can be rejected and the p-value is less than 0.05, indicating that the alternative hypothesis (H1) is accepted. The results of the stationarity test are presented in Table 3 below :

Table 3
Stationarity Test

Difference	Variable	Unit Root Test	
		ADF	Prob
1st Difference	LnFER		
	TWI	101.696	0.0000
	ER	68.7215	0.0000
	FD	137.995	0.0000

Table 3 shows that the ADF test estimates at the first-difference level yield probability values below 0.05. The probability value for the variable LNFER is 0.0000 < 0.05, for TWI is 0.0000 < 0.05, for RE is 0.0000 < 0.05, and for FD is 0.0000 < 0.05. Therefore, H0 is rejected and H1 is accepted. It can be concluded that the variables LnFER, TWI, RE, and FD are stationary at the first-difference level.

Optimal Lag Test

Determining the optimal lag is important to understand the response period of one variable to another and its impact on related variables (Pratama et al., 2025). The selected lag must satisfy at least one model selection criterion, namely LR, FPE, AIC, SC, or HQ. The results of the optimal lag test can be seen in Table 4 below.

Table 4
Optimal Lag Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-8487.609	NA	9.18e+23	66.52820	66.91595	66.68415
1	-8426.334	117.2857	6.45e+23	66.17448	66.78381*	66.41955
2	-8413.358	24.43059	6.60e+23	66.19811	67.02901	66.53229
3	-8361.022	96.90360	4.97e+23	65.91423	66.96671	66.33753*
4	-8341.566	35.41582*	4.85e+23*	65.88723*	67.16128	66.39965

The estimation results in Table 4 show that lag 4 is the most optimal lag, as indicated by the highest number of (*) symbols in the lag test. This finding suggests that selecting the appropriate lag helps normalize the influence between variables. Therefore, lag 4 is chosen as the optimal lag to be used in the subsequent analysis stages, including the stability test in the VECM model.

PVECM Stability Test

The PVECM stability test aims to ensure that the model and the variables at each lag are in a valid and stable condition. Once the model is confirmed to be stable, the analysis can proceed using the Impulse Response Function (IRF) and Variance Decomposition (VD), as explained by Pratama et al (2025). Model stability is achieved when all modulus values are below 1, indicating that the condition requirements have been met. Thus, H0 is rejected and H1 is accepted, signifying that the model produces consistent estimates and can be used for subsequent testing. The detailed test results are presented in Table 5

Table 5
PVECM Stability Test

Root	Modulus
0.461628 - 0.669301i	0.813058
0.461628 + 0.669301i	0.813058
-0.691312	0.691312
-0.539657 - 0.427247i	0.688309
-0.539657 + 0.427247i	0.688309
0.680215 - 0.021433i	0.680553
0.680215 + 0.021433i	0.680553
-0.204050 - 0.630085i	0.662301
-0.204050 + 0.630085i	0.662301
-0.036973 - 0.642458i	0.643521
-0.036973 + 0.642458i	0.643521
0.568972 - 0.263101i	0.626858
0.568972 + 0.263101i	0.626858
-0.293127 - 0.446439i	0.534071
-0.293127 + 0.446439i	0.534071

-0.265469	0.265469

Based on Table 5, all root values in the VECM stability test estimation have modulus values below 1, indicating that the model is valid and stable. This condition leads to the rejection of H0 and the acceptance of H1, meaning that the model is suitable for further analysis such as the Impulse Response Function (IRF) and Variance Decomposition (VD). The next step that needs to be conducted is the cointegration test.

Kao Cointegration Test

The cointegration test is used to identify the existence of long-run equilibrium relationships among variables Pratama et al (2025). When the trace statistic value is greater than the critical value, this indicates the rejection of H0 and the acceptance of H1. If this condition is met, the analysis can proceed to the Panel Vector Error Correction Model (PVECM) stage. However, if no cointegration relationship is found, the VAR approach becomes the appropriate alternative. The results of the Johansen cointegration test are presented in Table 6.

Table 6
Kao Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.304804	150.7795	47.85613	0.0000
At most 1 *	0.114329	54.43579	29.79707	0.0000
At most 2 *	0.073946	22.26222	15.49471	0.0041

The results presented in Table 6 confirm that there is a stable long-run relationship among the variables, as indicated by the presence of cointegration. This conclusion arises because all probability values meet the significance requirement, which is below 0.05 namely "none" = 0.0000, "at most 1" = 0.0000, and "at most 2" = 0.0041. This condition indicates the rejection of H0 and acceptance of H1, demonstrating that a long-run relationship exists within the model. Therefore, the analysis can proceed using the PVECM approach.

Granger Causality Test

According to Pratama et al (2025), the Granger causality test is used to assess the bidirectional causal relationship between variables. This means the test can identify whether variable X influences variable Y or vice versa. A variable is considered to have a significant effect if its probability value is below 0.05, leading to the rejection of H0 and the acceptance of H1. In this study, short-run causality analysis is also conducted through the Granger Causality Test. A summary of the estimation results is presented in Table 7.

Table 7
Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
FER does not Granger Cause TWI	294	4.21641	0.0025
TWI does not Granger Cause FER	294	0.28006	0.8908
FER does not Granger Cause ER	294	0.06125	0.9930
ER does not Granger Cause FER	294	0.33058	0.8573
FER does not Granger Cause FD	294	0.32149	0.8635
FD does not Granger Cause FER	294	0.7769	0.8635
TWI does not Granger Cause ER	294	1.06598	0.3736
ER does not Granger Cause TWI	294	0.9582	0.9582
TWI does not Granger Cause FD	294	8.94784	8.E-07
FD does not Granger Cause TWI	294	0.0884	0.0884
FD does not Granger Cause ER	294	0.78120	0.5382
ER does not Granger Cause FD	294	0.8268	0.8268

Based on the estimated results of the Granger Causality Test in the table above, the analysis can be explained as follows:

a. A probability value of 0.0025 < 0.05 indicates that TWI is significantly influenced by FER, resulting in the rejection of H0 and acceptance of H1. Conversely, the probability value of 0.8908 > 0.05 shows that FER is not influenced by TWI, meaning H0 is accepted and H1 is rejected. Thus, there is a one-way causal relationship from FER to TWI.
b. The probability value of 0.9930 > 0.05 indicates that ER is not influenced by FER, so H0 is accepted and H1 is rejected. Likewise, the probability value of 0.8573 > 0.05 shows that FER is also not influenced by ER, so H0 is accepted and H1 is rejected. Therefore, no causal relationship exists between FER and ER.
c. The probability value of 0.8635 > 0.05 indicates that FD is not influenced by FER, resulting in H0 being accepted and H1 rejected. Similarly, the probability value of 0.8635 > 0.05 shows that FER is not influenced by FD, meaning H0 is accepted and H1 is rejected. Thus, no causal relationship exists between FER and FD.
d. The probability value of 0.3736 > 0.05 shows that ER is not influenced by TWI, so H0 is accepted and H1 is rejected. Meanwhile, the probability value of 0.9582 > 0.05 indicates that TWI is not influenced by ER, resulting in H0 being accepted and H1 rejected. Hence, no causal relationship exists between TWI and ER.
e. The probability value of 8.E-07 < 0.05 indicates that FD is significantly influenced by TWI, so H0 is rejected and H1 is accepted. Conversely, the

probability value of 0.0884 > 0.05 shows that TWI is not influenced by FD, meaning H0 is accepted and H1 is rejected. Thus, there is a one-way causal relationship from TWI to FD.

f. The probability value of 0.5382 > 0.05 indicates that ER is not influenced by FD, resulting in H0 being accepted and H1 rejected. Meanwhile, the probability value of 0.8268 > 0.05 shows that FD is not influenced by ER, so H0 is accepted and H1 is rejected. Therefore, no causal relationship exists between FD and ER.

Panel Vector Error Correction Model (PVECM)

PVECM is used to identify the direct long-run causal relationships among the research variables. This model is developed from the VAR framework, which is non-stationary, following unit root testing at the required integration level (Pratama et al., 2025). Once these preliminary conditions are met, the estimation process can proceed to evaluate both short-run and long-run impacts through the VECM approach.

Short Term

Table 8
Short-term PVECM Results

Error Correction:	Coefficient	t-statistic
CointEq1	-0.004273	[-0.30157
D(FER(-1),2)	-0.299512	[-5.74423
D(FER(-2),2)	-0.322995	[-5.77473
D(FER(-3),2)	-0.153789	[-2.78028
D(FER(-4),2)	-0.353199	[-6.50445
D(TWI(-1),2)	1.51E+09	0.16556
D(TWI(-2),2)	5.09E+09	0.64598
D(TWI(-3),2)	5.15E+09	0.81907
D(TWI(-4),2)	-1.07E+09	[-0.22899
D(ER(-1),2)	297235.6	0.14855
D(ER(-2),2)	4218178.	0.17318
D(ER(-3),2)	-2823625.	[-0.09759
D(ER(-4),2)	-321742.8	[-0.01219
D(FD(-1),2)	-1.34E+08	[-0.94973
D(FD(-2),2)	-1.96E+08	[-1.28568
D(FD(-3),2)	-85667067	[-0.62816
D(FD(-4),2)	-96504537	[-0.83795
C	-44884242	[-0.04448
D(CAB)	6.95E+08	3.85344
D(FB)	84565998	1.40112
D(GE)	7.23E+09	0.83269
D(GTX)	58342366	1.08103
D(TO)	33948582	0.35933

Based on the t-statistic test results, decisions are made using the following criteria:
If t-statistic < t-table (1.97280) so, the effect is not significant.
If t-statistic > t-table (1.97280) so, the effect is significant.

According to the VECM model results, the following interpretations can be made:

a. Referring to the D(FER,2) estimation results, changes in the Trade War Index (TWI) at all lags do not show a significant effect on foreign exchange reserves in MENA countries. This is indicated by the t-statistic values at lag 1 [0.16556], lag 2 [0.64598], lag 3 [0.81907], and lag 4 [–0.22899], all of which are lower than the t-table value. Therefore, it can be concluded that the intensity of global trade wars does not produce an immediate short-run impact on foreign exchange reserves.
b. Exchange rate volatility (ERV) also does not have a significant short-run effect on FER. The t-statistic values for each lag [0.14855] at lag 1, [0.17318] at lag 2, [–0.09759] at lag 3, and [–0.01219] at lag 4 are all below the t-table threshold of 1.97280. This indicates that exchange rate fluctuations are not sufficiently strong to trigger an immediate response through adjustments in foreign exchange reserves, meaning that monetary intervention or currency stabilization does not appear rapidly in short-term dynamics.
c. The financial depth (FD) variable likewise shows no significant effect on foreign exchange reserves across all lags. The t-statistic values of [–0.94973] at lag 1, [–1.28568] at lag 2, [–0.62816] at lag 3, and [–0.83795] at lag 4 all fall below the t-table value, indicating that changes in FD do not influence FER within a short-run horizon. These findings suggest that financial sector deepening tends to exert a more structural and long-term impact.

Long Term

Table 8
Short-term PVECM Results

Cointegrating Eq:	CointEq1	
D(FER(-1))	1.000000	
D(TWI(-1))	7.59998	9.53264
D(ER(-1))	-9.51E-09	-2.01360
D(FD(-1))	-8.58786	[-3.92411
C	-2.94876	

According to the long-term estimation results in the cointegrating equation, several conclusions can be drawn.

a. The results indicate that in the long run, the Trade War Index (TWI) has a significant effect on foreign exchange reserves (FER). This is reflected in the t-statistic value of [9.53264], which far exceeds the t-table threshold, leading to the conclusion that rising global trade war intensity is positively correlated with the increase in foreign exchange reserves among MENA countries over the long term. This finding suggests that heightened global trade tensions encourage countries to strengthen their external positions by accumulating larger reserve buffers as protection against global uncertainty.
b. Meanwhile, the exchange rate (ER) demonstrates a significant negative long-term effect on FER, as reflected by its t-statistic value [–2.01360] > 1.96 in absolute terms. This indicates that fluctuations in the exchange rate tend to reduce foreign exchange reserves in the long run, which may be related to depreciation pressures that compel monetary authorities to utilize reserves for stabilization.
c. Meanwhile, financial depth (FD) shows a negative and significant long-run effect on foreign exchange reserves. This is supported by the t-statistic value of [–3.92411], which exceeds the t-table value in absolute terms. This finding suggests that greater financial deepening over the long term tends to reduce foreign exchange reserves. One possible interpretation is that a more developed financial sector encourages higher capital outflows, greater import-driven consumption, or increased foreign investment activity by domestic agents, ultimately reducing national reserve accumulation.
d. The negative constant value (–2.94876) indicates that without contributions from the main explanatory variables, the baseline level of foreign exchange reserves would be lower. This implies that increases in FER are strongly dependent on structural factors such as global trade war dynamics and financial sector development. Overall, the long-run results confirm the presence of cointegration between FER and the explanatory variables, with TWI exerting a positive and significant effect, FD exerting a negative and significant effect, and ERV showing no meaningful long-run influence.

Impulse Response Function (IRF)

The relationship between the dependent and independent variables in this study can be analyzed using the Impulse Response Function (IRF). This method allows researchers to observe how a shock affects other variables both in the short run and the long run (Ballarin, 2023). Through the IRF, it is also possible to determine how long the impact persists. In an IRF graph, the vertical axis represents the magnitude of the response in percentage form, while the horizontal axis shows the time horizon in years. The following explanation presents the interpretation of the IRF response of the Unemployment Rate (TP) variable to RLS as illustrated in table 9.

Table 9
IRF

Response of D(FER): Period	D(ER)	D(FD)	D(FER)	D(TWI)
1	768.7672	0.000000	0.000000	0.000000
2	4696.366	5.113093	8.090888	15.19737
3	28027.82	39.34648	78.09597	79.48486
4	167279.4	173.6360	457.6813	460.7489
5	996205.1	991.8001	2738.132	2719.923
6	5930777.	5901.691	16320.20	16407.06
7	35307495	35076.77	97169.96	97653.21
8	2.10E+08	208771.4	578505.6	581321.4
9	1.25E+09	1242844.	3443968.	3460821.
10	7.45E+09	7398909.	20502710	20603090
11	4.43E+10	44047317	1.22E+08	1.23E+08
12	2.64E+11	2.62E+08	7.27E+08	7.30E+08
13	1.57E+12	1.56E+09	4.33E+09	4.35E+09
14	9.36E+12	9.29E+09	2.58E+10	2.59E+10
15	5.57E+13	5.53E+10	1.53E+11	1.54E+11
16	3.32E+14	3.29E+11	9.13E+11	9.17E+11
17	1.97E+15	1.96E+12	5.43E+12	5.46E+12
18	1.18E+16	1.17E+13	3.23E+13	3.25E+13
19	7.00E+16	6.95E+13	1.93E+14	1.94E+14
20	4.17E+17	4.14E+14	1.15E+15	1.15E+15
21	2.48E+18	2.46E+15	6.82E+15	6.86E+15
22	1.48E+19	1.47E+16	4.06E+16	4.08E+16
23	8.79E+19	8.73E+16	2.42E+17	2.43E+17
24	5.23E+20	5.20E+17	1.44E+18	1.45E+18
25	3.11E+21	3.09E+18	8.57E+18	8.61E+18

In impulse response analysis of D(FER) provides insight into how foreign exchange reserves in MENA countries respond over time to shocks from Trade War Index (TWI), Exchange Rate Volatility (ER), and Financial Depth (FD). In the very short term, during the first period, D(FER) responds primarily to a shock in ER (768.77 units), while responses to FD and TWI are negligible, indicating that immediate fluctuations in reserves are most sensitive to exchange rate movements rather than trade war events or financial depth.

As time progresses, the response of D(FER) to all shocks increases substantially. By period 3, D(FER) shows notable reactions to shocks in ER (28,027.82 units), TWI (79.48 units), and FD (39.35 units), suggesting that the effects of trade tensions and financial deepening begin to materialize with a slight lag, though ER continues to dominate. From period 4 onward, the response to ER shock escalates dramatically, reaching 1.25×10^9 units by period 9 and ultimately surpassing 10^21 units by period

25. This indicates that over time, fluctuations in exchange rates have the largest and most persistent impact on foreign exchange reserves.

The response to TWI, while positive, grows more moderately, reaching 8.61×10^18 units by period 25, and FD shows a similar but slightly smaller long-term effect. This pattern reflects that, although trade war events and financial deepening have some influence on reserves over the long run, the dominant driver of reserve dynamics is exchange rate fluctuations. In practical terms, MENA countries' foreign exchange reserves are most sensitive to shocks in ER, while TWI and FD contribute marginally to long-term reserve adjustments. Overall, the IRF results reinforce the variance decomposition findings, showing that ER is the main determinant of reserve variability over time, whereas TWI and FD have relatively minor dynamic effects. The IRF thus provides a clear dynamic picture of how reserves react to different shocks, highlighting the central role of exchange rate management in stabilizing foreign exchange reserves in the region.

Variance Decomposition (VD)

Variance decomposition (VD) analysis is used to assess the contribution of each independent variable to the dependent variable (Jarrett et al., 2020). In this study, the main purpose of the VD analysis is to evaluate the extent to which the Trade War Index (TWI), Exchange Rate Volatility (ERV), and Financial Depth (FD) influence changes in Foreign Exchange Reserves (D(FER)) in the MENA countries. The VD results are presented in Table 10 as follows.

Table 10
VD

D(FER): Period	S.E.	D(FER)	D(TWI)	D(ER)	D(FD)
1	1.56E+10	100.0000	0.000000	0.000000	0.000000
2	1.90E+10	99.68216	0.039449	0.082591	0.195800
3	2.13E+10	88.97051	0.100113	10.49339	0.435986
4	4.39E+10	22.77503	0.023741	77.09816	0.103060
5	2.30E+11	0.883392	0.020695	99.09205	0.003867
6	1.37E+12	0.141565	0.006768	99.85148	0.000182
7	8.13E+12	0.150016	0.005812	99.84414	3.64E-05
8	4.84E+13	0.156966	0.005637	99.83736	3.25E-05
9	2.88E+14	0.158147	0.005634	99.83619	3.34E-05
10	1.72E+15	0.158368	0.005635	99.83596	3.35E-05
11	1.02E+16	0.158401	0.005635	99.83593	3.36E-05
12	6.08E+16	0.158406	0.005635	99.83593	3.36E-05
13	3.62E+17	0.158407	0.005635	99.83592	3.36E-05
14	2.16E+18	0.158407	0.005635	99.83592	3.36E-05
15	1.28E+19	0.158407	0.005635	99.83592	3.36E-05

16	7.64E+19	0.158407	0.005635	99.83592	3.36E-05
17	4.55E+20	0.158407	0.005635	99.83592	3.36E-05
18	2.71E+21	0.158407	0.005635	99.83592	3.36E-05
19	1.61E+22	0.158407	0.005635	99.83592	3.36E-05
20	9.60E+22	0.158407	0.005635	99.83592	3.36E-05
21	5.72E+23	0.158407	0.005635	99.83592	3.36E-05
22	3.40E+24	0.158407	0.005635	99.83592	3.36E-05
23	2.03E+25	0.158407	0.005635	99.83592	3.36E-05
24	1.21E+26	0.158407	0.005635	99.83592	3.36E-05
25	7.18E+26	0.158407	0.005635	99.83592	3.36E-05

The variance decomposition results for changes in foreign exchange reserves (D(FER)) indicate the extent to which the variability of D(FER) can be explained by itself and by other variables in the system (TWI, ER, FD) over a given time horizon. In the first period, 100% of the variation in D(FER) is explained by itself, while the contributions of TWI, ER, and FD are still zero. This suggests that, in the very short term, foreign exchange reserves are more influenced by their own lagged values than by external factors.Over time, the contributions of other variables begin to emerge. For example, in period 3, part of the variability in D(FER) is explained by ER at 10.49%, while TWI and FD remain relatively small (0.10% and 0.44%, respectively). This indicates that exchange rate volatility starts to affect changes in foreign exchange reserves several periods after the initial shock, although the impact of TWI and FD remains minimal.

Entering periods 4 to 5, almost the entire variation in D(FER) (77–99%) is explained by ER, while TWI and FD remain below 1%. In the long term (periods 10–25), the contribution of D(FER) to itself drastically declines to around 0.16%, TWI's contribution remains negligible (~0.0056%), FD approaches zero (~0.00003%), and almost all variation (99.83%) is explained by ER. This interpretation indicates that, although TWI and FD may have long-term or theoretical effects on foreign exchange reserves in the VECM model, from the perspective of long-term shock dynamics through variance decomposition, changes in foreign exchange reserves are primarily driven by exchange rate volatility (ER). In other words, shocks to ER have the greatest ability to explain fluctuations in foreign exchange reserves over time, while TWI and FD contribute very little to the variability of D(FER) in the long run

5. Discussion

The Impact of the Trade War on the Foreign Exchange Reserves of MENA Countries

The results of the analysis show that the Trade War Index (TWI), which is modeled as a dummy variable (1 for years when trade-war events occur and 0 otherwise), does not have a significant effect on foreign exchange reserves (FER) in the short term. The insignificant t-statistic values across all lags indicate that the occurrence of trade-war events in any given year does not immediately alter the reserve management behavior of MENA countries. This suggests that short-term adjustments to global trade tensions such as sudden tariff announcements or diplomatic escalations are not instantly transmitted into foreign exchange reserve changes. Policymakers in MENA economies do not rapidly revise reserve positions in direct response to isolated yearly trade-war shocks.

In contrast, the long-run estimation reveals that TWI has a positive and statistically significant effect on foreign exchange reserves. This implies that when trade wars persist across multiple years reflected by repeated occurrences of the dummy value "1" MENA countries accumulate more foreign exchange reserves over time. In other words, the structural effect of ongoing global trade tensions leads to a strategic buildup of reserves. This long-run increase can be interpreted as a precautionary response: prolonged trade wars create uncertainty in global financial markets, disrupt supply chains, and elevate risks surrounding commodity prices. As many MENA economies are oil-dependent exporters, such uncertainty incentivizes them to strengthen external buffers by stockpiling larger reserve holdings (Huang et al., 2023).

Theoretically, this finding is consistent with Buffer-Stock Theory, which places foreign exchange reserves as a buffer stock that is activated when real external risks arise. Within this theoretical framework, TWI as a dummy variable serves as a signal of escalating global risk. When trade wars intensify, the countries in this study increase their foreign exchange accumulation as a self-insurance measure to mitigate potential turmoil in the external sector. Thus, the increase in foreign exchange reserves during trade war tensions is a rational response to maintain macroeconomic stability. This study is consistent with Ahmed et al., (2023), Carlomagno & Albagli, (2022), Choi & Taylor, (2022), who found that global uncertainty due to trade wars encourages countries to increase foreign exchange reserves as a precautionary strategy to maintain macroeconomic stability.

The Effect of Financial Depth on Foreign Exchange Reserves in MENA Countries

The results of the study show that financial depth (FD) exerts a negative long-term influence on foreign exchange reserves in MENA countries, while its short-term effect is statistically insignificant. This indicates that a more developed financial sector does not automatically translate into higher foreign exchange reserve accumulation. Instead, deeper financial markets may encourage greater domestic liquidity creation, higher credit expansion, and increased import-driven economic activity—all of which can raise foreign currency demand and consequently reduce reserve holdings in the long run. In this context, financial deepening can shift the economic structure toward higher external exposure, causing foreign exchange reserves to gradually decline rather than accumulate.

From a theoretical perspective, this finding aligns with the notion that the buffer-stock role of reserves becomes less prominent when domestic financial markets expand and provide alternative liquidity sources. In several MENA economies, increased financial depth may lead governments and private sectors to rely more on domestic financing instruments rather than precautionary reserve accumulation (Saadaoui, 2024). As a result, the long-term reserve position weakens because liquidity management is increasingly handled through internal financial channels rather than through large foreign reserve buffers. This dynamic demonstrates that financial deepening in MENA does not strengthen the buffer function of reserves; instead, it may reduce the incentive to maintain high reserve levels over time (Ǧūda & Rizk, 2025).

The Effect of Exchange Rate Volatility on Foreign Exchange Reserves in MENA Countries

The results indicate that exchange rate volatility (ERV) has a negative long-term relationship with foreign exchange reserves in MENA countries; however, this effect is statistically insignificant. This means that although higher volatility tends to move reserve levels downward in the long run, the relationship is not strong enough to influence reserve management decisions. In the short run, ERV also shows no significant effect, indicating that fluctuations in the exchange rate do not trigger immediate adjustments in foreign exchange reserves.

From a theoretical perspective, this insignificant negative effect suggests that the Buffer-Stock Theory does not fully apply in the context of ERV in MENA countries. Instead of using reserves as a countercyclical buffer when exchange rate volatility increases, monetary authorities appear to rely on alternative stabilization tools—such as interest rate policies, macroprudential regulations, or managed exchange rate frameworks. As a result, exchange rate volatility, both in the short and long term, does not lead to meaningful changes in reserve levels.

6. Conclusions

The results of the study indicate that the Trade War Index (TWI) does not have a significant effect on foreign exchange reserves (FER) in the short term, but it shows a positive and significant impact in the long run, suggesting that prolonged global trade tensions encourage MENA countries to accumulate reserves as a precautionary strategy. Financial depth (FD) exerts a significant negative effect on FER in the long term while remaining insignificant in the short term, implying that deeper financial markets may increase domestic liquidity and foreign currency demand, ultimately reducing reserve holdings over time. Meanwhile, exchange rate volatility (ERV) demonstrates a negative and statistically significant long-term effect, indicating that persistent currency fluctuations tend to erode foreign exchange reserves as central banks respond to volatility pressures. However, in the short term, ERV does not show a significant impact on FER, suggesting that MENA countries do not immediately adjust their reserve positions in response to short-lived exchange rate movements.

Based on these findings, policymakers in MENA countries are encouraged to strengthen their external resilience during periods of persistent global trade tensions, given the positive long-term effect of TWI on reserve accumulation. At the same time, prudent management of financial deepening is required, as greater financial depth may weaken long-term reserve positions. Although ERV does not significantly influence reserves, monetary authorities should continue monitoring exchange rate movements and rely on complementary stabilization tools—such as interest rate adjustments, macroprudential policies, and exchange rate arrangements—to manage currency pressures. For future research, scholars are advised to employ more granular trade war indicators beyond dummy variables, integrate additional macroeconomic and structural determinants, and apply advanced estimation techniques such as PVAR or PMG-ARDL to capture cross-country heterogeneity. Future studies may also classify MENA countries based on economic characteristics and use higher-frequency data to generate more refined insights into the dynamics of foreign exchange reserves..

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