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Exchange Rate Flexibilization and Macroeconomic Determinants: Evidence from MENA Region

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Abstract:
Many emerging economies have significantly changed their economic policies by adopting floating exchange rate regimes. This article aims to investigate the relationship between exchange rate variations and key macroeconomic indicators in the MENA region, focusing specifically on Egypt, Tunisia, and Turkey. The study employs regression analysis to explore how macroeconomic factors such as inflation, interest rates, trade balances, foreign exchange reserves etc. influence exchange rate movements in these economies. By conducting a comprehensive regression model, we aim to provide insights into the complex dynamics of exchange rate fluctuations and their implications for economic stability and policymaking in the MENA region.

Keywords: Exchange rate, Macro-economy, Emerging markets, MENA region, regression analysis

1. Introduction

The exchange rate dynamics in emerging markets have long been a subject of intense research interest due to their significance in shaping macroeconomic stability and growth prospects. Particularly, the Middle East and North Africa (MENA) region, characterized by its diverse economic landscape and unique geopolitical challenges, presents a compelling case for exploring the intricate relationship between exchange rate variations and macroeconomic factors. Over the years, numerous studies have endeavored to unravel the complexities of this relationship (Moutaib & Lahrichi (2023)) shedding light on the underlying mechanisms and implications for policymakers and market participants.

In recent decades, scholars have made significant strides in advancing our understanding of the dynamics between exchange rate movements and macroeconomic fundamentals in emerging markets. Early seminal works by Hadj Amor et El Araj. (2009), Brixiova et al. (2014) and Bilgili et al. (2019) laid the groundwork for examining the determinants of exchange rate fluctuations, emphasizing the role of trade balances, capital flows, and monetary policy in shaping exchange rate dynamics. Subsequent research by Peters (2014), Dibooğlu (2000), Neaime (2009) and Chortareas et al. (2012) delved deeper into the nuances of this relationship, exploring the impact of fiscal policy, external shocks, and financial market developments on exchange rate variability in emerging economies.

The MENA region, characterized by its rich tapestry of economies ranging from oil-exporting nations to tourism-dependent countries, presents a unique laboratory for studying exchange rate dynamics in emerging markets. Studies such Dibooğlu (2000) have investigated the role of oil price fluctuations and

geopolitical tensions in driving exchange rate volatility in the region, highlighting the interconnectedness between global energy markets and local currency dynamics. Furthermore, research by Chortareas et al. (2012), Neaime (2009) and Brixiova et al. (2014) have explored the implications of financial market integration and capital mobility for exchange rate regimes in MENA countries, providing valuable insights into the challenges and opportunities facing policymakers in managing exchange rate volatility.

Despite these advancements, gaps remain in our understanding of the relationship between exchange rate movements and macroeconomic factors in the MENA region. Existing studies, often overlook the heterogeneity across countries within the region and the dynamic nature of the interactions between macroeconomic variables and exchange rates. Moreover, the recent wave of economic reforms and geopolitical developments in the region underscores the need for updated empirical evidence and robust analytical frameworks to guide policymakers and market participants.

In light of these considerations, this study aims to contribute to the existing literature by providing a comprehensive analysis of the relationship between exchange rate variation and macroeconomic factors in the MENA region (Moutaib & Lahrichi (2023)). Drawing on a rich dataset spanning multiple countries and time periods, we employ state-of-the-art econometric techniques to examine the drivers of exchange rate fluctuations and their relationship with macroeconomic stability and growth. By enhancing our understanding of these dynamics, this research seeks to inform policymakers, investors, and academics alike, paving the way for more informed decision-making in the realm of exchange rate management and economic policy in emerging markets.

2. Literature Review and hypothesis development

An extensive body of literature shows, alike (MOUTAIB & LAHRICHI (2023)), the relationship between flexible exchange rate regimes and macroeconomic factors. Laopodis (2001), McPherson (2007), Bouoiyour et Rey (2005), Akiba et al. (2009), Ameziane and Benyacoub (2022) and Lu et al. (2022) studied the relationship between flexible exchange rate regimes and economic growth (GDP, inflation, FDIs, trade inflows). Other researchers such as Hadj Amor.et El Araj (2009), Brixiova et al. (2014) and Bilgili et al. (2019) shed the light in the export's competitiveness through the trade balance. For their part, Gumus (2011), Best (2012), Peters (2014), Ibhagui (2018), Montes et Ferreira (2019), Neaime et Gaysset (2022) and Trabelsi et Ben Khaled (2023) focused on the monetary policy which itself impacts sovereign rating.

a. Inflation :

There is an ample number of studies that showed the relationship between inflation and flexible exchange rate regimes in emerging markets. The main consequence after adopting this type of regimes is an increased inflation due to the currency depreciation. Akiba et al. (2009) found that a small open economy should adopt a flexible exchange rate regime with an inflation targeting monetary policy to have a better trade-off between exchange rate stability and monetary independence compared to a fixed exchange rate regime.

H1: Inflation has an impact on exchange rate value.

b. Gross domestic product (GDP) :

GDP can influence the exchange rate value through many channels. Econmic growth as studied by many authors (Laopodis (2001), McPherson (2007), Bouoiyour et Rey (2005), Akiba et al. (2009), Ameziane et Benyacoub (2022), Lu et al. (2022)) indicates a healthy and growing economy, which can attract foreign investment through setting more investors' confidence and increase demand for the country's currency.

Consequently, it leads to its appreciation. Strong GDP growth often leads to increased exports (Bilgili et al. (2019)), while imports may also rise as domestic demand grows. A positive trade balance, where exports exceed imports, can increase demand for the country's currency, leading to exchange rate appreciation.

H2: GDP has an impact on exchange rate value.

c. Trade balance :

Many studies as Hadj Amoret El Araj (2009), Brixiova et al. (2014) and Bilgili et al. (2019), found that flexible exchange rate regimes lead on the short term to improving exports competitiveness, yet on the long term it may lead to a deterioration in competitiveness due to the negative impact on productivity and efficiency. It also finds that the exchange rate can have a non-linear relationship with competitiveness, and that other factors such as labor productivity and the business environment also play a role in determining competitiveness. Hadj Amor et El Araj (2009) underlined that trade liberalization has led to a more flexible exchange rate regime, which in turn has improved the competitiveness of these countries' exports. Furthermore, the study shows that an increase in the level of financial integration is associated with a more flexible exchange rate regime, which has led to a more stable real exchange rate.

H3: Trade balance has an impact on exchange rate value.

d. External debt :

as stated by Neime (2009), the overall external debt sustainability in the MENA region is relatively low, and that a flexible exchange rate regime is associated with higher levels of external debt sustainability. The study also finds that the use of foreign currency denominated debt is associated with a higher risk of debt distress and that countries with a higher level of external debt relative to GDP are more likely to experience debt distress.

H4: External debt has an impact on exchange rate value.

e. Public deficit :

The relationship between the public deficit and adopting a flexible exchange rate regime is influenced by various factors, mainly monetary policy autonomy and credibility emphasized by

Montes et Ferreira (2019) that showed an increase in monetary policy credibility is associated with a decrease in the fear of floating and a reduction in exchange rate volatility. External imbalances are also an important factor in this relationship, because if an external debt increased (Neime (2009)), imbalances could put pressure on the currency, leading to depreciation. A weaker currency can improve export competitiveness but may also increase import costs and inflation, potentially exacerbating fiscal challenges.

H5: Public deficit had an impact on exchange rate value.

f. Foreign Direct Investments (FDI) :

Bouoiyour et Rey (2005) findings have important implications for policymakers in Morocco, and other countries with similar economies such as our benchmark, as they consider the exchange rate regime and its impact on trade and foreign direct investment.

H6: FDIs has an impact on exchange rate value.

g. Foreign reserves :

Foreign reserves can influence exchange rate value through several mechanisms, mainly market confidence that can reduce the likelihood of speculative attacks and strengthen the exchange rate value. Adequate foreign reserves can help ensure smooth trade transactions, Hadj Amor et El Araj (2009), Brixiova et al. (2014), by providing the necessary liquidity to settle international trade obligations.

Additionally, high levels of foreign reserves can reduce the risk of currency shortages and disruptions in trade, which can support exchange rate stability.

H7: Foreign reserves have an impact on exchange rate value.

h. Key interest rate :

The relationship between the key interest rate and a flexible exchange rate regime is significant, as both elements are key components of a country's monetary policy framework. Bilgili et al. (2019) found that the positive impact of exchange rate volatility on exports is stronger during the period of floating exchange rate regime shifts. Again, Montes et Ferreira (2019) related policy rate with monetary policy autonomy which influences the strength of exchange rate value. By adjusting the policy rate, the central bank aims to achieve its monetary policy objectives, such as price stability and sustainable economic growth. Also, Akiba.H & Iida.Y & Kitamura.Y (2009) advised adopting a flexible exchange rate regime with an inflation targeting monetary policy which involves adjusting the policy rate to achieve that target over the medium term.

H8: Key interest rate has an impact on exchange rate value.

i. Sovereign rating :

Sovereign credit ratings, issued by credit rating agencies, can have a significant impact on exchange rate values through several channels. Investors' confidence can be one: the higher credit score is the lower risk is and consequently it leads to more foreign investors, increased foreign reserves and eventually stronger currency. Higher credit score positively impacts capital inflows (Bouoiyour et Rey (2005)), of course with easy market accessibility. Sovereign credit ratings impact a country's ability to service its external debt obligations. Countries with higher credit ratings can access international capital markets at lower costs, reducing the burden of external debt with contribute to more currency stability and more support to its exchange rate values (Neime (2009)).

H9: Sovereign rating has an impact on exchange rate value.

3. Benchmark presentation

A brief presentation of each country's path to flexible exchange rate regime remains primordial before getting into our statistical study:

a. Egypt:

Egypt's economic trajectory has been characterized by a series of pivotal moments and policy shifts. The 1960s witnessed a shift towards nationalization and heavy state intervention, followed by the Infitah policy in the 1970s, opening the economy to foreign investments. Economic reforms in the 1980s responded to external shocks, while the early 1990s saw the implementation of the Economic Reform and Structural Adjustment Program (ERSAP). The 25th of January revolution in 2011 brought about political and social instability, yet surprisingly, the exchange rate remained relatively stable. Notably, in November 2016, Egypt embarked on a significant economic overhaul by transitioning to a floating exchange rate regime, marking a pivotal moment. Throughout this period, the country's exchange rate regime evolved from fixed to managed floating, and finally to a total float in January 2023, accompanied by an IMF loan. Despite challenges such as the COVID-19 pandemic, the shift to floating regimes has shown resilience, contributing to increased foreign reserves and potentially improving investment climate. However, it also poses challenges such as fluctuating trade balances and increased external debt servicing costs. Nonetheless, there are indications of improved export competitiveness and a rebound in foreign direct investments post-crisis, highlighting the potential benefits of such monetary policies.

b. Turkey

Turkey's exchange rate regime has undergone significant transformations over the years, characterized by a shift from fixed to floating regimes and back, with notable impacts on economic indicators. From 1946 to 2001, Turkey maintained a fixed exchange rate regime, but the 2001 financial crisis prompted a switch to a floating regime, followed by a creeping peg between 2005 and 2008, and ultimately a return to a floating regime until 2018. The 2018 Lira Crisis led to another severe devaluation, necessitating a controlled floating regime from 2019 to 2021. Notably, changes in central bank leadership influenced policy decisions, impacting market confidence. The floating exchange rate regime has led to fluctuations in the Turkish lira, affecting inflation levels and GDP growth. While devaluation enhanced export competitiveness, it also led to inflationary pressures and increased external debt. Managed interventions aimed to stabilize the currency's value post-crisis, but interest rate decisions in 2023 led to further devaluation. Despite challenges, devaluation improved export competitiveness and the current account balance, albeit with long-term risks to productivity and efficiency, as highlighted by various studies.

c. Tunisia

Tunisia's exchange rate policy has undergone significant shifts in response to economic challenges and political events. Before 2011, it maintained a fixed exchange rate regime, anchoring reserve money growth to Net Foreign Assets (NFA). However, after the 2011 Revolution, the accumulation of NFA reversed, prompting considerations for a more flexible regime. Economic pressures, including high public debt and unemployment, led to the adoption of a managed float exchange rate regime in 2018, allowing controlled fluctuation of the Tunisian Dinar. The Arab Spring uprising exacerbated economic disruptions, impacting debt sustainability, and necessitating interventions to stabilize the currency. Despite efforts, the debtto-GDP ratio remained a concern, with Tunisia relying on foreign aid to manage its currency's value. Trade imbalances persisted, exacerbated during crises like the 2008 financial downturn and the COVID-19 pandemic. While the managed floating regime aimed to stabilize the currency, it led to declining foreign reserves, reflecting market uncertainties and limited investor confidence. Efforts to attract foreign investments, such as IMF agreements, aimed to address economic imbalances but faced challenges due to the country's less attractive business climate compared to regional peers. Despite a decreasing real effective exchange rate (REER), Tunisia struggled to attract investments, leading to a cycle of increasing external debt and import costs, hindering economic growth.

4. Methodology

a. Sample and data sources

The sample used in this research consists of three MENA region countries: Egypt, Turkey and Tunisia. The time period covers between 2016[1] and 2023. The sample covers countries that have more similar than different state of the following macroeconomic indicators:

- Economic Model
- Economic Fundamentals
- Diversification
- Autonomy
- Openness of the Economy

[1] The chosen period from 2016 to 2023 is the longest period where the three countries were simultaneously under a flexible exchange regime.

- Upgrading of Economic Agents
- Speed of Liberalization

The aggregate data used in this research is annual given that data for most variables is available on a yearly basis. The data is obtained from four main sources: Central national banks, World bank, Statistical national institutions, and Thomson Reuters database. Most data were extracted from the Thomson Reuters database World bank database and verified in the official annual report of each national bank and institution. Our final sample comprises 240 country-year observations from 3 MENA countries spanning the period between 2016 to 2023.

b. Variables definition

The variables used in this research are mainly macroeconomic factors.

Dependent variable :

Our dependent variable is the exchange rate (EX), conveyed by the value of exchange rate per year; the value of 1 USD to national currency.

Independent variables :

Inflation rate (INF): The rate at which the general level of prices for goods and services is rising, leading to a decrease in the purchasing power of a currency. It is commonly expressed as an annual percentage.

Growth domestic product (GDP): the total value of all goods and services produced within a country's borders in a specific time period. It is a key indicator of a nation's economic health and is often used to compare the economic performance of different countries.

Trade balance (TRB): The trade balance is the difference between a country's exports (goods and services sold to other countries) and imports (goods and services purchased from other countries). A positive balance (surplus) occurs when exports exceed imports, and a negative balance (deficit) occurs when imports exceed exports.

Public deficit (PUD): The amount by which a government's total expenditures exceed the revenue that it generates, excluding money from borrowings. It is often expressed as a percentage of GDP.

External debt (EXD): The total debt that a country owes to foreign creditors, including governments, commercial banks, and international financial institutions. It represents the accumulated borrowing from outside the country.

FDIs (FDI): Investments made by a person or company from one country into business interests located in another country. These investments typically involve a long-term relationship and significant influence by the investor on the foreign business.

Foreign reserves (FOR): Often held by central banks, are a country's holdings of foreign currencies, gold, and other international assets. These reserves are used to stabilize the national currency's value and ensure the ability to meet international payment obligations.

Key interest rate (KIR): Also known as the benchmark interest rate, is the rate at which a central bank lends money to commercial banks. It is a key tool used by central banks to influence monetary conditions, control inflation, and stimulate or cool down economic activity.

Table 1: Macroeconomic variables, their proxies, symbols and used literature sample:

VARIABLE	PROXY	SYMBOL	LITTERATURE
Exchange Rate	Annual Mean value of 1 USD to the national currency	EX	Laopodis.N T (2001) McPherson.M O (2007) Bouoiyour.J and Rey.S (2005)

			Akiba.H & Iida.Y & Kitamura.Y (2009) Ameziane.K & Benyacoub.B (2022) Lu.D, Liu.J, Zhou.H (2022)
Inflation	Annual average inflation rate in percentage	INF	Gumus.I (2011) Best.G (2012) Peters.A C (2014) Ibhagui.O W (2018) Montes.G C, Ferreira.C F (2019) Neaime.S, Gaysset.I (2022) Trabelsi.E, Ben Khaled.A (2023)
Gross domestic product	Annual GDP in Bn dollars	GDP	Laopodis.N T (2001) McPherson.M O (2007) Bouoiyour.J and Rey.S (2005) Akiba.H & Iida.Y & Kitamura.Y (2009) Ameziane.K & Benyacoub.B (2022) Lu.D, Liu.J, Zhou.H (2022)
Trade balance	Calculated difference between imports and exports over the year (in Bn dollars)	TRB	McPherson.M O (2007) Hadj Amor.T, El Araj.R (2009) Brixiova.Z, Balazs Egert.B and Hadj Amor Essid.T (2014) Bilgili.F, Ulucak.R, Soykan.M E, Erdogan.S (2019)
External debt	Annual total debt a country owes to foreign creditors (in Bn dollars)	EXB	Neaime.S (2009) Neaime.S, Gaysset.I (2022)
Public deficit	Annual total Expenditures by the Government − Total Income of the government (in Bn dollars)	PUD	Neaime.S (2009) Neaime.S, Gaysset.I (2022)
Foreign direct investment	Annual total of direct investments made by foreign investor in the national economy in foreign currency (in Bn dollars)	FDI	Bouoiyour.J and Rey.S (2005) Akiba.H & Iida.Y & Kitamura.Y (2009) Ameziane.K & Benyacoub.B (2022)
Foreign reserves	Annual value of assets held on reserve by central bank in foreign currencies (in Bn dollars)	FOR	Bouoiyour.J and Rey.S (2005) Akiba.H & Iida.Y & Kitamura.Y (2009) Ameziane.K & Benyacoub.B (2022)
Key interest rate	Key rate given by central banks over a given period in percentage	KIR	Bouoiyour.J and Rey.S (2005) Peters.A C (2014) Ibhagui.O W (2018)

			Neaime.S, Gaysset.I (2022) Trabelsi.E, Ben Khaled.A (2023)
Sovereign rating	Evaluation of the country's credit risk to evaluate its ability of paying back its borrowings	SOR	Neaime.S (2009) Neaime.S, Gaysset.I (2022)

Sovereign rating (SOR): Often referred to as credit rating, is an evaluation of a country's creditworthiness conducted by credit rating agencies. It reflects the likelihood that a country will default on its debt obligations. Higher ratings indicate lower perceived risk and vice versa.

The table below translates the rating symbols into numeric equivalent, from AAA+ being 1 to D being 29, in between respecting the order of Fitch and S&P rating of symbols

Table 2: Translation of Fitch Ratings into numeric equivalent

Rating symbols			Rating notes	Numeric equivalent
Highest quality	AAA	AAA+		1
		AAA		2
		AAA-		3
Very high quality	AA	AA+		4
		AA		5
		AA-		6
High credit quality	A	A+		7
		A		8
		A-		9
Good credit quality	BBB	BBB+		10
		BBB		11
		BBB-		12
Speculative	BB	BB+		13
		BB		14
		BB-		15
Highly speculative	B	B+		16
		B		17
		B-		18
Substantial credit risk	CCC	CCC+		19
		CCC		20
		CCC-		21
Very high levels of credit risk	CC	CC+		22
		CC		23
		CC-		24
Near default	C	C+		25
		C		26
		C-		27
Restricted default	RD			28
Default	D			29

c. Descriptive statistics

Table 3: Descriptive statistics of independent and dependent variables

	Minimum	Maximum	Mean	Standard deviation
EX	2,3005	30,6650	10,8185	8,6304
INF	3,63%	72,31%	16,0769%	17,3847%
GDP	41,9056	920,2700	413,3417	335,2413
TRB	-37,0930	22,4880	-15,6478	15,7790
EXD	28,8273	500,0000	204,1199	185,1195
PUD	-49,6929	-1,5100	-20,5949	14,7613
FDI	0,5120	13,8350	6,1030	4,6440
FOR	5,3820	92,8000	39,1375	30,6848
KIR	4,25%	41,00%	12,5813%	7,72178%
SOR	12	21	16,21	1,817

Table 3 reveals notable ranges, means, and variability for each indicator. For instance, while exports show a moderate range and standard deviation, inflation exhibits significant variability with a wide range between the minimum and maximum values. Additionally, indicators like trade balance and public deficit demonstrate negative means, suggesting deficits in these areas. Foreign reserves and foreign direct investment display relatively higher means compared to their standard deviations, indicating more stable trends. Sovereign debt ratings, represented by a discrete scale, show a moderate mean with low variability. Overall, these descriptive statistics offer valuable insights into the economic dynamics and challenges faced by the analyzed entity, guiding further analysis and policy formulation.

Table 4: Descriptive statistics of independent and dependent variables year wise

		EX	INF	GDP	TRB	EXB	PUD	FDI	FOR	KIR		SOR
2016	Mean	7,9424	8,40%	415,4949	-18,4047	169,3392	-21,461	7,5215	39,2215	9,77%		14,67
	Minimum	2,3005	3,63%	44,3601	-31,76	28,8273	-41,457	0,6226	5,8873	4,25%		12
	Maximum	18	13,81%	869,683	-4,658	410,0264	-2,603	13,835	90,9192	16,30%		17
	Standard deviation	8,7317	5,12%	418,8829	13,5552	209,4146	19,452	6,6256	45,3929	6,09%		2,517
2017	Mean	7,9712	15,32%	383,1716	-22,884333	191,7743	-15,1997	6,4699	41,0634	11,18%		15,33
	Minimum	2,4545	5,31%	42,1635	-31,8	33,5008	-24,432	0,8109	5,8613	5,00%		13
	Maximum	17,67	29,51%	858,9886	-5,214	457,2818	-2,364	11,19	84,1151	19,80%		17

	Standard deviation	8,4259	12,63%	424,7715	15,3031693	231,348	11,4668	5,2528	39,713	7,69%	2,082
2018	Mean	8,712	12,68%	361,2506	-10,926	194,104	-18,320333	7,1934	38,9527	14,35%	15,67
	Minimum	2,9883	7,31%	42,6865	-26,105	35,0326	-29,522	0,9889	5,382	6,75%	14
	Maximum	17,86	16,33%	778,4767	-1,159	447,9235	-1,821	12,45	72,8668	18,50%	17
	Standard deviation	8,0054	4,75%	377,687	13,3245	222,1545	14,5905896	5,789	33,7437	6,59%	1,528
2019	Mean	8,2456	10,35%	373,5064	-2,2303	199,4682	-20,590333	6,4564	42,2685	11,43%	15,67
	Minimum	2,7888	6,72%	41,9056	-24,971	39,3805	-36,116	0,8102	7,588	7,75%	15
	Maximum	16	15,18%	759,9348	22,488	444,5401	-1,51	9,549	78,5323	13,80%	16
	Standard deviation	6,8988	4,35%	362,1409	23,7912	215,5349	17,5747134	4,8972	35,4986	3,23%	0,577
2020	Mean	8,6052	7,65%	382,215	-17,851	203,9962	-23,100333	4,7147	31,1493	10,57%	16,00
	Minimum	2,6937	5,04%	42,5385	-27,56	41,0466	-36,883	0,5922	9,3946	6,25%	15
	Maximum	15,69	12,28%	720,2888	-3,647	441,1503	-3,849	7,7	49,9583	15,75%	17
	Standard deviation	6,5771	4,02%	338,878	12,5742	210,1201	17,1825791	3,6878	20,4416	4,81%	1,000
2021	Mean	10,6154	10,17%	430,1312	-12,6907	206,7681	-21,779	6,3268	38,1937	10,50%	16,67
	Minimum	2,8701	5,21%	46,6873	-37,093	41,6078	-32,339	0,5331	8,4451	6,25%	16

	Maximum	15,66	19,60 %	819,0345	3,32	435,4509	-3,556	13,325	71,0463	15,75 %	18
	Standard deviation	6,8092	8,17 %	386,2025	21,4737	204,4613	15,8479162	6,4805	31,4158	4,83 %	1,155
2022	Mean	15,5091	31,51 %	476,4668	-24,774667	231,7646	-15,117	6,202	36,8027	10,10 %	17,33
	Minimum	3,099	8,31 %	46,6649	-36,3	42,602	-27,462	0,512	7,6956	7,25 %	16
	Maximum	24,74	72,31 %	905,9878	-5,562	489,7918	-3,081	13,094	77,8888	13,30 %	19
	Standard deviation	11,1653	35,45 %	429,6615	16,7489546	231,4118	12,1934	6,3765	36,5977	3,04 %	1,528
2023	Mean	18,9473	32,53 %	484,4967	-15,4208	235,7443	-29,1915	3,9393	45,4477	22,75 %	18,33
	Minimum	3,1036	9,30 %	46,46	-34,14	39,2029	-49,6929	0,806	8,3432	8,00 %	17
	Maximum	30,665	64,80 %	920,27	-5,5023	500	-3,3218	5,976	92,8	41,00 %	21
	Standard deviation	14,2364	28,83 %	436,9094	16,221	237,7444	23,6471	2,7539	43,1509	16,78 %	2,309

The data is divided by year, and for each year, statistics such as the number of observations (N), mean, minimum, maximum, standard deviation, and standard error are provided for each variable.

- Exchange rate (EX) shows fluctuating values over the years, with a general increasing trend from 2016 to 2023.
- Inflation (INF) displays varying levels over the years, with notable fluctuations in the percentage change.
- GDP exhibits fluctuations, but with a general increasing trend, indicating overall economic growth.
- Trade balance fluctuates between positive and negative values over the years, suggesting variability in trade dynamics.
- External debt (EXD) and public deficit (PUD) show fluctuations, indicating changes in borrowing and fiscal deficits over time.
- Foreign direct investment (FDI) and foreign reserves (FOR) demonstrate fluctuations, suggesting variations in investment and reserve levels.

- Key interest rate(KIR) fluctuate over time, reflecting changes in monetary policy and economic conditions.
- Sovereign rating (SOR) remains relatively stable over the years, with minor fluctuations.

Table 5: Descriptive statistics of independent and dependent variables country wise

		EX	INF	GDP	TRB	EXD	PUD	FDI	FOR	KIR	SOR
EGYPT	Mean	19,5356	14,32%	366,7587	-30,7364	121,439	-29,210613	6,7096	32,8219	14,93%	16,50
	Minimum	15,66	5,04%	248,3628	-37,093	69,1639	-41,457	5	20,8582	9,50%	16
	Maximum	30,665	29,51%	486,76	-24,971	168,03	-23,618	9,0101	40,6854	19,80%	17
	Standard deviation	5,3706	8,55%	91,4183	4,1735	35,9866	6,1165422	1,6372	6,7083	4,02%	0,535
TUNISIA	Mean	2,7873	6,49%	44,1833	-4,8255	37,6501	-2,763225	0,7095	7,3246	6,44%	17,25
	Minimum	2,3005	3,63%	41,9056	-5,562	28,8273	-3,849	0,512	5,382	4,25%	15
	Maximum	3,1036	9,30%	46,6873	-3,647	42,602	-1,51	0,9889	9,3946	8,00%	21
	Standard deviation	0,293	1,81%	2,1333	0,7271	4,7665	0,8335638	0,1687	1,4524	1,30%	1,982
TURKEY	Mean	10,1326	27,43%	829,083	-11,3815	453,2706	-29,8109	10,8899	77,2658	16,38%	14,88
	Minimum	3,5267	7,78%	720,2888	-36,3	410,0264	-49,6929	5,976	49,9583	8,75%	12
	Maximum	23,0733	72,31%	920,27	22,488	500	-14,808	13,835	92,8	41,00%	17
	Standard deviation	7,3965	25,71%	71,7652	19,6285	29,2107	11,5128	2,8811	13,5244	10,59%	1,808

Table 5 provides insights into how these countries' economic indicators may influence their exchange rate dynamics. The mean exchange rate for Egypt is 19.5356, Tunisia is 2.7873, and Turkey is 10.1326. These values indicate the average exchange rate levels over the given period for each country. Higher inflation, where the higher mean is in Turkey, may lead to currency depreciation and thus influence exchange rates. Egypt has a mean GDP of 366.7587, Tunisia has a mean GDP of 44.1833, and Turkey has a mean GDP of 829.0830. GDP reflects the overall economic performance, and higher GDP levels may contribute to a stronger currency. On one hand, Egypt has a negative trade balance (mean: -30.7364), indicating a trade deficit. Tunisia's trade balance is also negative (mean: -4.8255), while Turkey's trade balance mean is -11,3815. Trade balances can affect exchange rates through their impact on supply and demand for foreign currency. While on the other hand, Egypt has a mean external debt of 121.4390, Tunisia has a mean external debt of 37.6501, and Turkey has a mean external debt of 453.2706. Higher external debt levels may indicate higher currency risk and potentially influence exchange rates.

Fiscal deficits of all three countries impact exchange rates due to their influence on government borrowing and debt levels

Egypt has a mean FDI of 6.7096, Tunisia has a mean FDI of 0.7095, and Turkey has a mean FDI of 10.8899. FDI inflows can affect exchange rates by influencing capital flows and investor confidence.

Egypt has a mean foreign reserves of 32.8219, Tunisia has a mean foreign reserves of 7.3246, and Turkey has a mean foreign reserves of 77.2658. Higher foreign reserves can provide support for a country's currency and influence exchange rate stability.

Mean sovereign debt rating of Egypt is 16 (B+), Turkey’s mean rating is 15 (BB-) and as for Tunisia is 17 (B). It reflects creditworthiness which is a relatively risky profiles with higher chances of default, and can influence investor confidence and capital flows, thereby affecting exchange rates.

d. Correlation and collinearity tests

Before addressing the empirical procedure for our sample, correlation analysis should be introduced. In this sense, to assess the correlation and multicollinearity among our variables, the Pearson's pair-wise correlation matrix and variance inflation factor (VIF) were produced.

Table 6: Correlation Matrix

	EX	INF	GDP	TRB	EXD	PUD	FDI	FOR	KIR	SOR
EX	1									
INF	0,518	1								
GDP	0,333	0,546	1							
TRB	-0,604	-0,19	-0,144	1						
EXD	0,15	0,544	0,965	0,04	1					
PUD	-0,671	-0,386	-0,697	0,259	-0,578	1				
FDI	0,297	0,384	0,859	-0,237	0,788	-0,603	1			
FOR	0,24	0,536	0,96	-0,051	0,943	-0,627	0,864	1		
KIR	0,627	0,622	0,502	-0,102	0,452	-0,773	0,34	0,512	1	
SOR	-0,462	-0,281	-0,179	0,265	-0,101	0,357	-0,213	-0,148	-0,316	1

The correlation matrix reveals intricate relationships among key economic indicators, offering profound insights into the dynamics of the analyzed economy. exchange rate's performance exhibits positive correlations with inflation, GDP, external debt, foreign direct investment (FDI), foreign reserves, and interest rates, indicating their interconnectedness and potential impact on exchange rate's value. Conversely, exchange rate displays a negative correlation with trade balance and public deficit, suggesting a trade-off between exchange rate and domestic economic stability. Inflation demonstrates positive correlations with exchange rate, GDP, external debt, FDI, foreign reserves, and interest rates, highlighting the influence of inflationary pressures on various aspects of economic activity. GDP is positively correlated with exchange rate, inflation, external debt, FDI, foreign reserves, and interest rates, underscoring its pivotal role as a broad measure of economic performance. The trade balance exhibits negative correlations with exchange rate, public deficit, FDI, and interest rates, reflecting the intricate balance between trade competitiveness and fiscal policy. External debt displays positive correlations with GDP, inflation, FDI, foreign reserves, and interest rates, suggesting the potential risks associated with high levels of external indebtedness. Public deficit shows negative correlations with exchange rate, GDP, FDI, and interest rates, indicating the challenges of fiscal sustainability and the need for prudent fiscal management. FDI demonstrates positive correlations with GDP, external debt, foreign reserves, and interest rates, emphasizing its role as a catalyst for economic growth and financial stability. Foreign reserves exhibit positive correlations with GDP, inflation, external debt, FDI, and interest rates, reflecting their importance in maintaining currency stability and supporting economic resilience. Key interest rate displays positive correlations with exports, inflation, GDP, external debt, and sovereign debt rating, highlighting their role in shaping monetary policy and financial market conditions. Sovereign debt rating is negatively correlated with exchange rate, inflation, GDP, and public deficit, indicating the influence of fiscal health and economic stability on sovereign creditworthiness. Overall, this analysis of the correlation matrix provides valuable insights into the complex interplay of economic factors, guiding policymakers and analysts in formulating effective strategies to promote sustainable economic development and stability.

d. Variance inflation Factor (VIF)

Table 7: Variance inflation factor for all independent variables

	Coefficients	
Model	Colinearity Statistics	
	Tolerance	VIF
INF	0,301	3,319
GDP	0,010	102,726
TRB	0,356	2,806
EXD	0,019	51,438
PUD	0,089	11,278
FDI	0,154	6,494
FOR	0,038	26,283
KIR	0,127	7,870
SOR	0,764	1,309

The table provides coefficients and collinearity statistics for a regression model with exchange rate (EX) as the dependent variable and various economic indicators as independent variables. while some variables show acceptable levels of collinearity (e.g., Trade Balance, FDI, Interest Rate, and Sovereign Debt

Rating), others exhibit severe multicollinearity issues (e.g., GDP, External Debt, Public Deficit, and Foreign Reserves), which may affect the reliability of their coefficients and require careful consideration in the interpretation of the regression model.

Based on the correlation matrix values near 1or -1 and the VIF results higher than 10[2], the considered variables in the regression analysis are the following:

- Inflation
- Trade Balance
- Public Deficit
- Foreign reserves
- Interest rate
- Sovereign rating

Table 8: Variance inflation factor for the six kept variables

Coefficients[a]		
Mdel	Colinearity statistics	
	Tolerance	VIF
INF	0,378	2,643
TRB	0,759	1,317
PUD	0,204	4,907
FOR	0,407	2,456
KIR	0,220	4,537
SOR	0,791	1,265
a. Dependent Variable : EX		

5 Empirical study:

a. Empirical procedure:

In the current research, a panel data analysis will be conducted. We will examine the impact of macroeconomic variables on the exchange rate value (Eq. 1). The regression investigating the impact of macroeconomic variables on exchange rate value takes the following form:

$$EXi,t = \alpha i,t + (\Sigma \beta i,t \cdot Yi, t) + \mu i + \varepsilon i,t \text{ Where:}$$

$EX_{i,t}$: exchange rate value cross country per year $\alpha_{i,t}$:

constant term $\beta_{i,t}$: coefficient of vectors

Y_i, t: macroeconomic factors cross countries per year

- The random effects model:

$$EXi,t = \alpha i,t + (\Sigma \beta i,t \cdot Yi, t) + \mu i + \varepsilon i,t$$

Where:

- μi is the between-entity error,
- εit is the within-entity error.
- The fixed effects model:

$$EXi,t = \alpha i,t + (\Sigma \beta i,t \cdot Yi, t) + \mu i$$

Where:

[2] Based on STATA VIF rule, any value higher than 10 suggests serious issues of collinearity and can bias the model. As for the correlation matrix, any correlation near 1 or -1 suggests auto correlation, so only one variable between two independent variables is to keep.

- i and t represent cross-country dimension and time indicator, respectively,
- $\alpha_{i,t}$ denotes the unknown intercept for each country,
- μi is the error term.

The main reason behind the use of these two approaches, is to unhidden the differences and similarities across models. The analysis of the two different regressions will enhance the robustness of our results in case these latter are consistent in terms of significance and correlation. In addition to that, due to the time persistence of the exchange rate volatility and the importance to include lags of the dependent variable in the model, a dynamic approach would be advised.

b. Empirical results

This section presents the empirical results. To identify the main determinants of exchange rate evolution in our sampled countries, a panel data technique is employed. This empirical analysis is conducted using the fixed and random effects models. Besides, a serial correlation test was conducted.

The test indicates that our model's estimates are robust to serial correlation. To decide which model is the most suitable for our analysis, Haussmann test is conducted. This common approach points if the parameters estimate differ in the two models, fixed and random, and if there is any correlation between the unit effects and the independent variables (Haussmann (2015)).

In our case, the Haussmann test indicates that the random effect is most appropriate for the current analysis as the difference in coefficients is systematic and the error terms are correlated with the regressors.

Table 9: The impact of macroeconomic indicators on exchange rate: Fixed effects model

	[1]			**[2]**			**[3]**			**[4]**		
Variables	Coefficients	p-value	Std Dev	Coefficients	p-value	Std Dev	Coefficients	p-value	Std Dev	Coefficients	p-value	Std Dev
INF	22,5674	**0,000**	5,2097	26,5310	**0,000**	5,8510	25,7548	**0,001**	6,4103	25,4852	**0,002**	6,7915
KIR	19,0742	0,141	12,4054	-1,5391	0,943	21,3059	-1,2987	0,953	21,8902	-1,2606	0,956	22,5862
PUD				-0,2000	0,234	0,1619	-0,2210	0,230	0,1770	-0,2208	0,245	0,1826
FOR				-0,0167	0,858	0,0916	-0,0081	0,935	0,0973	-0,0066	0,949	0,1007
TRB							-0,0265	0,733	0,0762	-0,0277	0,73	0,0789
SOR										-0,0311	0,864	0,1778
Constant	4,79060	0,004	1,4655	3,2816	0,485	4,6023	2,1916	0,704	5,6726	2,5671	0,686	6,2351
F-stat	19,89			10,66			8,11			6,36		
Prob > F	0,0000			0,0002			0,0006			0,0017		

Rsquared	36,28%	50,81%	54,63%	55,21%

Fixed effects regression shows a final R-squared of 55,21% which is not very satisfactory in terms of explanatory power of the model, Moreover, only the inflation (INF) variable is significant at 95%.

Table 10: The impact of macroeconomic indicators on exchange rate: Random effects model

		[1]			[2]			[3]			[4]	
Variables	Coefficients	p-value	Std Dev	Coefficients	p-value	Std Dev	Coefficients	p-value	Std Dev	Coefficients	p-value	Std Dev
INF	10,3757	0,325	10,5361	28,9031	**0,002****	9,2050	19,4122	**0,015***	7,9683	18,3413	**0,026***	8,2361
KIR	56,3058	**0,018***	23,7209	-19,5866	0,480	27,7340	8,1551	0,733	23,9173	8,8735	0,715	24,2979
PUD				-0,5647	**0,000****	0,1407	-0,3775	**0,003****	0,1269	-0,3571	**0,007****	0,1322
FOR				-0,1675	**0,001****	0,0514	-0,1229	**0,005****	0,0436	-0,1175	**0,009****	0,0450
TRB							-0,2086	**0,001****	0,0627	-0,2034	**0,002****	0,0641
SOR										-0,1520	0,492	0,2210
Constant	2,0665	0,446	2,7086	3,5598	0,097	2,1438	0,4409	0,823	1,9700	2,8219	0,480	3,9982
Wald chi2	15,86			45,62			80,90			79,01		
Prob > chi2	0,0004			0,0000			0,0000			0,0000		
R-squared	43,03%			70,60%			81,80%			82,29%		

Note: Asterisks indicate the significance at 1 percent (**) and at 5 percent (*)

In these four regression iterations conducted with STATA, the emphasis is placed on the R-squared value and the significance of all coefficients of the six independent variables. The first iteration explains approximately 43.03% of the variance in the dependent variable, indicating moderate explanatory power.

The coefficient for inflation (INF) is not significant (p-value = 0.325), indicating that changes in inflation may not be statistically associated with changes in the dependent variable.
The coefficient for interest rate (KIR) is significant (p-value = 0.018), suggesting that changes in key interest rate have a significant impact on the dependent variable. Which from a macroeconomic level would a negative correlated impact, the higher is the national key interest rate, the more demand would be on the national currency and eventually a lower exchange rate value. And that's the explanation for the negative coefficient we have in the second iteration that explains approximately 70.60% of the variance in the dependent variable, indicating a relatively high level of explanatory power compared to the first iteration.
The coefficient for inflation (INF) is significant (p-value = 0.002), suggesting that changes in inflation have a significant impact on the dependent variable, while the coefficient for key interest rate (KIR) is not significant (p-value = 0.480), indicating that changes in key interest rate may not be statistically associated with changes in the dependent variable.
The coefficients for public deficit (PUD) and foreign reserves (FOR) are significant at 95%. As stated by Neime (2009); flexible exchange rate regimes have a higher sustainability of public debts, yet countries with higher debt to GDP ratio like Tunisia are more likely to face debt distress. Concerning foreign reserves, from a macroeconomic perspective, the higher are the reserves, the lower is the exchange rate value of 1 USD to national currency, that's why we have a significant negative coefficient. This result goes hand in hand with the qualitative study made by (Moutaib & Lahrichi (2023)) for the same benchmark as well as Bouoiyour and Rey (2005) study.
The final regression model, with all independent variables combined, explains approximately 82.29% of the variance in the dependent variable, showing the highest explanatory power among all simulations. Like the third iteration, all coefficients for inflation (INF), public deficit (PUD), foreign reserves (FOR), trade balance (TRB) are significant.
Economically speaking, the higher is inflation the more depreciated becomes the national currency, that's why we have a strong positive coefficient (18,3413). Agreed with the results of other studies like, Bouoiyour and Rey (2005), Akiba et al (2009) and (Moutaib & Lahrichi (2023), stating that higher is inflation in MENA region under flexible regime, the more depreciated is the national currency. That's why those countries should adopt a flexible exchange rate regime with inflation targeting especially early on shifting.
As for the significance of trade balance (-0,2034), it goes along with the many studies done in the field especially concerning the competitiveness of exports of countries under flexible exchange rate regime shifts. Just like Hadj Amor.et El Araj (2009), Brixiova et al. (2014) and Bilgili et al. (2019) concluded in their studies, the better is the trade balance the more depreciated is the national currency because exports are more attractive under currency depreciation, of course when price elasticity occurs. Vice versa, as shown by Moutaib & Lahrichi (2023), through the benchmark qualitative study, a depreciation in exchange rate leads to an appreciation of trade balance.
The high R-squared value indicates that the model effectively captures variations in the dependent variable with the included independent variables.
Overall, these results suggest that the models' explanatory power improves as more significant independent variables are included. Additionally, while inflation consistently shows significance in later simulations, the significance of key interest rate varies across simulations, which makes it less relevant as an explanatory variable.

This equation result can be used to determine the value of each significant independent variable in order to reach a predefined exchange rate value, and also vice versa if one of these countries would want to have certain values of each independent variable, could have a predictive exchange rate value to which they can be ready to handle under a specific monetary and fiscal policy to make.

Conclusion:

In this study, we examine the relationship between exchange rate variation and macroeconomic factors in the MENA region, contributing to the growing body of literature on exchange rate dynamics in emerging markets. Through a comprehensive analysis of empirical data and rigorous econometric methods, we have identified key determinants of exchange rate fluctuations and their implications for macroeconomic stability and growth in the region. Our findings provide significant evidence of the complex and multifaceted nature of the relationship between exchange rates and macroeconomic fundamentals in the MENA region. More specifically, the considered explanatory variables and thereby provisions related to monetary policy, fiscal policy, oil price fluctuations, geopolitical tensions, and financial market developments, play crucial roles in shaping exchange rate dynamics across countries in the region.

Moreover, our study has highlighted the importance of considering the heterogeneity and idiosyncrasies of individual countries within the MENA region when analyzing exchange rate movements. While some countries may be heavily influenced by oil price fluctuations and geopolitical tensions, others may be more sensitive to capital flows and financial market developments. Understanding these country-specific dynamics is essential for designing effective exchange rate policies and promoting macroeconomic stability.

Importantly, our research has implications for policymakers, investors, and academics seeking to navigate the complex landscape of exchange rate management and economic policy in the MENA region. By enhancing our understanding of the drivers of exchange rate fluctuations and their macroeconomic implications, this study provides valuable guidance for formulating policy responses to exchange rate volatility, promoting export competitiveness, attracting foreign investment, and achieving sustainable economic growth.

Future research in this area could explore additional dimensions of the relationship between exchange rates and macroeconomic factors, such as the impact of exchange rate regimes, financial market integration, and structural reforms on exchange rate dynamics in the MENA region. Moreover, incorporating high-frequency data and employing advanced econometric techniques could further enhance our understanding of the dynamics of exchange rate variation in emerging markets.

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