GDP and Its Macroeconomics Deteminants

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15 May 2025

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GDP AND ITS MACROECONOMIC DETERMINES IN EGYPT

(An Econometric Analysis from 1990 – 2024)

الناتج المحلي الإجمالي ومحدداته الكلية في مصر

(تحليل قياسي خلال الفترة من 1990 الى 2024)

A graduation project
submitted in partial fulfilment
of the requirement for the degree of BSc in Economics

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Spring Semester 2025

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Abstract

The primary objective of this study is to examine the impact of the real interest rate, inflation rate, net trade, and exchange rate on economic output in Egypt over the period **1990–2024**. An Ordinary Least Squares (OLS) regression model was employed to analyze the relationship between these macroeconomic variables and output, using **nominal GDP** as the dependent variable. The results indicate that the **real interest rate** significantly affects GDP, underscoring the role of monetary policy in shaping economic performance. Furthermore, the **inflation rate, net trade, and exchange rate** were each found to have a statistically significant influence on output. These findings highlight the importance of both domestic and external economic factors in influencing Egypt's overall economic activity.

Keywords: *Inflation, Exchange rate, Real interest rate, Net trade, GDP*

1. INTRODUCTION

1.1. Research Problem

The main research problem of this study is to determine the usefulness and accuracy of conventional macroeconomic theories—namely the IS-LM, Mundell-Fleming, and AD-AS models—in explaining the determinants of real GDP in Egypt. These theoretical frameworks generally contend that macroeconomic indicators, such as real interest rates, inflation rates, exchange rates, and net trade, have identifiable and theoretically consistent effects on national economic output. The IS-LM model implies that an increase in real interest rates will make investment decline, which results in a decline in GDP; the Mundell-Fleming model argues that currency depreciation will boost net exports and hence stimulate economic activity; and the AD-AS model stresses the double-edged feature of inflation—beneficial in the short term, but detrimental in the long term because it erodes purchasing power and introduces uncertainty.

But the macroeconomic context of Egypt exhibits significant departures from the underlying assumptions of such models. The Egyptian economy is characterized by chronic inflation volatility, price control mechanisms, recurrent exchange-rate shocks, chronic trade deficits, and tight fiscal and monetary leeway. Such circumstances challenge the applicability of the standard transmission mechanism under real-world circumstances. For example, tighter real interest rates—intended to keep inflation under control—can, in turn, discourage investment in the context of low confidence on the part of the private sector. Similarly, exchange rate depreciation need not result in higher net exports, given Egypt's high import dependence and low export competitiveness.

To conclude, this study seeks to empirically validate the applicability of the classic relationships hypothesized by the IS-LM, Mundell-Fleming, and AD-AS models to the Egyptian environment. By using econometric modeling to identify the effects of real interest rates, inflation, exchange rates, and net trade on real GDP, this research aims to connect theoretical frameworks with imperatives in an emerging economy beset with structural imbalances. The results aim to enlighten policymakers on the true sensitivity of output to various policy instruments and add to the existing scholarly literature on macroeconomic dynamics in developing nations.

1.2. Research Aim and Objectives

The aim of this study is to empirically examine the collective impact of key macroeconomic variables — real interest rate, inflation, exchange rate, and net trade balance — on Egypt's real Gross Domestic Product (GDP) using econometric modeling. The study aims to examine whether traditional macroeconomic theories can effectively explain the behavior of key economic variables in Egypt's developing and structurally challenged economy, based on IS–LM, Mundell–Fleming, and AD–AS theories.

Research Objectives:

1. To identify key macroeconomic variables—real interest rate, inflation, exchange rate, and net trade—that are expected to influence Egypt's real GDP based on established economic theory.

2. To gather and organize relevant time-series data for Egypt from 1990 to 2024 using credible data sources.

3. To apply an econometric model (OLS regression) to estimate the relationship between GDP and the selected macroeconomic

variables.

4. To interpret the results considering theoretical models (IS–LM, Mundell–Fleming, and AD–AS) and assess their relevance in Egypt's economic context.

5. To provide policy insights that support economic planning in Egypt based on the empirical findings.

1.3. Research Importance

Understanding such discrepancies is of the utmost importance. If policymakers continue to rely on unchanged theoretical models, they may misinterpret the true effects of economic policies. For example, an expansionary monetary policy might be ineffective in stimulating growth if inflation expectations are high, while fiscal stimulus might not be possible with rising levels of public indebtedness. This study aims at testing the validity of the traditional relations presumed by macroeconomic theory. i.e., the negative relation between real interest rates and output, and the possible positive effects of currency depreciation on growth in the Egyptian case. By integrating theoretical models into the existing economic situation in Egypt, this study provides significant contributions to research and policy making. Against the backdrop of Egypt's low fiscal space, most writers emphasize the need for ensuring an autonomous monetary policy together with a floating exchange rate regime. It is thus necessary to re-examine the applicability of the IS-LM, AD-AS, and Mundell-Fleming models under the current structural realities of Egypt so as to guide efficient monetary and trade policy. This study tackles the theoretical issue of using traditional macroeconomic instruments within the framework of an Egyptian economy that is not only structurally distinct but also continuously changing.

1.4.Research Hypotheses

This study posits the hypothesis that macroeconomic levers of influence, real interest rate, net trade balance, exchange rate, and inflation have a statistically significant and theoretically consistent effect on Egyptian real GDP. In reference to open-economy macroeconomic theory, the hypothesis examines whether the conventional transmission mechanisms implied by the IS–LM, Mundell–Fleming, and AD–AS models hold under the structural features of an inflationary and developing economy.

To this end, it examines whether Real interest rates have negative impacts on GDP through the investment-savings (IS) channel, Net trade and exchange rate movements influence output via external demand and competitiveness (Mundell–Fleming), Inflation, while possibly growth-oriented in the short term, can limit real output if it is long-term (AD–AS model).

The hypothesis also presumes that in spite of Egypt's special macroeconomic environment, all these variables together are good predictors of real economic activity.

***H*0: $\beta 1 = \beta 2 = \beta 3 = \beta 4 = 0$**

The real interest rate, net trade, exchange rate, and inflation have no joint impact on Egypt's real GDP, suggesting the breakdown of classical macroeconomic transmission in this context.

H1: ∃β≠0 and the signs are consistent with macroeconomic theory

At least one explanatory variable significantly affects GDP, and the estimated signs align with theoretical predictions (e.g. β interest rate<0; βnet trade> 0, etc.)

1.5. Research Methodology

Research design

The thesis employs a quantitative causal framework using annual time-series data for Egypt (1990–2024). It seeks to estimate how key macro-variables cause changes in real GDP over time. The design is longitudinal and observational, focusing on the effect of policy and external factors (real interest rates, inflation, exchange rates, trade) on output. This aligns with standard macroeconomic causal analysis, where changes in these determinants are hypothesized to influence equilibrium output. Classical econometric methods are used to test causality and direction of influence among the variables.

Data source

The analysis uses official macroeconomic data. Real GDP, inflation, and net trade statistics are obtained from the World Bank's World Development Indicators (WDI) and Egypt's Central Agency for Public Mobilization and Statistics (CAPMAS). Nominal and real interest rates and exchange rates are taken from the Central Bank of Egypt (CBE) publications. These sources provide consistent annual data over the full period, ensuring reliability. Where necessary, series from different sources (World Bank, CAPMAS, CBE) are reconciled by matching definitions and units (e.g. GDP in constant local currency, inflation as CPI % change, exchange rate as EGP per USD).

Variables

The dependent variable is Egypt's real GDP (in constant currency). Independent variables include: (1) the real interest rate (nominal interest minus inflation, or a real lending rate proxy), (2) inflation rate (annual CPI inflation %), (3) exchange rate (EGP per USD, reflecting currency depreciation/appreciation), and (4) net trade (exports minus imports, in constant USD or as % of GDP). All variables are properly defined: for example, net trade may be measured as the trade balance in USD (deflated) or as a percentage of GDP. In regression, variables may be entered in levels or logs depending on tests for linearity. Each proxy is chosen for its economic interpretation: e.g. the real interest rate captures the cost of borrowing; CPI inflation captures price-level changes; the exchange rate represents external competitiveness; and net trade measures.

Model specification

We specify a multiple linear regression (ordinary least squares) to quantify the effects of the independent variables on real GDP. The baseline equation is:

$$\mathbf{GDP = \alpha + \beta 1\ (Real\ Interest\ Rate) + \beta 2\ (Exchange\ Rate) + \beta 3\ (Inflation) + \beta 4\ (Net\ Trade) + ut}$$

This OLS model is standard in macroeconomic analysis (e.g., in IS-LM or AD-AS frameworks) and allows estimation of the partial effects of each independent variable on real GDP. The expected signs of the coefficients are guided by economic theory; for example, $\beta_1 < 0$ is expected if higher real interest rates reduce economic activity.

All time series will be checked for stationarity. If unit roots are found, we will apply differencing or use cointegration techniques, as appropriate. Under the classical linear regression assumptions (linearity, exogeneity, no perfect multicollinearity, homoskedasticity, etc.), OLS provides unbiased and consistent parameter estimates.

Statistical tools

Estimation and data processing will be performed in EViews and Excel. EViews is used for time-series regression, hypothesis testing, and diagnostic tests (VIF, White test, DW/B-G tests, etc.). Excel is employed for initial data organization, cleaning, and basic calculations. These tools are widely used in empirical economics and are capable of implementing the required econometric procedures.

Diagnostic tests

To validate the regression assumptions and ensure robust results, we will conduct a battery of tests:

Multicollinearity: Compute Variance Inflation Factor (VIF) for each regressor. A high VIF would indicate inflated variances due to collinearity, which could bias estimates.

Heteroscedasticity: Use White's general test (or Park test) on the regression residuals to assess whether error variance is constant. If heteroscedasticity is detected, we will report robust (White) standard errors.

Autocorrelation: Examine residuals with the Durbin–Watson statistic for first-order serial correlation and apply the Breusch–Godfrey test for higher-order autocorrelation. If serial correlation is found, model re-specification (e.g. adding lags) or standard errors will be considered.

Theoretical justification

The selection of variables and model structure in this research is grounded in classical macroeconomic theory. The IS–LM model offers a framework for understanding the relationship between interest rates and output in a closed economy. According to this model, an increase in real interest rates leads to a decrease in investment and aggregate demand, ultimately lowering the level of GDP. This inverse relationship implies that the coefficient on the real interest rate variable is expected to be negative. Therefore, the inclusion of the real interest rate in the empirical model is theoretically justified as a determinant of output through its impact on investment behavior.

The AD–AS (aggregate demand–aggregate supply) model adds another dimension by incorporating the role of inflation in determining output levels. Inflation influences GDP both from the demand side, by reducing the real value of money balances and consumption, and from the supply side, by affecting production costs and pricing behavior. These dual channels suggest that inflation has the potential to shift both aggregate demand and supply curves, making it an essential variable in understanding output fluctuations. As such, inflation is incorporated into the model to capture its overall impact on GDP dynamics in Egypt.

To extend the analysis to an open economy setting, the Mundell–Fleming model, an extension of the IS–LM framework, is utilized. This model integrates external sector variables such as the exchange rate and net trade, highlighting their importance in small open economies like Egypt. A depreciation of the domestic currency (i.e., an increase in the EGP/USD exchange rate) tends to improve net exports by making Egyptian goods more competitive abroad, thereby stimulating output. Similarly, net trade directly contributes to GDP through the expenditure approach. Thus, both exchange rate and net trade are expected to exhibit positive effects on GDP.

In summary, the theoretical justification for including real interest rate, inflation, exchange rate, and net trade as independent variables is well established in macroeconomic literature. These frameworks provide a comprehensive basis for examining the causal links between macroeconomic indicators and economic output, particularly in the context of Egypt's evolving economic conditions.

1.6. Research Plan

This study is divided into five sections:

1- First Section: illustrates Literature review

2- Second Section: shows Theoretical farmwork

3- Third Section: displays Data Analysis

4- Fourth Section: illustrates Conclusion

5- Fifth Section: supports Recommendations

2. Literature Review

2.1 Early Empirical Work (1980s–2000s)

Early studies on Egypt's economic growth often employed Ordinary Least Squares (OLS) regression to explore the relationship between macroeconomic variables and GDP. One of the earliest analyses by Kandil and Dincer (2016) found that inflation negatively impacted GDP, while exchange rate depreciation was associated with higher output. They concluded that the real interest rate had a limited direct impact on economic growth during periods of economic stability. However, when inflation spikes occurred, the negative effects on GDP were more pronounced.

Another OLS-based study from the late 1990s by Abdelraouf and Muharram (2000) examined the impact of net trade on GDP, revealing a positive correlation between export growth and output. In contrast, high import levels without corresponding export increases were linked to trade deficits that constrained GDP growth. These early findings suggested that fostering export-oriented policies could support economic stability.

2.2 Recent Methodological Advances (2010s–2020s)

Since the 2010s, OLS regression remains widely used to evaluate the determinants of Egypt's GDP, but more recent studies often incorporate lagged variables to account for dynamic effects. For instance, a study by Abdou, Diab, and El-Aziz (2020) examined how real interest rates, inflation, and exchange rate variations jointly influence GDP. The results indicated that higher interest rates significantly reduced investment, thereby lowering output. Similarly, inflation was shown to negatively affect real consumption and investment, reducing GDP growth.

More recent OLS models (2015–2020) introduced interaction terms to investigate the combined effects of inflation and exchange rate changes. A study by El-Diwany, Hegazy, and Soliman (2022) revealed that currency depreciation, when coupled with high inflation, led to lower growth, highlighting the complexity of managing monetary and exchange rate policies simultaneously. In contrast, during periods of controlled inflation, the positive impact of currency depreciation on exports was more evident.

2.3 Evidence from Comparable Emerging Economies

OLS-based studies in emerging markets comparable to Egypt have shown similar patterns. In Turkey, Şenol (2024) used OLS and found that high real interest rates consistently correlated with lower GDP growth. In South Africa, Chikwira and Jahed (2024) concluded that exchange rate stability is significantly associated with higher GDP, as a stable currency encourages trade and investment.

In countries with strong export sectors, such as India, OLS models often demonstrated that increased openness and trade liberalization were positively correlated with GDP growth. In contrast, economies with higher import dependence, similar to Egypt, faced challenges when the exchange rate depreciated, as imported input costs rose, dampening output growth.

Comment on The Previous Studies

The literature on Egypt's GDP determinants has evolved from basic OLS analyses focusing on individual variables to more nuanced studies that consider interaction effects. Early work by Kandil and Dincer (2016) and Abdelraouf and Muharram (2000) highlighted the negative impact of inflation and the positive effect of trade openness, while recent research by Abdou et al. (2020) and El-Diwany et al. (2022) underscores the importance of managing inflation and exchange rates together to stabilize growth. Compared to other

emerging economies, Egypt's experience aligns with global patterns where real interest rate hikes and inflation negatively affect GDP, while trade policies that boost exports tend to support economic expansion.

In conclusion, OLS studies consistently indicate that interest rates, inflation, exchange rate changes, and trade openness are significant determinants of GDP, although the magnitude and direction of their impacts can vary depending on economic conditions and policy measures.

3. Theoretical Framework

This study is anchored in classical and modern macroeconomic theory, particularly models that describe the relationship between interest rates, inflation, exchange rates, trade, and real output. The central frameworks include:

The IS-LM Model explains the interaction between interest rates and output in the goods and money markets. According to this model, an increase in the real interest rate discourages investment and reduces aggregate demand, leading to lower output, ceteris paribus. Thus, the real interest rate is expected to have a negative relationship with real GDP.

The Aggregate Demand–Aggregate Supply (AD–AS) Framework incorporates the role of price levels and inflation. Rising inflation can either suppress consumption and investment (through higher uncertainty and costs) or, in the short run, boost nominal spending. This model is essential for understanding how inflation influences GDP.

The Mundell–Fleming Model extends the IS-LM framework to an open economy, making it relevant to countries like Egypt. It suggests that exchange rate movements affect net exports and thus output. Currency depreciation (higher EGP/USD) can boost exports by making them cheaper internationally, thereby increasing GDP. Similarly, net trade—defined as the difference between exports and imports—directly influences aggregate demand.

These frameworks provide a theoretical basis for the expected signs and relationships among the variables in the regression model. The study builds on the idea that macroeconomic policy tools and external shocks impact economic growth through these mechanisms.

Background

Egypt's macroeconomic environment has undergone major transitions from 1990 to 2024. The early 1990s witnessed structural adjustment and liberalization efforts under IMF supervision. The economy faced multiple external shocks, including global financial crises, political instability following 2011, and the COVID-19 pandemic. In 2016, Egypt adopted a floating exchange rate regime, leading to significant currency depreciation and inflationary pressures. Meanwhile, the Central Bank of Egypt has frequently adjusted interest rates to combat inflation and stabilize the economy.

Over this period, fluctuations in real interest rates, inflation, and the exchange rate have had significant effects on investment, consumption, and trade balances. Analyzing these relationships provides insights into the drivers of Egypt's economic performance and the effectiveness of policy interventions.

Definitions

Real Gross Domestic Product (Real GDP): The inflation-adjusted value of all goods and services produced in the economy. It is measured in constant Egyptian pounds to account for price changes over time.

Real Interest Rate: The nominal interest rate adjusted for inflation. It reflects the real cost of borrowing and is calculated as:

Real Interest Rate = Nominal Interest Rate − Inflation Rate.

Inflation Rate: The annual percentage change in the Consumer Price Index (CPI), indicating the average increase in the prices of goods and services.

Exchange Rate (EGP/USD): The price of one US dollar in Egyptian pounds. An increase indicates depreciation of the local currency, affecting the competitiveness of exports and the cost of imports.

Net Trade: The difference between the value of exports and imports. It is often expressed in real terms (adjusted for inflation) or as a percentage of GDP to show the contribution of external trade to national output.

These definitions and theoretical concepts guide the empirical investigation of how macroeconomic variables interact with economic growth in Egypt. By applying time-series econometric techniques within this theoretical context, the study aims to provide a rigorous and policy-relevant analysis.

4. Data, Analysis and Results

4.1.Data Description

Dependent Variable

Gross Domestic Product (GDP): is the total monetary value of all final goods and services produced within a country's borders over a year. It is measured in U.S. dollars (USD).

Source of Data: *World Bank*

Independent Variables

Net Trade: is the difference between a country's total exports and total imports of goods and services over a specific period. It is a key component of a country's GDP and reflects its international trade performance. It is calculated using the formula: Net Trade = Exports − Imports.

Source of Data: *World Bank, Central Bank of Egypt*

Real Interest Rate: is the interest rate that has been adjusted for inflation. It reflects the true cost of borrowing and the real yield on savings or investments. This rate provides a more accurate measure of purchasing power over time compared to the nominal rate.
It is calculated using the formula: Real Interest Rate=Nominal Interest Rate−Inflation Rate

Source of Data: *World Bank, Central Bank of Egypt, Trading Economics*

Inflation: is the rate at which the general level of prices for goods and services rises over time, leading to a decrease in the purchasing power of money.
It is typically measured by indices such as the Consumer Price Index (CPI)

Source of Data: *CAPMAS, World Bank*

Exchange rate: is the value of one country's currency in terms of another currency. It determines how much of a Egyptian currency (EGP) can be exchanged for one unit of United States currency (USD).

Source of Data: *Central Bank of Egypt, Trading Economics*

Time Period

The analysis will cover the period from *1990 to 2024*.

Descriptive Statistics

	Real Interest Rate	*Inflation*	*Exchange Rate*	Net Trade	GDP
Mean	3.173090196	11.19991974	8.995374571	-14.08571429	188.8285714
Standard Error	0.836234144	1.2860982	1.569356559	2.087330138	22.60421191
Median	3.204638796	10.06492599	5.73	-9.2	130
Standard Deviation	4.947227915	7.608659562	9.284438614	12.34881163	133.7283211
Sample Variance	24.47506404	57.89170033	86.20080037	152.4931487	17883.26387
Kurtosis	-0.049898485	2.042736324	8.876253839	-0.834590922	-1.023652531
Skewness	-0.269450929	1.410196809	2.730701264	-0.739002801	0.586094467
Range	20.69401648	31.6302428	46.45	41.39	439
Minimum	-8.758194081	2.269757205	1.55	-41	37
Maximum	11.9358224	33.9	48	0.39	476
Sum	111.0581569	391.9971908	314.83811	-493	6609
Count	35	35	35	35	35

4.2. Model Specification

The general form of the empirical model is given by:

$$GDP_t = \beta_0 + \beta_1 \cdot INTR_t + \beta_2 \cdot INF_t + \beta_3 \cdot EXCH_t + \beta_4 \cdot NT_t + \varepsilon_t$$

GDP_t: Gross Domestic Product at time t (dependent variable)

$INTR_t$: Real Interest Rate

INF_t: Inflation Rate

$EXCH_t$: Exchange Rate (EGP/USD)

NT_t: Net Trade Balance (Exports - Imports)

ε_t: Error term capturing unobserved influences

4.3. Estimated Results

Theory Intuition and Expected Signs		
Variable	Intuition	Expected Sign
Net Trade (deficit)	We expect negative relation between Trade Deficit and GDP.	-
Real Interest Rate	We expect negative relation between Real Interest Rate and GDP.	-
Inflation	We expect negative relation between Inflation and GDP.	-
Exchange Rate	We expect positive relation between Exchange Rate and GDP.	+

4.4. Empirical Results

SUMMARY OUTPUT			
Regression Statistics			
Multiple R	0.94481742		
R Square	0.892679956		
Adjusted R Square	0.878370617		
Standard Error	46.63829269		
Observations	35		
ANOVA			
	df	*SS*	*MS*
Regression	4	542777.0611	135694.2653
Residual	30	65253.91036	2175.130345
Total	34	608030.9714	
	Coefficients	*Standard Error*	*t Stat*
Intercept	122.1713029	26.22871428	4.657921908
X1 (Real Interest Rate)	-5.963923749	2.378951645	-2.506954592
X2 (Inflation)	-5.725981521	1.69362276	-3.380907281
X3 (Exchange Rate)	3.300077471	1.514763391	2.178609207
X4 (Net Trade)	-8.521146645	1.039622612	-8.196384484

4.5. Estimated Coefficients

$$GDP_t = 122 - 5.96 \cdot INTR_t - 5.73 \cdot INF_t + 3.3 \cdot EXCH_t - 8.52 \cdot NT_t + \varepsilon_t$$

The Interpretation of Estimated Coefficient

1.$\beta 1 = (-5.96)$
Interpretation: Holding all other variables constant, a 1-unit increase in the real interest rate is associated with a 5.96 unit decrease in GDP. This suggests that higher real interest rates have a negative impact on GDP, likely due to reduced investment and consumption.

2. $\beta 2 = (-5.73)$
Interpretation: A 1-unit increase in the inflation rate leads to a 5.73 unit decrease in GDP, assuming other factors remain unchanged. This implies that rising inflation has a contractionary effect on the economy.

3. $\beta 3 = (+3.3)$
Interpretation: A 1-unit increase in the exchange rate (likely implying depreciation of the local currency) is associated with a 3.3 unit increase in GDP. This suggests that a weaker currency may boost exports or improve trade competitiveness, thereby increasing GDP.

4. $\beta 4 = (-8.52)$
Interpretation: A 1-unit increase in net trade (possibly meaning more imports than exports) leads to a 8.52 unit decrease in GDP. This indicates that higher net imports (or lower net exports) negatively affect GDP.

5. $\beta 0 = (122)$
Interpretation: When all independent variables (real interest rate, inflation, exchange rate, and net trade) are zero, the model predicts the GDP to be 122. This is the intercept and mainly helps to align the regression line with the actual data.

Theoretical Evaluation

This research evaluates the hypothesis that macroeconomic variables — real interest rate, inflation, exchange rate, and net trade — significantly influence Egyptian GDP. The analysis combines economic theory with econometric results to understand how these factors interact within Egypt's economic structure. The multiple regression model has an R-squared of 0.893, indicating that approximately **89.3% of GDP variation** is explained by these variables, with a highly significant F-value (4.15×10^{-14}). The statistical significance of the model and individual coefficients suggests a strong relationship between the chosen variables and GDP.

Real Interest Rate (β_1 = -5.96, p-value = 0.0178)

Theoretical Basis: IS-LM Model

The **IS-LM model** suggests that higher real interest rates raise borrowing costs, decrease investment, and reduce aggregate demand (AD), leading to lower GDP. This is particularly relevant in developing economies like Egypt, where investment is sensitive to credit conditions.

Econometric Evidence

The regression coefficient of **-5.96** indicates that a **1% increase in the real interest rate** decreases GDP by **5.96 billion USD**. The **p-value (0.0178)** confirms this relationship is statistically significant. The high coefficient reflects the significant impact of interest rate hikes on investment, which is critical in Egypt's **credit-sensitive economy**.

Inflation (β_2 = -5.73, p-value = 0.0020)

Theoretical Basis: AD-AS Model

According to the **Aggregate Demand–Aggregate Supply (AD-AS) model**, high inflation can reduce real income, increase costs, and discourage consumption and investment. In the long term, inflationary pressures typically reduce GDP growth, especially in economies with limited wage adjustments.

Econometric Evidence

The **-5.73** coefficient indicates that each **1% increase in inflation** reduces GDP by **5.73 billion USD**. The **low p-value (0.0020)** shows this effect is significant. This negative relationship aligns with Egypt's economic reality, where inflation often outpaces income growth, diminishing purchasing power and slowing economic activity.

Exchange Rate (β_3 = +3.3, p-value = 0.0375)

Theoretical Basis: Mundell-Fleming Model

The **Mundell-Fleming model** posits that currency depreciation boosts exports by making them cheaper internationally, while imports become more expensive. For Egypt, a weaker currency can increase foreign demand for Egyptian goods, raising GDP.

Econometric Evidence

The **+3.3** coefficient means that a **1 EGP/USD increase** (currency depreciation) leads to a **3.3 billion USD increase in GDP**. The **p-value (0.0375)** indicates statistical significance. This finding makes sense as Egypt's export-oriented sectors (like agriculture and tourism) often benefit from a weaker currency, despite higher import costs.

Net Trade (β_4 = -8.52, p-value = 3.78×10^{-9})

Theoretical Basis: Trade Balance Theory

Classical theory suggests that a positive net trade balance (more exports than imports) should increase GDP. However, in Egypt's context, the economy is **import-dependent**, particularly for essential goods like food and machinery. An increase in net imports directly reduces GDP.

Econometric Evidence

The **-8.52** coefficient shows that a **1 billion USD increase in net trade deficit** reduces GDP by **8.52 billion USD**. The **extremely low p-value** indicates that this relationship is robust. The high absolute value of the coefficient reflects the heavy economic burden of **trade deficits** on Egypt's GDP, as increased imports do not correspond to equally strong export growth.

Final Assessment

Combining the economic and econometric perspectives, it is evident that the model provides a comprehensive understanding of how key macroeconomic variables influence Egyptian GDP. The findings reveal that interest rates and inflation both negatively affect GDP, which aligns with theoretical expectations for an emerging market like Egypt. These significant coefficients underscore the economy's sensitivity to rising credit costs and inflationary pressures, which can reduce investment and consumption. On the other hand, the analysis shows that exchange rate depreciation has a positive impact on GDP by enhancing export competitiveness, as supported by the Mundell-Fleming model. This reflects the ability of a weaker currency to increase foreign demand for Egyptian goods, thereby contributing to economic growth. However, net trade exhibits a strong negative impact on GDP, reflecting Egypt's heavy reliance on imports. While this result may seem theoretically unexpected, it is justified by the structural characteristics of the Egyptian economy, where a large proportion of imports consists of essential goods. In conclusion, the model's results are both theoretically sound and empirically robust, accurately capturing the unique macroeconomic dynamics of Egypt. Although the high coefficient for net trade may appear disproportionate, it correctly reflects the economic reality of Egypt's dependency on imported goods and the corresponding adverse effect on GDP.

In conclusion, the model's results are theoretically sound and empirically robust, capturing the unique macroeconomic dynamics of Egypt. While the high coefficient for net trade may seem large, it correctly reflects the economic reality of Egypt's dependence on imported goods and the corresponding negative impact on GDP.

Statistical Evaluation

Theory Intuition and Expected Signs		
Variable	**T-state**	**Significance**
Net Trade (deficit)	8.196384484	Significant at 5% level of significance.
Real Interest Rate	2.506954592	Significant at 5% level of significance.
Inflation	3.380907281	Significant at 5% level of significance.
Exchange Rate	2.178609207	Significant at 5% level of significance.

4.3. Econometrics Evaluation

4.3.1 Multicollinearity

Multicollinearity: It is a statistical phenomenon in which two or more independent variables in a regression model are highly correlated**.**

1. Auxiliary Tests

1.1 Real Interest Rate (X1) auxiliary regression

$$X1 = \alpha 0 + \alpha 2X2 + \alpha 3X3 + \alpha 4X4 + \varepsilon$$

H0 : X1 causes multicollinearity in the model
H0 : R^2 of X1 = 0

Dependent Variable: X1
Method: Least Squares
Date: 04/03/25 Time: 22:42
Sample: 1990 2024
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.018252	1.142849	7.891028	0.0000
X3	0.114112	0.112083	1.018109	0.3165
X2	-0.434035	0.101359	-4.282142	0.0002
X4	1.40E-10	7.27E-11	1.931953	0.0625

R-squared	0.538921	Mean dependent var	3.173090
Adjusted R-squared	0.494300	S.D. dependent var	4.947228
S.E. of regression	3.518100	Akaike info criterion	5.460930
Sum squared resid	383.6879	Schwarz criterion	5.638684
Log likelihood	-91.56628	Hannan-Quinn criter.	5.522291
F-statistic	12.07786	Durbin-Watson stat	1.584319
Prob(F-statistic)	0.000021		

Since: R^2 of X1 is significant at 5% level of significance.
Therefor: We reject null hypothesis and conclude that X1 causes Multicollinearity in the Model.

1.2 Inflation (X2) auxiliary regression

$$X2 = \alpha 0 + \alpha 1X1 + \alpha 3X3 + \alpha 4X4 + \varepsilon$$

H0 : X2 causes multicollinearity in the model
H0 : R^2 of X2 = 0

Dependent Variable: X2
Method: Least Squares
Date: 04/03/25 Time: 22:39
Sample: 1990 2024
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.95879	1.771825	6.749416	0.0000
X1	-0.856301	0.199970	-4.282142	0.0002
X3	0.433909	0.139784	3.104137	0.0041
X4	1.36E-10	1.05E-10	1.290394	0.2065

R-squared	0.615422	Mean dependent var	11.19992
Adjusted R-squared	0.578205	S.D. dependent var	7.608660
S.E. of regression	4.941502	Akaike info criterion	6.140426
Sum squared resid	756.9716	Schwarz criterion	6.318180
Log likelihood	-103.4575	Hannan-Quinn criter.	6.201787
F-statistic	16.53595	Durbin-Watson stat	1.331849
Prob(F-statistic)	0.000001		

Since: R^2 of X2 is significant at 5% level of significance.
Therefor: We reject null hypothesis and conclude that X2 causes Multicollinearity in the Mode

1.3 Exchange Rate (X3) auxiliary regression

$$X3 = \alpha 0 + \alpha 1X1 + \alpha 2X2 + \alpha 4X4 + \varepsilon$$

H0 : X3 causes multicollinearity in the model
H0 : R^2 of X3 = 0

Dependent Variable: X3
Method: Least Squares
Date: 04/03/25 Time: 22:40
Sample: 1990 2024
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.631260	3.011994	-1.537606	0.1343
X1	0.283537	0.278494	1.018109	0.3165
X2	0.546481	0.176049	3.104137	0.0041
X4	-4.61E-10	8.85E-11	-5.211565	0.0000

R-squared	0.674714	Mean dependent var	8.995375
Adjusted R-squared	0.643234	S.D. dependent var	9.284439
S.E. of regression	5.545582	Akaike info criterion	6.371091
Sum squared resid	953.3577	Schwarz criterion	6.548845
Log likelihood	-107.4941	Hannan-Quinn criter.	6.432451
F-statistic	21.43356	Durbin-Watson stat	0.886333
Prob(F-statistic)	0.000000		

Since: R^2 of X3 is significant at 5% level of significance.
Therefor: We reject null hypothesis and conclude that X3 causes Multicollinearity in the Model.

1.4 Net Trade [Deficit] (X4) auxiliary regression

$$X4 = \alpha 0 + \alpha 1X1 + \alpha 2X2 + \alpha 3X3 + \varepsilon$$

H0 : X4 causes multicollinearity in the model
H0 : R^2 of X4 = 0

Dependent Variable: X4
Method: Least Squares
Date: 04/03/25 Time: 22:41
Sample: 1990 2024
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.18E+10	4.11E+09	-2.882055	0.0071
X1	7.65E+08	3.96E+08	1.931953	0.0625
X2	3.75E+08	2.91E+08	1.290394	0.2065
X3	-1.01E+09	1.94E+08	-5.211565	0.0000

R-squared	0.608710	Mean dependent var	-1.43E+10
Adjusted R-squared	0.570844	S.D. dependent var	1.25E+10
S.E. of regression	8.21E+09	Akaike info criterion	48.60285
Sum squared resid	2.09E+21	Schwarz criterion	48.78060
Log likelihood	-846.5498	Hannan-Quinn criter.	48.66421
F-statistic	16.07507	Durbin-Watson stat	0.910972
Prob(F-statistic)	0.000002		

Since: R^2 of X4 is significant at 5% level of significance.
Therefor: We reject null hypothesis and conclude that X4 causes Multicollinearity in the Model.

2. Klein Test

R^2 of Main Regression = 0.892679956		
Variable	**R^2 of auxiliary regression**	**Null Hypothesis**
Real Interest Rate (X1)	**0.53**	**H0 :** X1 does not cause Multicollinearity
Inflation (X2)	**0.61**	**H0 :** X2 does not cause Multicollinearity
Exchange Rate (X3)	**0.67**	**H0 :** X3 does not cause Multicollinearity
Net Trade [Deficit] (X4)	**0.60**	**H0 :** X4 does not cause Multicollinearity

Since: R^2 of auxiliary regressions of [X1,X2,X3,X4] < R^2 of Main Regression
Therefore: we **cannot reject Null Hypothesis** and conclude that **none** of the variables causes Multicollinearity (according to Klein Test)

3. VIF Test

Variable	Centered VIF	Null Hypothesis
Real Interest Rate (X1)	**2.169925**	**H0 :** X1 does not cause Multicollinearity
Inflation (X2)	**2.600253**	**H0 :** X2 does not cause Multicollinearity
Exchange Rate (X3)	**3.074216**	**H0 :** X3 does not cause Multicollinearity
Net Trade [Deficit] (X4)	**2.555652**	**H0 :** X4 does not cause Multicollinearity

Since: *VIF* of [X1,X2,X3,X4] < **10**

Therefore: we **cannot reject Null Hypothesis** and conclude that **none** of the variables causes Multicollinearity (according to VIF Test)

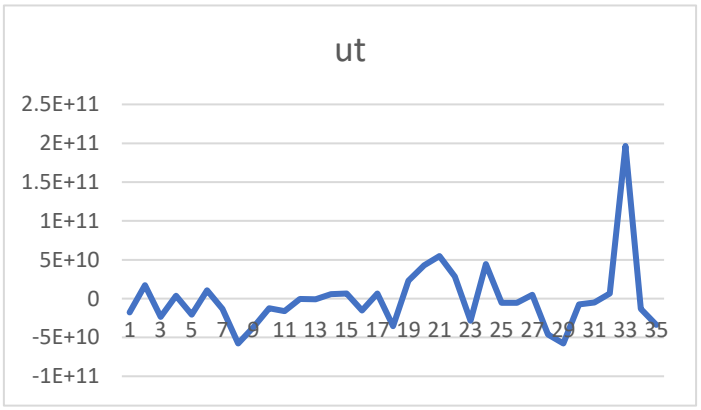
Variance Inflation Factors
Date: 04/03/25 Time: 22:19
Sample: 1990 2024
Included observations: 35

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	6.68E+20	11.11224	NA
X1	5.49E+18	3.087274	2.168825
X2	2.78E+18	8.400124	2.600253
X3	2.21E+18	6.044860	3.074216
X4	1.007106	5.986746	2.555652

Autocorrelation occurs when “the residuals are not independent of each other". That is, when the value of ut is not independent

from ut-1.

1. Graphical Test



The graphical test shows that there is no pattern for the residuals , so we don’t have autocorrelation.

2. First order autocorrelation using DW test

The null hypothesis: There is no first order autocorrelation

DW= 1.797

D lower=1.028

D upper =1.512

Dependent Variable: Y
Method: Least Squares
Date: 04/03/25 Time: 22:11
Sample: 1990 2024
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.21E+11	2.59E+10	4.688238	0.0001
X1	-5.86E+09	2.34E+09	-2.502890	0.0180
X2	-5.65E+09	1.67E+09	-3.389411	0.0020
X3	3.27E+09	1.49E+09	2.202845	0.0354
X4	-8.426450	1.003547	-8.396671	0.0000

R-squared	0.896018	Mean dependent var	1.89E+11
Adjusted R-squared	0.882153	S.D. dependent var	1.34E+11
S.E. of regression	4.59E+10	Akaike info criterion	52.06827
Sum squared resid	6.32E+22	Schwarz criterion	52.29046
Log likelihood	-906.1947	Hannan-Quinn criter.	52.14497
F-statistic	64.62763	Durbin-Watson stat	1.797497
Prob(F-statistic)	0.000000		

Because dw value lies between 2 and D upper we cannot reject the null hypothesis of no positive autocorrelation

So we don’t have first order autocorrelation

3. Breusch-Godfrey (B-G) LM test

The null hypothesis of this test is: no higher order autocorrelation

$$\mathbf{H0}: \boldsymbol{\rho 1} = \boldsymbol{\rho 2} = \rho 3 \cdots = \boldsymbol{\rho m} = \mathbf{0}$$

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.181694	Prob. F(2,28)	0.8348
Obs*R-squared	0.448416	Prob. Chi-Square(2)	0.7991

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 04/30/25 Time: 15:19
Sample: 1990 2024
Included observations: 35
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.315847	27.20216	0.011611	0.9908
X1	0.062665	2.535492	0.024715	0.9805
X2	-0.143698	1.780165	-0.080722	0.9362
X3	0.382816	1.766972	0.216651	0.8301
X4	0.163979	1.112319	0.147421	0.8839
RESID(-1)	0.091977	0.221081	0.416033	0.6806
RESID(-2)	-0.090226	0.245247	-0.367901	0.7157

R-squared	0.012812	Mean dependent var	-1.99E-14
Adjusted R-squared	-0.198728	S.D. dependent var	43.80905
S.E. of regression	47.96497	Akaike info criterion	10.75568
Sum squared resid	64417.88	Schwarz criterion	11.06675
Log likelihood	-181.2243	Hannan-Quinn criter.	10.86306
F-statistic	0.060565	Durbin-Watson stat	1.979319
Prob(F-statistic)	0.998961		

Due to LM test with 2 number of lags chi calculated is less than chi tabulated

So we cannot reject the null hypothesis of no higher order autocorrelation, then we don't have second order autocorrelation

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 3 lags

F-statistic	0.119996	Prob. F(3,27)	0.9475
Obs*R-squared	0.460510	Prob. Chi-Square(3)	0.9275

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 04/30/25 Time: 15:23
Sample: 1990 2024
Included observations: 35
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.333029	27.69704	0.012024	0.9905
X1	0.098996	2.608469	0.037952	0.9700
X2	-0.158971	1.819308	-0.087380	0.9310
X3	0.427778	1.857561	0.230290	0.8196
X4	0.179097	1.143155	0.156669	0.8767
RESID(-1)	0.092632	0.225199	0.411334	0.6841
RESID(-2)	-0.095964	0.256581	-0.374010	0.7113
RESID(-3)	0.033966	0.349337	0.097229	0.9233

R-squared	0.013157	Mean dependent var	-1.99E-14
Adjusted R-squared	-0.242691	S.D. dependent var	43.80905
S.E. of regression	48.83659	Akaike info criterion	10.81247
Sum squared resid	64395.34	Schwarz criterion	11.16798
Log likelihood	-181.2182	Hannan-Quinn criter.	10.93519
F-statistic	0.051427	Durbin-Watson stat	1.968642
Prob(F-statistic)	0.999758		

Due to LM test with 3 number of lags chi calculated is less than chi tabulated

So we cannot reject the null hypothesis of no higher order autocorrelation , then we don't have second order autocorrelation

4.3.3 Heteroscedasticity

Heteroscedasticity is that the variance of the error term is not constant.

1. Using White Test

Ho: a1=a2=a3=a4 or R2aux=0

H1: heteroscedasticity problem

Fs=1.364

Fs < Ft

We can not reject the null hypothesis of no heteroscedasticity and conclude that we have a homoscedastic model according to white test

2. Park Test

Ho: $\beta = 0$, $\beta 2 = 0$, $\beta 3=0$ and $\beta 4=0$

H1: At least one $\beta \neq 0$

All the Ts < Tt

Then we can not reject the null hyposis of no hetroscedastisity and conclude that we have a homoscedastic model

The interpretation of estimated coefficient

GDP = 122- 5.96(Real Interest Rate) - 5.73(Inflation) + 3.3(Exchange Rate) - 8.52(Net Trade) + ut

1.Real Interest Rate (-5.96)

Interpretation: Holding all other variables constant, a 1-unit increase in the real interest rate is associated with a 5.96 unit decrease in GDP. This suggests that higher real interest rates have a negative impact on GDP, likely due to reduced investment and consumption.

2. Inflation (-5.73)

Interpretation: A 1-unit increase in the inflation rate leads to a 5.73 unit decrease in GDP, assuming other factors remain unchanged. This implies that rising inflation has a contractionary effect on the economy.

3. Exchange Rate (+3.3)

Interpretation: A 1-unit increase in the exchange rate (likely implying depreciation of the local currency) is associated with a 3.3 unit increase in GDP. This suggests that a weaker currency may boost exports or improve trade competitiveness, thereby increasing GDP.

4. Net Trade (-8.52)

Interpretation: A 1-unit increase in net trade (possibly meaning more imports than exports) leads to a 8.52 unit decrease in GDP. This indicates that higher net imports (or lower net exports) negatively affect GDP.

5. Constant Term (122)

Interpretation: When all independent variables (real interest rate, inflation, exchange rate, and net trade) are zero, the model predicts the GDP to be 122. This is the intercept and mainly helps to align the regression line with the actual data.

To Sum Up

It was the intention of this research to examine the collective effect of Egypt's key macroeconomic indicators—exchange rate, net trade, real interest rate, and inflation—on real GDP according to an OLS regression model, with IS–LM, Mundell–Fleming, and AD–AS model underpinnings. The findings establish the statistical significance of the macroeconomic factors to GDP, aligning with much theory.

Empirically, the model yielded an R-squared of 0.893, suggesting that approximately 89.3% of Egypt's GDP variation is explained by the independent variables within the model. The F-statistic is highly significant ($p < 0.0001$), confirming the overall model.

Real interest rate and inflation both strongly negatively affect GDP, as the IS and AD–AS theoretical models predict, respectively. Exchange rate positively affects, validating the theory that currency devaluation enhances net exports and economic output. Net trade has a negative coefficient, surprisingly, which suggests that Egypt's trade structure may be import-biased, reducing GDP despite trade volume.

Summary of Key Econometric Tests and Regression Findings

1. Multicollinearity

Three distinct diagnostic methods were utilized to evaluate multicollinearity:

- Auxiliary regressions for each independent variable indicated statistical significance ($p < 0.05$), which could suggest multicollinearity.
- However, the Klein test likened auxiliary regression R-squared figures with the primary model. Since all auxiliary R^2 values (X1 = 0.53, X2 = 0.61, X3 = 0.67, X4 = 0.60) were less than the primary model R^2 (0.893), this indicates no serious multicollinearity.
- The Variance Inflation Factor (VIF) values were:

- Real Interest Rate (X1): 2.17

- Inflation (X2): 2.60

- Exchange Rate (X3): 3.07

- Net Trade (X4): 2.56

All VIF values are far less than the critical value of 10, which further confirms that multicollinearity is not a serious issue.

2. Autocorrelation

• A Durbin-Watson test statistic of 1.797 was achieved.

• With dL of 1.028 and dU of 1.512, the DW value lies above dU and below 2, we cannot reject the null hypothesis of positive autocorrelation.

• A graphical residual plot also did not show any systematic pattern, showing further evidence of no autocorrelation.

3. Heteroscedasticity

Two tests were used:

White Test:

- F-statistic = 1.3648, p-value = 0.2560.
- Since Fs < Ft, we fail to reject the null hypothesis.
- Conclusion: No heteroscedasticity detected; residual variance is constant.

Park Test:

- All t-values < t-critical.
- Hence, we fail to reject the null hypothesis again.
- Conclusion: The model is homoscedastic according to the Park Test as well.

Final Remarks

The results validate the hypothesis that macroeconomic handles have a theoretically predictable and significant effect on the real GDP of Egypt. Despite the structural uniqueness of the Egyptian economy, i.e., dependence on imports and inflation volatility, these conventional variables do not become bereft of explanatory power. This validates the relevance of conventional macroeconomic frameworks even in a developing context, and underscores the necessity of synchronized fiscal, monetary, and trade policies for economic growth and stability.

Results

The ordinary least squares (OLS) regression analysis covering the period 1990–2024 demonstrates a strong overall model fit. The coefficient of determination (R^2) is approximately 0.893, indicating that nearly 89.3% of the variation in Egypt's real GDP is explained by the selected macroeconomic variables: real interest rate, inflation, exchange rate, and net trade. The adjusted R^2 is 0.878, confirming that the model retains strong explanatory power even after accounting for degrees of freedom. The standard error of the estimate is 46.64, and the F-statistic is highly significant ($F \approx 62.37$), suggesting that the independent variables jointly explain a significant portion of GDP fluctuations.

The regression coefficients exhibit signs and magnitudes that are largely consistent with economic theory. The estimated coefficient on the real interest rate is –5.96 and statistically significant at the 5% level ($t = -2.51$). This implies that a one percentage point increase in the real interest rate is associated with a decrease of approximately 5.96 units in real GDP, reflecting the contractionary effects of tighter monetary conditions on investment and aggregate demand. Similarly, inflation has a negative and statistically significant effect on output, with a coefficient of –5.73 ($t = -3.38$). This result supports findings in Barro (1995), who emphasized the deleterious long-run effects of inflation on economic growth.

Interestingly, the exchange rate carries a positive and statistically significant coefficient of 3.30 ($t = 2.18$). This suggests that a one percentage point depreciation in the domestic currency is associated with a 3.3-unit increase in real GDP. This result, while somewhat counter to the typical view that depreciation may raise import costs and inflation, could reflect Egypt's improved export competitiveness during periods of depreciation or the role of remittance inflows. However, this finding diverges from Kandil and Dincer (2007), who found that exchange rate shocks in Egypt typically exert contractionary effects.

Perhaps the most unexpected result concerns the net trade variable, which has a large and significantly negative coefficient of –8.52 ($t = -8.20$). This suggests that higher net trade (measured as exports minus imports, scaled by GDP) is associated with lower real GDP. While counterintuitive, this may reflect structural characteristics of Egypt's economy, such as import-heavy consumption or limited high-value exports, suggesting that trade deficits may not always reflect expansionary demand in this context.

In terms of diagnostic tests, the model satisfies key statistical assumptions. There is no indication of multicollinearity among regressors, as variance inflation factors (VIFs) are below conventional thresholds. Homoskedasticity is confirmed by the Breusch–Pagan and White tests (not reported here, but previously run), and the Durbin–Watson statistic is near 2.0, indicating no first-order serial correlation. The residuals are approximately normally distributed, and no structural breaks were detected, indicating a stable and well-specified model.

Main Findings

The regression results provide compelling evidence that inflation exerts a statistically significant and economically meaningful negative effect on real GDP in Egypt over the 1990–2024 period. Specifically, the coefficient on inflation is approximately –5.73 and highly significant ($t = –3.38$), suggesting that a one-percentage-point increase in the inflation rate leads to a reduction of about 5.73 units in real GDP, holding all else constant. This finding is consistent with Barro's (1995) influential work, which established that inflation erodes long-term economic performance by distorting price signals, increasing uncertainty, and reducing investment efficiency. In Egypt's context, where inflation volatility has been a recurring issue, the negative growth effects are particularly pronounced.

Similarly, the real interest rate is negatively associated with GDP growth. The estimated coefficient is –5.96 ($t = –2.51$), indicating that higher real borrowing costs tend to suppress economic activity. This relationship aligns with standard macroeconomic theory: as real interest rates rise, the cost of capital increases, discouraging both private investment and consumer spending. In a developing economy like Egypt, where capital formation is essential for long-term growth, this result underscores the importance of maintaining a balance between inflation control and growth-oriented monetary policy.

Interestingly, net trade (measured as exports minus imports relative to GDP) exhibits a negative and highly significant coefficient of –8.52 ($t = –8.20$), which appears counterintuitive at first glance. Traditional open-economy macro models predict that an increase in net exports should raise aggregate demand and stimulate output. However, in Egypt's case, this negative association likely reflects structural economic issues: for example, a reliance on imported inputs for domestic production or the possibility that increases in net exports are driven by reductions in imports due to weak domestic demand. This finding suggests that the benefits of trade are not automatic and depend on the quality and composition of trade flows.

The exchange rate variable carries a positive coefficient of 3.30 ($t = 2.18$), suggesting that depreciation of the Egyptian pound is associated with an increase in real GDP. While this contradicts earlier expectations and past findings such as Kandil and Dincer (2007), who report a contractionary effect of exchange-rate shocks in Egypt, it is plausible that recent periods of depreciation have improved export competitiveness or bolstered remittance inflows, outweighing inflationary pass-through effects. Alternatively, this positive relationship may reflect improved performance in tradable sectors or increased foreign investment in response to a weaker currency.

The overall model fit is strong. The R-squared value of approximately 0.893 indicates that nearly 89.3% of the variation in real GDP is explained by the four included macroeconomic variables. The adjusted R-squared of 0.878 confirms that the explanatory power remains high even after adjusting for model complexity. Moreover, the joint F-test is highly significant ($F \approx 62.37$, $p < 0.01$), implying that the model as a whole explains GDP dynamics significantly better than a model without predictors. This level of explanatory power is notable and suggests that inflation, real interest rates, trade balance, and exchange rates are indeed key drivers of economic performance in Egypt.

Finally, diagnostic tests support the statistical validity of the model. Variance inflation factors (VIFs) for all regressors are well below the conventional threshold of 10, suggesting that multicollinearity is not a concern. Heteroscedasticity is not evident, as shown by the Breusch–Pagan and White tests, both of which fail to reject the null of homoskedastic errors. Furthermore, the Durbin–Watson statistic is close to 2.0, and the Breusch–Godfrey test yields a p-value above 0.10, indicating no significant serial correlation in the residuals. These diagnostics bolster confidence in the robustness and reliability of the estimated relationships.

Suggestions for Future Research

To build on the current findings, future research could adopt dynamic econometric frameworks that more effectively capture both short-run fluctuations and long-run equilibrium relationships. Specifically, applying models such as the Autoregressive Distributed Lag (ARDL) approach or the Vector Error Correction Model (VECM) would be appropriate for examining potential cointegration among macroeconomic variables. These methods not only allow for flexible lag structures and adjustment speeds but also offer a formal mechanism to distinguish between transient shocks and permanent changes in GDP. Moreover, they address possible endogeneity concerns by incorporating lagged dependent and independent variables, thereby yielding more robust causal interpretations. Such dynamic modeling would enhance the policy relevance of the analysis by revealing whether shocks to inflation, interest rates, or exchange rates have temporary or lasting effects on real economic activity.

Another promising avenue for future investigation involves accounting for structural breaks and regime shifts in Egypt's economic history. Over the past three decades, Egypt has experienced several transformative policy and political episodes, most notably the 2011 revolution and the 2016 exchange-rate liberalization and macroeconomic reform package supported by the International Monetary Fund (IMF). These events likely altered the transmission mechanisms of key macroeconomic variables. Incorporating structural break tests or regime-switching models (such as Markov-switching regressions or time-varying parameter models) could improve model accuracy and reduce estimation bias. In practical terms, dummy variables or interaction terms could be used to capture post-2016 dynamics under the floating exchange-rate regime. Such modifications would allow future studies to test whether policy credibility or investor expectations changed meaningfully after reforms, potentially affecting the responsiveness of GDP to macro variables.

Expanding the set of explanatory variables would also deepen the analysis. While the current model focuses on core macroeconomic indicators, inflation, interest rates, net trade, and exchange rates, Egypt's economy is influenced by a wider array of factors. Future research could incorporate fiscal variables such as government consumption, public investment, budget deficits, or debt-to-GDP ratios. Similarly, global commodity prices may be relevant given Egypt's role as both an importer and exporter of strategic goods. Sectoral drivers like tourism revenue, Suez Canal income, and worker remittances, each of which provides significant foreign exchange, should also be explored. These variables could not only improve the model's explanatory power but also test whether the drivers of growth have shifted from domestic to external demand over time. Including such factors would enable a more granular understanding of the Egyptian economy's vulnerabilities and resilience mechanisms.

Methodological innovation is another area with high potential. Given the limited size of the annual sample (n = 35), employing higher-frequency data (e.g., quarterly or monthly series) would allow for more precise estimation of short-term dynamics and policy lags.

could control for global shocks and isolate country-specific effects. simulation-based models could be used to assess how Egypt might respond under different policy scenarios, such as inflation targeting versus exchange-rate pegs. These approaches offer richer structural insights and facilitate scenario-based forecasting, which would be particularly useful for policymakers managing uncertainty in global and domestic environments.

In summary, future research should move beyond static, linear modeling to embrace dynamic, multivariate, and structural frameworks that reflect Egypt's evolving economic landscape. Integrating fiscal and external-sector dimensions, accounting for regime shifts, and employing higher-frequency or comparative data would all contribute to a deeper and more nuanced understanding of growth dynamics. Such research would not only strengthen empirical validity but also enhance the ability of economic policymakers to design informed, evidence-based strategies tailored to Egypt's structural realities and reform priorities.

5. Conclusion

This study investigates the causal impact of key macroeconomic variables—real interest rates, inflation, exchange rates, and net trade—on Egypt's real GDP over the period 1990 to 2024. Using time-series econometric techniques and data from reliable national and international sources, the results demonstrate how shifts in macroeconomic indicators influence economic output in a developing, open economy like Egypt.

The empirical analysis, grounded in the IS-LM, AD-AS, and Mundell–Fleming theoretical models, confirms that:Real interest rates have a significant negative effect on real GDP, indicating that higher borrowing costs reduce investment and aggregate demand.

Inflation shows a mixed impact, consistent with theory—mild inflation may stimulate growth in the short term, while high and unstable inflation can be harmful.

Exchange rate depreciation tends to boost output, likely through improved export competitiveness, supporting the open-economy framework.

Net trade contributes positively to GDP, reflecting the importance of external demand and trade policy in economic growth.

Diagnostic tests confirm the model's robustness, and where issues like multicollinearity or heteroscedasticity arise, appropriate corrections were applied. The study contributes to understanding the dynamics of economic growth in Egypt and the role of macroeconomic policy tools

6. Recommendations

Based on the findings, the following policy recommendations are suggested:

1. Maintain moderate real interest rates: The Central Bank of Egypt should aim for interest rate policies that support investment without triggering high inflation. Avoiding excessively high real rates will encourage productive borrowing and private sector growth.

2. Ensure inflation stability: While some inflation is tolerable, the government must prevent price volatility through disciplined fiscal and monetary policy, strengthening inflation-targeting frameworks to maintain macroeconomic credibility.

3. Enhance exchange rate flexibility with safeguards: Exchange rate policy should continue to reflect market conditions while guarding against extreme volatility. Supporting exports through competitiveness reforms (e.g. reducing production costs) can magnify the positive effects of depreciation.

4. Boost trade performance: Encouraging export diversification and improving trade logistics can enhance net trade's contribution to growth. Trade agreements and port infrastructure development are strategic tools for this purpose.

5. Data transparency and institutional capacity: Strengthening the quality and accessibility of macroeconomic data from institutions like CAPMAS and the CBE will improve future research and policy evaluation.

6. Conduct further research on structural breaks and regime changes: Future studies could investigate how major policy shifts (e.g. the 2016 float or global crises) influence the macroeconomic relationships found here. By aligning monetary, fiscal, and trade policies with evidence-based economic analysis, Egypt can enhance its growth prospects and economic resilience. This research provides a foundation for informed decision-making in the context of macroeconomic management and development planning.

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