The Impact of Exchange Rate Volatility on Foreign Direct Investment Inflows the Case of Egypt

By

Dr. Salwa Mohamed Abdelaziz
Associate Professor of Economics, Faculty of Economics and Political Sciences, Cairo University
salwa_abdelaziz@feps.edu.eg

Dr. Nagwa Samak
Professor of Economics, Faculty of Economics and Political Sciences, Cairo University
nagwasamak@feps.edu.eg

Dr. Mamdouh Abdelmoula Abdelsalam
Associate Professor of Economics, Faculty of commerce, Menoufia University
amdouh.abdelmoula@commerce-monofia.edu.eg

Mayar Walid Sobhy
Researcher, Faculty of Economics and Political Sciences, Cairo University
mayarwalid97@gmail.com

Dr. Fawzia Ahmed
Associate Professor of Economics, Faculty of Economics and Political Sciences, Cairo University
fawzia.ahmed@feps.edu.eg

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The Impact of Exchange Rate Volatility on Foreign Direct Investment Inflows the Case of Egypt

Dr. Salwa Mohamed Abdelaziz; Dr. Nagwa Samak; Dr. Mamdouh Abdelmoula Abdelsalam; Mayar Walid Sobhy and Dr. Fawzia Ahmed

Abstract

This study investigates the impact of exchange rate volatility on Foreign Direct Investment (FDI) inflows in Egypt from (2002-2024), Exchange rate volatility is measured using the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, which captures the dynamic nature of exchange rate movements over time. To assess the impact of this volatility on FDI inflows, the study employs a Vector Autoregression (VAR) model, allowing for the examination of the interrelationships between multiple economic variables. The findings reveal that increased exchange rate volatility is associated with a significant reduction in FDI inflows, highlighting the risk-averse behavior of foreign investors in the face of currency instability. The research underscores the importance of maintaining stable macroeconomic policies and effective currency management to mitigate the adverse effects of volatility, thereby enhancing Egypt's attractiveness as a destination for foreign investment. This study contributes to the understanding of exchange rate dynamics and their implications for FDI in developing countries, providing valuable insights for policymakers.

Keywords: Exchange Rate Volatility - Foreign Direct Investment (FDI)- Trade Openness.

1. Introduction

Foreign Direct Investment (FDI) plays a pivotal role in the economic development of emerging markets by providing much-needed capital, technology transfer, and employment opportunities. For countries like Egypt, attracting FDI is crucial for fostering economic growth, enhancing productivity, and integrating into the global economy. However, the inflow of FDI is influenced by a myriad of factors, one of the most significant being the stability of the host country’s

currency. Exchange rate volatility, characterized by unpredictable fluctuations in the value of a currency, poses a substantial risk to foreign investors. It can erode profit margins, increase transaction costs, and create uncertainty about the future value of investments.

As Egypt is like many other developing nations, has experienced periods of significant exchange rate volatility, particularly in the wake of political and economic upheavals. These fluctuations in the exchange rate can deter foreign investors, who may seek more stable environments for their investments. Understanding the relationship between exchange rate volatility and FDI inflows is therefore crucial for policymakers aiming to create an attractive investment climate.

Significance of this study: as Egypt has experienced notable fluctuations in its exchange rate over the years, which can create uncertainty and risks for the domestic economy. Exchange rate volatility can negatively affect investor confidence and deter foreign investment, hindering economic growth and stability. By investigating the impact of exchange rate volatility, political instability, and foreign direct investment (FDI), this study can provide valuable insights into the extent to which exchange rate volatility influences FDI inflows in Egypt.

Objectives of the Study: The study aims to assess the impact of exchange rate volatility on FDI inflows in Egypt, considering both short-term and long-term effects. It aims to identify the channels through which exchange rate volatility influences FDI decisions, including its effects on investor confidence, profitability, and risk perception. Moreover, the study intends to investigate the role of external and internal shocks, such as financial crises, economic reforms, political instability, and global events, in shaping the relationship between exchange rate volatility and FDI in Egypt. By addressing these objectives, the study seeks to contribute to the existing body of knowledge on the determinants of FDI and the impact of exchange rate volatility, particularly in the context of emerging economies like Egypt.

So, the findings of this paper are expected to provide valuable insights into the ways in which exchange rate volatility affects FDI in Egypt. Moreover, by identifying the degree to which exchange rate instability deters foreign investment, the paper aims to offer policy recommendations that could help mitigate these effects, ultimately enhancing Egypt's attractiveness as a destination for foreign capital. This introduction sets the stage for a detailed exploration of the complex dynamics between exchange rate volatility and FDI, highlighting the importance of stable macroeconomic policies in fostering a conducive environment for foreign investment.

Research Question: This study seeks to answer the following main question:

- What is the impact of exchange rate volatility on Foreign Direct Investment (FDI) inflows in Egypt?

In addition to other sub-questions as:

- What are the main determinants of Foreign Direct Investment (FDI)?
- What are the factors that lead to the volatility of the currency?

Methodology: to answer the research question, the study will adopt a quantitative research design to analyze the relationship between exchange rate volatility and foreign direct investment (FDI) in Egypt using Johansen and Juselius's cointegration system approach, 1990 in the form of vector auto-regressive pattern (VAR) The model will include lagged values of FDI, exchange rate volatility, GDP, openness, and world oil price. The data for the study will be from (2002-2024) collected from reliable sources such as the Central Bank of Egypt, the World Bank, and other relevant economic databases. The main purpose of focusing on this specific period in the study is to examine the impact of exchange rate volatility on Foreign Direct Investment (FDI) in Egypt. By considering this period, we can assess the effects of different factors and events on FDI inflows and better understand the dynamics between exchange rate volatility and investment decisions.

Research Hypotheses: There is a negative impact of Exchange rate volatility on FDI inflows.

To answer research question and achieve research objectives, the study will divided to four parts between introduction and conclusion, conceptual and theoretical frame work, literature review, dynamics of Exchange Rate and FDI in Egypt During 2002 to 2024, Measuring the impact of Exchange Rate Volatility on Foreign Direct Investment Inflows in Egypt from 2002- 2024,conclusion and policy recommendations.

2. Conceptual and Theoretical Framework

This part of study establishes the conceptual and theoretical foundation for understanding the determinants of exchange rate volatility and foreign direct investment (FDI). A robust framework is essential for analyzing the complex interactions between these two economic phenomena and identifying the key factors that influence them. By dissecting both the theoretical underpinnings and empirical evidence, this chapter aims to provide a comprehensive overview of the forces shaping exchange rate movements and FDI flows.

2.1 Factors Influencing Exchange Rate Volatility

Exchange rate volatility is shaped by a broad range of economic, financial, and political factors that interact in complex ways. Macroeconomic variables such as inflation rates, interest rates, and current account balances are often cited as primary determinants of exchange rate movements. Bahmani-Oskooee and Hegerty (2007) emphasize that disparities in inflation rates between trading partners can lead to currency depreciation, thus increasing exchange rate volatility. When a country experiences inflation higher than that of its trading partners, its goods become more expensive, leading to reduced demand for its exports, which in turn pressures the currency to depreciate.

Interest rate differentials are another crucial factor, as highlighted by Chinn (2012). Differences in interest rates between countries can prompt capital flows, with investors moving their funds to economies offering higher returns, thus affecting exchange rates. This movement of capital is often accompanied by speculative activities that can further increase volatility. Additionally, current account imbalances, where a country imports more than it exports, can weaken a currency and lead to greater volatility as the country may struggle to attract sufficient capital inflows to finance the deficit.

Political factors also play a significant role in exchange rate volatility. Leblang and Bernhard (2006) argue that political instability, such as government changes, policy uncertainty, and social unrest, can undermine investor confidence and lead to rapid currency depreciation. This is particularly relevant in emerging markets like Egypt, where political events often have immediate and pronounced effects on currency markets. In such environments, even rumors or minor policy shifts can cause substantial fluctuations in exchange rates as investors react to perceived risks.

Furthermore, exchange rate volatility can be driven by external shocks such as changes in global commodity prices, geopolitical events, and shifts in investor sentiment in international financial markets. For example, a sudden increase in oil prices can negatively affect oil-importing countries by increasing their import bills, leading to currency depreciation and higher volatility (Reinhart & Rogoff, 2004). Similarly, global financial crises or changes in monetary policy in major economies, such as the United States, can trigger capital outflows from emerging markets, exacerbating exchange rate instability.

2.2 Factors Influencing Foreign Direct Investment

Foreign Direct Investment (FDI) is influenced by a variety of factors, both internal to the investing firm and external in the host country's environment. According to Dunning's (1980) eclectic paradigm, FDI decisions are driven by ownership, location, and internalization advantages. Ownership advantages refer to the proprietary assets and capabilities of firms, such as technological know-how, brand reputation, and management expertise, which provide them with a competitive edge in foreign markets. These advantages enable firms to overcome the costs and risks associated with operating in a foreign environment.

Location advantages, on the other hand, pertain to the host country's characteristics that make it an attractive destination for investment. These include economic factors such as market size, labor costs, and access to resources, as well as political and institutional factors like political stability, regulatory quality, and the rule of law (Globerman & Shapiro, 2003). For example, Egypt's large and growing consumer market, strategic geographic location, and access to trade routes make it an attractive destination for FDI, particularly in sectors such as manufacturing, logistics, and energy.

Internalization advantages explain why firms choose to engage in FDI rather than licensing or outsourcing production to local firms. Internalization allows firms to retain control over their proprietary assets and production processes, thereby reducing the risks associated with contractual agreements and potential loss of intellectual property. By establishing a direct presence in the host country, firms can better manage their operations, adapt to local market conditions, and capture a larger share of the value created by their investments.

In addition to these firm-specific factors, macroeconomic stability is a critical determinant of FDI inflows. Asiedu (2002) found that countries with stable macroeconomic environments, characterized by low inflation, sustainable fiscal policies, and consistent economic growth, are more likely to attract FDI. Investors seek environments where the risks of currency depreciation, inflation, and economic instability are minimized. This is particularly relevant in the context of Egypt, where macroeconomic reforms, including the liberalization of the exchange rate and fiscal consolidation, have been implemented to create a more stable and predictable investment climate.

Institutional quality is another important factor influencing FDI. The effectiveness of legal and regulatory frameworks, protection of property rights, and transparency in governance are critical in attracting foreign investment (North, 1990). High-quality institutions reduce transaction costs, minimize risks related to expropriation or arbitrary changes in policy, and ensure a level playing field for investors. Countries with strong institutions are better able to attract and retain FDI, as investors are more confident that their investments will be protected and that they will be able to repatriate profits.

3. Literature review

This part of the study delves into the intricate relationship between exchange rate volatility and FDI, exploring the diverse perspectives presented within the existing literature. As Scholars have engaged in a lively debate regarding the impact of exchange rate volatility on FDI, with findings encompassing a spectrum of outcomes. Some studies suggest a negative correlation, where increased volatility discourages foreign investment due to heightened uncertainty and potential for profit erosion. Conversely, other research indicates a positive

relationship, positing that currency depreciation in the host country can entice foreign firms by lowering production costs and enhancing export competitiveness. Additionally, a significant portion of the literature highlights a more nuanced, mixed relationship, where the effect of exchange rate volatility on FDI depends on various factors such as the investing firm's motivations, the target industry, and the economic conditions of both the home and host countries

3.1 review of studies that argue the negative relationship between exchange rate volatility and FDI.

The relationship between exchange rate volatility and foreign direct investment (FDI) is a complex and debated topic in economic literature, with studies presenting both positive and negative effects. Numerous studies have highlighted the negative impact of exchange rate volatility on FDI. For example, research on Nigeria by Udoh and Egwaikhide (2008) and Akinlo (2004) indicates that exchange rate volatility increases transaction costs, planning difficulties, and erodes investor confidence, thereby discouraging FDI. Similarly, Campa (1995) and Cushman (1985) found that higher volatility deters FDI due to increased uncertainty, a finding supported by Barrell et al. (2003) for US FDI in Europe and the UK. Servén (2003) used GARCH models to demonstrate the negative impact of exchange rate volatility on investment in developing countries, with financial development and trade openness as mitigating factors. Studies by Del Bo (2017) and Hanusch et al. (2018) across multiple countries confirmed the negative relationship between exchange rate volatility and FDI inflows.

Sector-specific impacts have also been noted, with Alfaro et al. (2009) showing negative effects in the manufacturing sector due to complex supply chains and high exposure to import-export risks. Mishkin (2009) noted that increased volatility deters foreign financial institutions from expanding due to heightened risks. From the home country perspective, Alfaro et al. (2017) found that increased volatility in developed economies leads to cautious outward FDI decisions by multinational corporations due to higher currency risks.

However, some studies suggest mitigating factors and present mixed results. Caporale et al. (2019) suggested that a well-developed financial system with robust institutions can mitigate the negative effects of exchange rate volatility by providing hedging instruments and risk management tools. Wei et al. (2020) indicated that political risk, alongside exchange rate volatility, hampers FDI inflows. However, Masih & Masih (2021) found that political stability might outweigh currency stability in attracting FDI, thus weakening the negative impact of volatility. Additionally, Aizenman et al. (2018) introduced the concept of "fear of floating" and argued that volatility might benefit FDI in resource-rich, trade-open economies. Karolyi (2020) discussed how investors' overreaction to negative events, like exchange rate fluctuations, can lead to disproportionate FDI withdrawals during high volatility periods.

In conclusion, while the majority of studies highlight a negative relationship between exchange rate volatility and FDI, due to increased uncertainty and risks, various factors such as financial system development, political stability, and specific sector characteristics can influence this relationship. The overall impact of exchange rate volatility on FDI is nuanced and dependent on the broader economic and institutional context of the host and home countries.

3.2 review of studies that argue for a positive relationship between exchange rate volatility and FDI:

A few studies have established a positive relationship between exchange rate volatility and FDI .as the relationship between exchange rate volatility and foreign direct investment (FDI) is undergoing a shift in perspective, challenging traditional views. While currency fluctuations were historically seen as a deterrent to FDI due to increased uncertainty, recent studies propose a more nuanced understanding. One potential opportunity arising from volatility is the "undervaluation effect," where a weakened host country currency makes foreign assets cheaper for investors, stimulating FDI inflows as investors seek bargains (Aggarwal, 2010). Additionally, exchange rate volatility might attract speculative investment, contributing to overall capital inflows (Behram & Pandit, 2003). Moreover, firms can utilize hedging strategies to manage currency exposure, making FDI more viable in volatile environments (UNCTAD, 2013).

However, empirical evidence on this topic remains mixed, with some studies supporting the traditional view while others find a positive or insignificant relationship. The effects likely depend on various factors, including industry-specific dynamics. Globerman and Storer (2009) found that the impact of exchange rate volatility on FDI varied across industries, influenced by factors such as trade openness and competition levels.

Studies focusing on developed economies provide further insights. Goldberg and Kolstad (1995) examined bilateral US FDI outflows to select countries and found that foreign firms increase FDI when exchange rate uncertainty aligns with export demand shocks in target markets. Similarly, Chowdhury and Wheeler (2008) used GARCH and VAR models to analyze FDI inflows in developed countries, revealing a positive and significant impact of exchange rate volatility on FDI in countries like Japan, Canada, and the US. This perspective is supported by Osinubi et al. (2009) in their study on Nigeria.

In conclusion, while there are differing perspectives, the complex nature of the relationship between exchange rate volatility and FDI requires ongoing exploration. While some studies suggest potential benefits of volatility for FDI, others emphasize its adverse effects. Further research is needed to understand the nuanced dynamics and implications for economic growth.

3.3 The studies that make a case for Mixed or inconclusive results between exchange rate volatility and FDI.

A study by Silvia et al. (2016) focusing on Latin America suggests that exchange rate volatility negatively influences FDI inflows in the region, indicating that uncertainties in currency values may deter investors. Conversely, Maroula and Khraiche (2013) find a nuanced pattern wherein exchange rate volatility positively affects FDI in economies with lower levels of financial development, but this impact diminishes in more financially developed countries. Similarly, Kozo and Kiyota (2004) emphasize the discouraging effect of high exchange rate volatility on FDI inflows, advocating for stable yet flexible exchange rate regimes to attract investment.

However, some studies highlight the potential mitigating factors or indirect effects of exchange rate dynamics on FDI. For example, Untying the Gordian Knot: The Multiple Links Between Exchange Rates and Foreign Direct Investment (Nigel, Pain., Desiree, van, Welsum, 2004) suggests that fixed exchange rate regimes may indirectly stimulate investment. Additionally, Sisira et al. (2016) emphasizes the importance of exchange rate stability and infrastructure development in attracting FDI to Sri Lanka, suggesting that a conducive environment can offset the negative impact of exchange rate volatility.

On the other hand, studies focusing on specific countries like Pakistan (Samran et al., 2013) and Sri Lanka (Sisira et al., 2016) reveal significant negative impacts of exchange rate volatility on FDI, highlighting the adverse effects of increased fluctuations in the exchange rate on foreign investment. These findings underscore the importance of economic stability, as reflected by exchange rate stability and inflation rates, in attracting FDI.

Overall, the relationship between exchange rate volatility and FDI is multifaceted, influenced by factors such as financial development, political stability, and infrastructure quality. While some studies suggest a negative impact of volatility on investment, others emphasize the potential for mitigating factors or indirect effects. Understanding these dynamics is crucial for policymakers seeking to create an attractive environment for foreign investment amid fluctuating exchange rates.

4. Dynamics of Exchange Rate and FDI in Egypt During 2002 to 2024.

Over the past two decades, Egypt has experienced significant economic transformations, including structural reforms, currency devaluations, and shifts in monetary policy. These changes have had profound impacts on the exchange rate, influencing both its level and volatility. Concurrently, Egypt has endeavored to attract foreign direct investment to boost economic growth, create jobs, and enhance technological and managerial expertise. FDI inflows have been influenced by a multitude of factors, including economic policies, political stability, and global economic conditions, Thus, analyzing the dynamics of exchange rates and FDI in Egypt provides valuable insights into the broader economic environment and informs strategies to foster a conducive investment climate.

4.1 Dynamics of Exchange Rate in Egypt During 2002 to 2024.

Over the past two decades, Egypt's exchange rate has undergone substantial fluctuations driven by a series of transformative events. The early 2000s marked a period of relative stability, where the Egyptian pound (EGP) was managed under a fixed or controlled exchange rate system. However, the Arab Spring of 2011 triggered a wave of political and economic instability that had a profound impact on the country's currency.

In the subsequent years, Egypt embarked on a series of economic reforms aimed at stabilizing the economy and securing international financial support. The landmark agreement with the International Monetary Fund (IMF) in 2016, which led to the devaluation of the EGP and a shift towards a more flexible exchange rate regime, was a pivotal moment in the country's economic history.

The COVID-19 pandemic introduced new challenges, impacting global markets and Egypt's economic stability. As Egypt navigates through these disruptions, the exchange rate continues to be a crucial barometer of its economic health.

The evolution of Egypt's exchange rate from 2002 to 2024, analyzing the factors that have influenced its fluctuations and assessing the broader implications for the country's economic stability and growth. By examining historical data, policy changes, and external influences, this study seeks to provide a comprehensive understanding of the forces shaping Egypt's currency and offer insights into future trends.

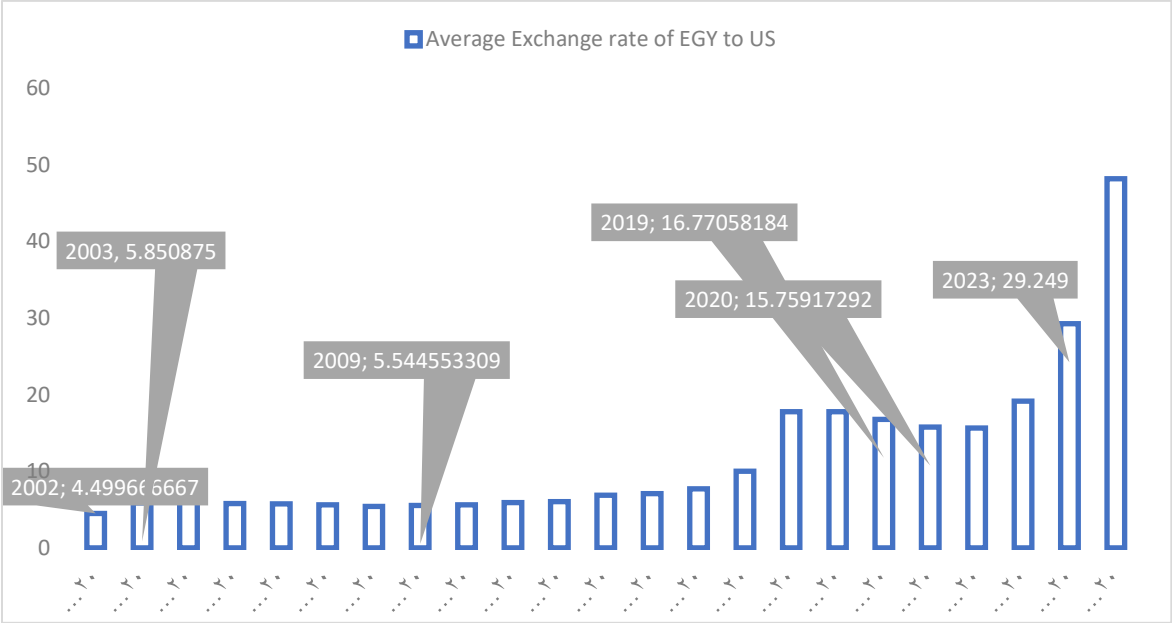

Figure 1: Exchange rate of Egyptian pound against US dollar During 2002 to 2024.
Source: World Bank Data Base, 2024

Furthermore, A key turning point came in 2011 with the 25th revolution. The ensuing political instability until 2013 significantly impacted the exchange rate, creating a volatile environment that deterred investment. This period highlights the sensitivity of currency value to political uncertainty.

In November 2016, Egypt transitioned to a more flexible exchange rate regime by floating the EGP. This move, part of a broader economic reform program, aimed to attract foreign investment and improve export competitiveness. However, the float also led to a sharp depreciation of the EGP against the US dollar and other currencies, initially raising inflation. While this initial volatility may have discouraged some investors, the float ultimately helped secure an IMF loan, aiding the reform program that included measures such as subsidy cuts, tax reforms, and increased foreign borrowing. **(CBE, 2023) Figure 1** illustrates the exchange rate fluctuations of the Egyptian pound (EGP).

4.2 Dynamics of FDI in Egypt from 2002 to 2024.

The period from 2002 to 2024 has been marked by several significant events that have influenced Egypt's economic landscape and FDI dynamics:

As mentioned in Figure 2: During the early 2000s, Egypt saw a steady increase in FDI inflows, driven by significant economic reforms aimed at liberalizing the economy and attracting foreign investments.

2002-2004: The period saw modest FDI inflows, with 0.76 billion USD in 2002, dropping to 0.30 billion USD in 2003, and rising to 1.59 billion USD in 2004. This growth was due to the initial phases of economic reforms.

2005-2007: FDI inflows surged dramatically, peaking at 9.35 billion USD in 2006. This was the result of aggressive privatization, deregulation, and efforts to improve the business environment.

2008-2010: The global financial crisis impacted FDI, with inflows dropping to 5.83 billion USD in 2008 and further to 2.92 billion USD in 2010.

The 2011 revolution brought about significant political and economic instability, leading to a sharp decline in FDI inflows.

2011: FDI inflows turned negative, with an outflow of 0.20 billion USD, highlighting the severe impact of the political upheaval on investor confidence.

2012-2013: FDI began to recover slowly, reaching 1.00 billion USD in 2012 and 1.45 billion USD in 2013, as the country started stabilizing.

Following the period of instability, the Egyptian government implemented various economic reforms to restore investor confidence and stabilize the economy.

2014-2016: FDI inflows showed a steady increase, rising from 1.51 billion USD in 2014 to 2.44 billion USD in 2016. The floating of the Egyptian pound in 2016 played a significant role in this recovery.

2017-2019: The upward trend continued, with FDI inflows reaching 2.98 billion USD in 2017 and peaking at 3.10 billion USD in 2018 before slightly dropping to 2.83 billion USD in 2019. This period saw diversification in sectors attracting FDI, including manufacturing, construction, and renewable energy.

The global economic environment has posed new challenges for FDI in Egypt, particularly due to the COVID-19 pandemic and the ongoing Ukraine-Russia war.

2020-2021: The pandemic caused a decline in FDI inflows, which dropped to 1.52 billion USD in 2020 and further to 1.21 billion USD in 2021. The economic uncertainties and lockdown measures affected investor decisions.

2022-2023: The recovery began in 2022 with FDI inflows increasing to 2.39 billion USD. However, the data for 2023 is not available. The Ukraine-Russia war influenced global economic conditions, affecting commodity prices and supply chains, which in turn impacted FDI.

The FDI trends in Egypt from 2002 to 2023 highlight the significant impact of economic reforms, political stability, and global economic conditions on foreign investment. The pre-revolution period saw substantial growth in FDI, which was disrupted by the 2011 revolution. Subsequent economic reforms helped restore investor confidence and attract FDI, although recent global challenges have posed new obstacles. Understanding these trends is crucial for formulating policies to enhance FDI inflows, contributing to sustainable economic growth in Egypt.

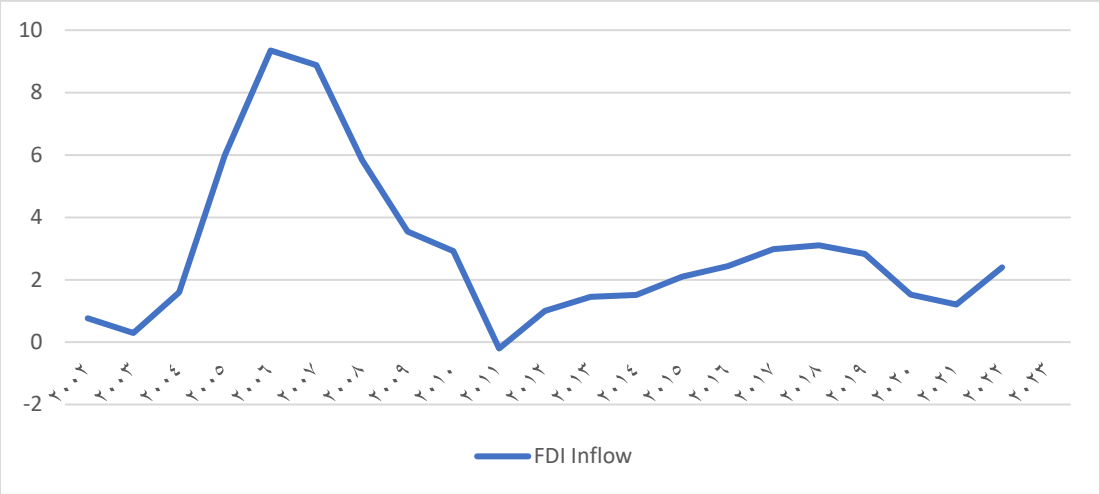

Figure 2: FDI Inflow From 2002 to 2024 in Egypt.

Source: World Bank Data Base, 2024.

5. Measuring the impact of Exchange Rate Volatility on Foreign Direct Investment Inflows in Egypt from 2002- 2024

5.1 Model Specification

The Study investigate the delicate correlation between Foreign Direct Investment (FDI) and exchange rate volatility. It will use a vector autoregressive (VAR) model to examine the relationship between FDI and the independent variables upon the available date of the period of 2002 and 2024. The VAR model will include lagged values of FDI, exchange rate volatility, GDP, openness, and world oil price. The general form of the econometric model can be expressed as follows:

$$\mathbf{FDI_T} = \propto_0 + \propto_1 \mathbf{YD_T} + \propto_2 \mathbf{Op_T} + \propto_3 \mathbf{SE_T} + \propto_4 \mathbf{IR_T} + \propto_5 \mathbf{IN_T} \propto_5 \mathbf{FED_T} + \mathbf{U_T}$$

where:

- FDI_T= Foreign direct investment at time t
- YD_T= Gross domestic product at time t
- Op_T = Level of openness at time t
- SE_T = Volatility of the exchange rate at time t
- IR_T = Real interest rate at Time t
- IN_T= inflation rate at time t

- FED_T= Federal Interest rate at time t

Table 1"Model Variables"

Variable	Description	Theoretical Rationale (Reference)	Exogeneity
Dependent Variable			
FDI Inflows (Millions of USD)	The amount of foreign direct investment entering Egypt.		Endogenous
Independent Variables			
GDP (Millions of USD)	The gross domestic product of Egypt.	Larger market size attracts FDI for higher profitability (Wei, 2000).	Endogenous
Openness (Trade/GDP Ratio)	The level of trade openness of the Egyptian economy.	More open economies facilitate FDI activities and access to a larger market (Bevan et al., 2014).	Endogenous
Deposit Rate (%)	The interest rate offered on deposits by banks.	Higher deposit rates can incentivize investment in Egyptian financial instruments (Ramphal, 2018).	Endogenous
Inflation Rate (%)	The percentage change in the general price level.	High inflation erodes future investment returns (Dunning, 1993).	Endogenous
Exchange Rate Volatility (GARCH Model)	The estimated volatility of the Egyptian exchange rate.	Fluctuations in exchange rate increase uncertainty and transaction costs, discouraging FDI (Agboba, 2017).	Endogenous
Global Influences (Exogenous Variable)			
Federal Interest Rate (%)	The interest rate set by the central bank of another major economy (e.g., US).	May influence investor risk perception and relative attractiveness of Egypt (Discussed in Text).	Exogenous

- **Descriptive Statistics**

  - **Data and Data Sources**

The study will be based entirely on secondary data that is obtained from the World Bank, the International Monetary Fund, the Central Bank of Egypt, and the Ministry of Finance. The study used time series data from 2002 to 2024.

When analyzing the impact of exchange rate volatility on Foreign Direct Investment (FDI) in Egypt, the period from 2002 to 2024 was chosen due to the availability of comprehensive and reliable data for this timeframe. This period encompasses significant economic and political events that have influenced Egypt's exchange rate dynamics, such as the 2003 devaluation of the Egyptian pound, the 2011 revolution, and subsequent economic reforms.

All the data were obtained from the World Bank Development Indicator, the International Monetary Fund, and CAPMAS. This study intends to examine the impact of Monetary Policy indeed on interest rates and Exchange rates on FDI inflows. To run the model and variables free from problems associated with time series data, the diagnostic test was carried out on the literature with vector auto-regressive pattern (VAR) and GARCH to measure the exchange rate volatility. SPSS software will be used to analyze the data. The focus of the study will be conducted in the Arab Republic of Egypt from 2002 to 2024. Examining an internal shock in the revolution’s periods and economic reforms, while the external shocks in the Covid-19 period, Financial Criss of 2007, and Russian Ukraine war.

  - **Sample Statistics**

This section presents the descriptive statistics of the data used for the econometric model investigating the factors affecting the exchange rate volatility in Egypt. Table 3, titled "Pre-Diagnostic Sample Statistics," summarizes key characteristics of eight variables potentially influencing the exchange rate over 22 years (likely from 2002 to 2024), based on the availability of 88 observations for each variable before running the model.

Table 2 "Pre-Diagnostic Sample statistics"

Variable	Obs	Mean	Std. Dev.	Min	Max
garch_volatility	88	0.0933	0.1342	0.0101	0.8583
Log fdi	88	3.4084	0.2652	2.889	3.8905
deposit Rate	88	0.8933	0.091	0.7709	1.1239
Inflation Rate	88	0.9502	0.2631	0.3161	1.5076
Degree of Openness	88	1.1065	0.1653	0.7246	1.2971
federal funds effective rate	88	-0.2174	0.653	-1.1549	0.7207
Differentiation of Log GDP	88	3.115557	.1174598	2.911738	3.320915

The dataset consists of 88 observations across eight variables related to exchange rate volatility and macroeconomic indicators, including foreign direct investment (FDI), interest rates, inflation, openness, and economic growth. Below is a detailed analysis of each variable's statistical properties presented in paragraph form:

The **GARCH Volatility** variable has a mean of 0.0933, indicating the typical level of volatility observed in the dataset. The standard deviation of 0.1342 reflects a moderate level of variability in exchange rate volatility, suggesting that fluctuations are not extreme but still present. The minimum and maximum values, ranging from 0.0101 to 0.8583, show a wide range of volatility levels during the observed period, highlighting periods of both relative stability and significant market fluctuations.

For **Log FDI**, the average value is 3.4084, suggesting a relatively stable level of foreign investment during the study period. The standard deviation is 0.2652, indicating low variability in FDI inflows and suggesting consistent investment patterns. The FDI values range from 2.889 to 3.8905, reflecting differences in investment levels across different periods. This range illustrates periods of both increased and decreased foreign investment, potentially in response to changes in economic conditions or government policies.

The **Deposit Rate** has a mean of 0.8933, representing the average interest rate offered by banks for deposits. A standard deviation of 0.091 indicates low variability, suggesting stable deposit rate conditions. The deposit rate ranges from 0.7709 to 1.1239, indicating some changes in interest rates over time, possibly due to monetary policy adjustments or shifts in economic conditions affecting savings behavior.

The **Inflation Rate** has a mean of 0.9502, indicating a moderate level of inflation in the observed period. The standard deviation is 0.2631, showing noticeable variation in inflation rates, suggesting periods of both stable and rising prices. The inflation rate ranges from 0.3161 to 1.5076, reflecting significant fluctuations in price levels over time, which could be influenced by factors such as changes in demand, supply shocks, or policy measures.

For **Degree of Openness**, the average value is 1.1065, suggesting the extent of economic integration with global markets. The standard deviation of 0.1653 indicates moderate variability, reflecting changes in trade policies or global economic conditions. Values range from 0.7246 to 1.2971, showing variations in openness levels across different periods, which could be affected by shifts in international trade dynamics or domestic policy changes.

The **Federal Funds Effective Rate** has a mean of -0.2174, indicating the average effective rate of the federal funds during the period. The high standard deviation of 0.653 reflects significant fluctuations in the effective federal funds rate, suggesting variable monetary policy conditions. The range, from -1.1549 to 0.7207, highlights the variability in interest rate conditions, influenced by economic cycles or policy responses to changing economic environments.

Lastly, the **Differentiation of Log GDP** shows an average value of 3.1156, indicating growth trends in the economy. The standard deviation of 0.1175 suggests limited variability, pointing to steady economic growth over the period. The differentiation of GDP ranges from 2.9117 to 3.3209, illustrating the extent of economic expansion and contraction over time, potentially driven by various factors, such as technological advancements, changes in consumer behavior, or external economic shocks.

The descriptive statistics provide a comprehensive overview of the dataset, highlighting the variability and range of key economic indicators. The analysis reveals moderate fluctuations in exchange rate volatility, consistent FDI inflows, and relatively stable interest rates. Inflation rates and federal funds rates exhibit more variability, reflecting broader economic changes and policy shifts. Understanding these statistical properties is essential for the subsequent econometric analysis, as they provide context for interpreting the relationships and interactions between the variables.

- **Stationarity Test**

In time series analysis, achieving stationarity is a critical step to ensure reliable statistical modeling and forecasting. Non-stationary data, which can exhibit trends or varying volatility over time, can lead to misleading results. To address these issues, we often apply transformations such as logarithms to stabilize variance and differencing to handle trends. In this analysis, we applied logarithmic transformations to some variables to manage variance in addition to differentiation of log GDP to deal with its inherent trend. We then used the Augmented Dickey-Fuller (ADF) test to check for stationarity in these transformed series.

The results from the ADF test indicate that most of the transformed series are stationary.

- For the log-transformed Foreign Direct Investment Inflow (logfdiinflow), the ADF statistic of -3.575 is significantly more negative than the 1% critical value of -2.372, and the p-value of 0.0003 supports the rejection of the null hypothesis of a unit root. This confirms that the log transformed FDI inflow series is stationary.
- The Deposit Rates (depositrates) have an ADF statistic of -1.984, which is less negative than the 1% critical value but more negative than the 5% critical value. The p-value of 0.0253 suggests that there is some evidence that the series is close to stationary, though additional confirmation may be beneficial.
- The Degree of Openness (degreeofopennes) has an ADF statistic of -2.199, which is slightly less negative than the 1% critical value but more negative than the 5% critical value. The p-value of 0.0153 implies that the series is likely stationary, though further tests could provide additional assurance.
- The Inflation Rate (inflationrate) shows an ADF statistic of -2.728, which is more negative than the 5% critical value, and the p-value of 0.0039 indicates strong evidence of stationarity.

- For the Federal Effective Rate (federalfeffectiverate), the ADF statistic of -2.327 is near the 5% critical value, with a p-value of 0.0112 suggesting that the series is likely stationary.
- The differenced GDP (d_gdp) has an exceptionally negative ADF statistic of -11.823, far surpassing the 1% critical value of -2.373. The p-value of 0.0000 confirms that the differenced GDP series is stationary.
- Lastly, GARCH Volatility (garch_volatility), used here to measure exchange rate volatility, shows an ADF statistic of -8.527, which is far more negative than the 1% critical value. The p-value of 0.0000 strongly indicates that this series is stationary.

Table 3 "ADF Test for the Model Variables"

Variable	ADF Statistic (Z(t))	1% Critical Value	5% Critical Value	10% Critical Value	p-value	Stationarity Status
Log-transformed FDI Inflow (logfdiinflow)	-3.575	-2.372	-1.663	-1.292	0.0003	Stationary
Deposit Rates (depositrates)	-1.984	-2.372	-1.663	-1.292	0.0253	Stationary
Degree of Openness (degreeofopennes)	-2.199	-2.372	-1.663	-1.292	0.0153	Stationary
Inflation Rate (inflationrate)	-2.728	-2.372	-1.663	-1.292	0.0039	Stationary
Federal Effective Rate (federalfeffectiverate)	-2.327	-2.372	-1.663	-1.292	0.0112	Stationary
Differences of Log GDP (d_gdp)	-11.823	-2.373	-1.664	-1.292	0	Stationary
GARCH Volatility (garch_volatility)	-8.527	-2.372	-1.663	-1.292	0	Stationary

In summary, the ADF test results show that most of the series, after appropriate transformations, are stationary. This is crucial for ensuring that subsequent time series analyses will be reliable. The few series close to stationarity suggest that further scrutiny might be warranted, but overall, the transformations applied have effectively stabilized the data.

- **Empirical Results**

- **GARCH Model for Exchange Rate Volatility**

The GARCH(1,1) model was used to measure the volatility of the exchange rate. This model is designed to capture the time-varying nature of volatility in financial time series, making it well-suited for analyzing exchange rate fluctuations.

The model optimization process involved switching between the BH and BFGS methods, ultimately converging to a final log-likelihood value of 130.83608 after 26 iterations. This high log-likelihood indicates a strong fit of the model to the data.

In the mean equation, the constant term has a coefficient of -0.0076587 with a standard error of 0.0020057. The z-statistic of -3.82 and the p-value of 0.000 confirm its statistical significance. This negative coefficient suggests a slight average decline in exchange rate returns over the period analyzed. For the variance equation, the ARCH(1) term has a coefficient of 2.77741 and a standard error of 0.3910041. The z-statistic of 7.10 and the p-value of 0.000 indicate that this term is highly significant. This large coefficient demonstrates that past squared returns have a substantial impact on current volatility, reflecting a high sensitivity of volatility to recent shocks in the exchange rate.

The GARCH(1) term shows a coefficient of 0.3836164 with a standard error of 0.0308083. The z-statistic of 12.45 and the p-value of 0.000 confirm its significance. This term captures the persistence of volatility, showing that past volatility has a strong influence on current volatility.

The constant term in the variance equation is 0.0000273 with a standard error of 0.0000818. The z-statistic of 0.33 and the p-value of 0.738 reveal that this term is not statistically significant. This suggests that the ARCH and GARCH terms are sufficient to explain the volatility of the exchange rate, and the constant term does not add significant explanatory power.

Table 4 "GARCH Model Results"

Parameter	Coefficient	Standard Error	z-Statistic	p-Value	95% Confidence Interval
Constant (Mean Eq.)	-0.0076587	0.0020057	-3.82	0	[-0.0115899, -0.003727]
ARCH(1) Term	2.77741	0.391004	17.1	0	[2.011057, 3.54376]
GARCH(1) Term	0.3836164	0.0308083	12.45	0	[0.3232333, 0.443999]
Constant (Variance Eq.)	0.0000273	0.0000818	0.33	0.738	[-0.000133, 0.000187]

Overall, the GARCH(1,1) model effectively measures exchange rate volatility, with significant contributions from both past returns and past volatility. The model captures the dynamic nature of volatility well, while the insignificant constant term in the variance equation suggests that the ARCH and GARCH components are sufficient for explaining the volatility behavior.

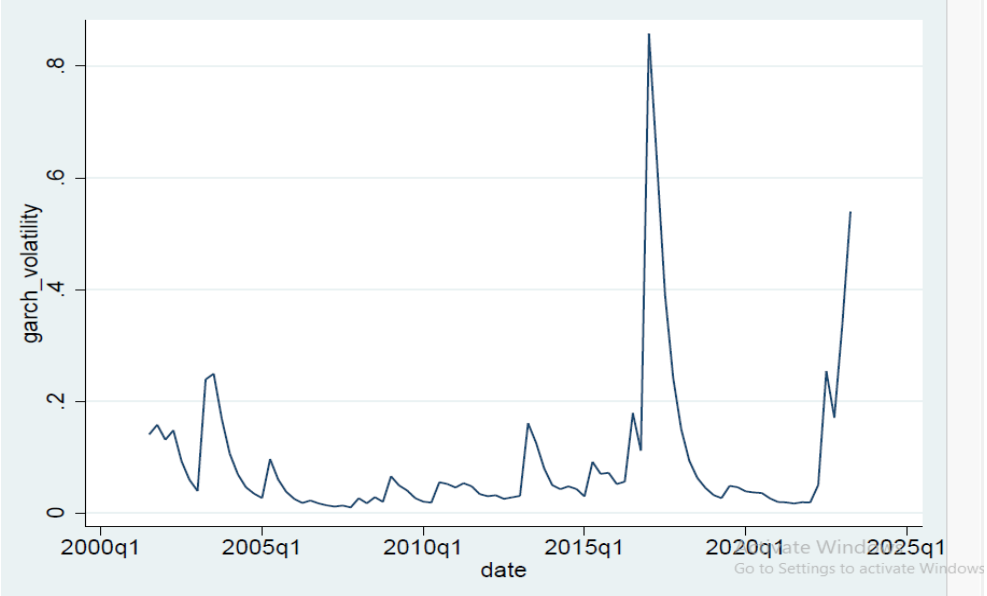

Figure 3 "Exchange rate Volatility Using GARCH"

Source: Researcher STATA output

- **VAR Model Results**

This section presents the analysis of a Vector Autoregression (VAR) model designed to understand the interrelationships between exchange rate volatility and several economic indicators over the period from Q1 2002 to Q2 2023. The model includes the following variables: GARCH volatility (`garch_volatility`), Foreign Direct Investment (FDI) inflow (`logfdi`), deposit rates (`depositrates`), inflation rate (`inflationrate`), degree of openness (`degreeofopenness`), and federal funds effective rate (`federalfundseffectiverate`), along with the differenced GDP (`d_gdp`). The analysis uses the VAR model with one lag to capture the temporal dynamics of these variables.

The VAR model's fit is assessed through several statistics:

Table 5" VAR Model Fit and Diagnostic Statistics"

Criteria	Value
Log Likelihood	1168.968
Akaike Information Criterion (AIC)	-25.5108
Final Prediction Error (FPE)	1.16E-21
Hannan-Quinn Information Criterion (HQIC)	-24.6839
Schwarz Bayesian Information Criterion (SBIC)	-23.456

These statistics suggest a good fit of the model, with the AIC, HQIC, and SBIC indicating strong model selection criteria.

Optimal Lag:

Table 6 "Selection-Order Criteria for Optimal Lag Length for VAR Model"

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	569.13				1.90E-16	-13.5212	-13.4275	-13.2881
1	1124.44	1110.6	64	0	1.30E-21	-25.3599	-24.5169	-23.2616 *
2	1205.84	162.81	64	0	9.20E-22	-25.7793	-24.187	-21.8159
3	1315.05	218.42	64	0	3.50E-22	-26.8687	-24.5271 *	-21.0402
4	1391.13	152.16*	64	0	3.2e-22*	-27.1598*	-24.0689	-19.4661

The table presents the selection-order criteria for determining the optimal lag length for a model, likely a Vector Autoregression (VAR) model. The criteria include Log-Likelihood (LL), Likelihood Ratio (LR), degrees of freedom (df), p-value (p), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC).

- Analysis

For Lag 1, significant improvements are observed in the model fit, evidenced by a substantial increase in LL and a highly significant LR test ($p = 0.000$). FPE, AIC, HQIC, and SBIC values all decrease, indicating better predictive accuracy and model fit.

While Lags 2, 3, and 4 continue to improve LL, FPE, AIC, and HQIC values, they come with increased model complexity as indicated by higher SBIC values compared to Lag 1.

Lag 1 is chosen as the optimal lag length for several reasons. It provides a significant improvement in model fit over the baseline, as evidenced by substantial increases in Log-Likelihood and highly significant Likelihood Ratio tests. The model's predictive accuracy, as indicated by the lowest Final Prediction Error (FPE) and Akaike Information Criterion (AIC) values, is also markedly better at Lag 1. Importantly, the Schwarz Bayesian Information Criterion (SBIC), which penalizes for model complexity more heavily than AIC and HQIC, is at its lowest value for Lag 1. This suggests that while additional lags (2, 3, and 4) might offer marginal improvements in fit and prediction, they do so at the cost of increased complexity.

Choosing Lag 1 balances the trade-off between model fit and complexity, making it a more parsimonious and efficient model. It ensures that the model remains interpretable and manageable, avoiding overfitting that can arise from unnecessarily adding more lags. Therefore, Lag 1 is the most appropriate choice for capturing the dynamics of the data while maintaining a balance between accuracy and simplicity.

- **Impulse responses Functions:**

The image shows a series of impulse response function (IRF) graphs from a Vector Autoregression (VAR) model, where the impulse variable appears to be the exchange rate volatility (as indicated by "garch_volatility"), and the response variables are various macroeconomic indicators.

1. Foreign Direct Investment (FDI): appears to have a small negative response to exchange rate volatility, which slightly decreases over time. This could indicate that higher exchange rate volatility discourages FDI, likely due to increased uncertainty and risk for investors.
2. Exchange Rate Volitality: This graph shows the response of exchange rate volatility to its own shock. It initially increases and then gradually decreases, indicating a temporary effect that dissipates over time.
3. Degree of Openness: The degree of openness (likely referring to trade openness) shows minimal response to exchange rate volatility, remaining close to zero. This suggests that exchange rate volatility does not significantly affect the degree of openness in the short term.
4. Deposit rates: The response of deposit rates to exchange rate volatility shows a slight positive effect, which diminishes over time. This suggests that an increase in exchange rate volatility might lead to a small increase in deposit rates, possibly due to perceived risk or uncertainty.
5. GDP: The response of GDP growth (d_gdp) to an exchange rate volatility shock seems to be negligible, as the IRF is close to zero across all time steps. This suggests that exchange rate volatility does not significantly impact GDP growth in the short run.

6. The response of the inflation rate to exchange rate volatility shows a small positive effect that diminishes over time. This could indicate that higher exchange rate volatility might lead to a slight increase in inflation, possibly due to pass-through effects from exchange ratendinges to prices.

Overall, the IRFs indicate that exchange rate volatility has varying impacts on different macroeconomic variables. The effects are generally small and dissipate over time, indicating that the shocks are temporary. The confidence intervals (shaded areas) also show the range of uncertainty around the estimates, with some effects being more significant than other.

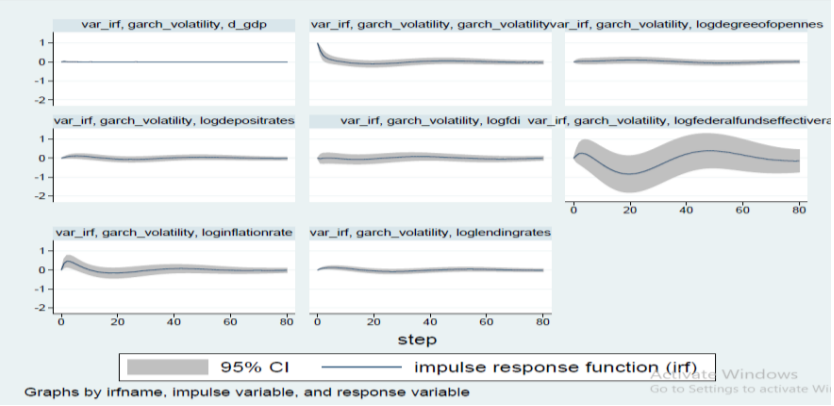

Figure 4"Impulse Response Function"

Source 1 Source: Researcher STATA output

Post Diagnostic:

- **Stability of VAR Model**

On the other hand, The stability of the VAR model is assessed through its eigenvalues. The eigenvalue stability condition is critical for ensuring that the VAR model is stable and its impulse response functions are meaningful. The eigenvalues and their moduli are as follows:

Table 7 "Eigenvalue Stability Condition"

Eigenvalue	Modulus
0.9580545 + 0.09989869i	0.963249
0.9580545 - 0.09989869i	0.963249
0.9388774 + 0.08384087i	0.942613
0.9388774 - 0.08384087i	0.942613
0.7890507	0.789051
0.4857852 + 0.05193355i	0.488553
0.4857852 - 0.05193355i	0.488553
-0.2588705	0.25887

All eigenvalues lie inside the unit circle, indicating that the VAR model satisfies the stability condition. This confirms that the model is stable and suitable for forecasting and impulse response analysis.

- **Multicollinearity**

The table below displays the Variance Inflation Factor (VIF) values for various variables in your regression model. VIF is used to assess the level of multicollinearity among predictor variables. Multicollinearity occurs when predictor variables are highly correlated with each other, which can lead to unreliable estimates of the regression coefficients.

Table 8" VIF and 1/VIF Values for Regression Variables"

Variable	VIF	1/VIF
Deposit Rates	2.91	0.344182
degree of Openness	2.53	0.394521
inflation Rates	2.18	0.459001
Garch volitality	1.84	0.543375
Federal Rates	1.84	0.543444
Differences of Log GDP	1.01	0.991609
Mean VIF	2.172857	

Multicollinearity occurs when predictor variables are highly correlated, leading to potential issues with the estimation of regression coefficients and their standard errors. In the table, VIF values are listed alongside their reciprocal values (1/VIF), which can help understand the proportion of variance in a variable not explained by the other variables in the model.

Examining the VIF values, we see that `deposits` has the highest VIF at 2.91, followed closely by ` `inflation`, `garch_volatility`, and `federal`, have lower VIFs, ranging from 1.84 to 2.53. The variable `d_gdp` has a particularly low VIF of 1.01, indicating minimal correlation with other predictors. Generally, a VIF value above 10 is considered problematic for multicollinearity. Since all your VIF values are significantly below this threshold, it suggests that multicollinearity is not a severe issue in your model.

The mean VIF for the model is 2.17, which reinforces the idea that, on average, multicollinearity is relatively low across your variables. This indicates that the relationships among your predictors are not overly redundant, and the model should provide reliable estimates of the regression coefficients. While the current VIF values suggest that multicollinearity is not a major concern, it is advisable to continue monitoring these values as you modify your model. Additionally, reviewing the correlation matrix among predictors could offer further insights into the relationships between variables. Although VIF is a helpful diagnostic, it is important to use it alongside other diagnostic tools to ensure the overall robustness and validity of your regression analysis.

6. Conclusion and Policy Recommendations

The study examined the impact of exchange rate volatility on Foreign Direct Investment (FDI) in Egypt over the period from 2002 to 2024. The analysis revealed that exchange rate volatility has a noticeable, albeit initially negative, impact on FDI inflows. The results indicate that heightened exchange rate uncertainty and risk lead to a significant initial decrease in FDI, as foreign investors are typically deterred by the unpredictability of returns in volatile environments.

However, the negative impact on FDI was found to be modest and diminished over time, suggesting that investors may adapt to volatile conditions or that other mitigating factors, such as government policies or economic reforms, may play a role in cushioning the long-term effects. This adaptation highlights the resilience of investors and the potential for economic adjustments that facilitate continued investment despite exchange rate fluctuations.

The analysis also revealed minimal immediate impacts of exchange rate volatility on GDP and inflation, indicating that short-term fluctuations in exchange rates do not significantly alter economic output or inflation rates immediately. Instead, these effects may manifest indirectly or with a delay. Meanwhile, interest rates, deposit showed a slight positive response to increased volatility, as financial institutions adjust to perceived instability by modifying rates to reflect higher risk levels. Similarly, the federal funds rate initially responded positively to volatility, indicating a temporary tightening of monetary policy, which could affect investment decisions, including FDI.

So, the study can list the following recommendations to mitigate the immediate effects of volatility and enhance the overall resilience of the Egyptian economy.

Short Run recommendations:

Enhance Investor Communication:

Action: Develop a targeted communication strategy to regularly update foreign investors on exchange rate policies and economic outlooks specific to Egypt.

Strategy: Establish regular briefings and updates through official channels, including economic reports, press releases, and investor webinars.

Facilitate Currency Hedging:

Action: Encourage the financial sector to offer more robust currency hedging products tailored to the needs of foreign investors operating in Egypt.

Strategy: Work with banks and financial institutions to develop and promote hedging instruments such as forward contracts, options, and swaps specifically designed for the Egyptian market.

Monitor and Adjust Monetary Policy:

Action: Implement targeted monetary policy measures to prevent excessive fluctuations in interest rates that might arise from exchange rate volatility.

Strategy: Conduct periodic reviews of monetary policy adjust interest rates incrementally to maintain stability and provide clear guidance on future policy directions.

Long-Run Recommendations:

Implement Structural Economic Reforms:

Action: Pursue reforms aimed at diversifying Egypt's economic base, such as promoting sectors less sensitive to exchange rate fluctuations and enhancing fiscal stability.

Strategy: Develop and implement a comprehensive reform plan focusing on sectors like technology, renewable energy, and manufacturing, and promote policies that support economic diversification.

Strengthen Institutional Frameworks:

Action: Enhance legal and regulatory frameworks to ensure better protection for foreign investors and reduce bureaucratic barriers.

Strategy: Streamline regulatory processes, improve legal protections for investors, and establish an investment ombudsman to address grievances and ensure fair treatment.

Develop a Long-Term Exchange Rate Stabilization Strategy:

Action: Formulate and implement a strategy to stabilize the exchange rate, including measures such as building foreign exchange reserves and adopting flexible yet managed exchange rate policies.

Strategy: Build up foreign exchange reserves through a mix of policy measures and international support and explore managed float systems or currency pegs to provide stability.

Promote Economic Resilience Through Diversification:

Action: Invest in infrastructure and support sectors that can withstand exchange rate volatility, such as technology and manufacturing.

Strategy: Implement large-scale infrastructure projects to improve logistics and connectivity and provide incentives for investment in technology-driven and export-oriented industries.

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أثر تقلبات سعر الصرف على الاستثمار الأجنبي المباشر

دراسة تطبيقيه على مصر

الملخص

تبحث هذه الدراسة تأثير تقلبات سعر الصرف على تدفقات الاستثمار الأجنبي المباشر في مصر خلال الفترة من (٢٠٠٢-٢٠٢٤)، ويتم قياس تقلب سعر الصرف باستخدام نموذج الانحدار الذاتي المشروط المتغير (GARCH)، الذي يجسد الطبيعة الديناميكية لسعر الصرف مع مرور الوقت. ولتقييم تأثير هذا التقلب على تدفقات الاستثمار الأجنبي المباشر، تستخدم الدراسة نموذج الانحدار الذاتي (VAR)، مما يسمح بفحص العلاقات المتبادلة بين المتغيرات الاقتصادية المتعددة، وكشفت نتائج الدراسة أن زيادة تقلب أسعار الصرف يرتبط بانخفاض كبير في تدفقات الاستثمار الأجنبي المباشر في مصر، والذى تم تفسيره بمحاولة المستثمرين الأجانب تجنب المخاطرة في مواجهة عدم استقرار العملة، وتؤكد الدراسة على أهمية الحفاظ على سياسات اقتصادية كلية مستقرة وإدارة فعالة للعملة، للتخفيف من الآثار السلبية للتقلبات، وذلك لتعزيز جاذبية مصر كوجهة للاستثمار الأجنبي، وبالتالي تسهم هذه الدراسة في فهم ديناميكيات سعر الصرف وآثارها على الاستثمار الأجنبي المباشر في البلدان النامية، مما يوفر رؤى لواضعي السياسات.

الكلمات الدالة: الاستثمار الأجنبي المباشر، تقلبات سعر الصرف، مصر، النمو الاقتصادي، تقلبات العملة، تحليل السلاسل الزمنية.