

RESEARCH

Exchange Rate Policy, Transportation Costs, and Inflation Dynamics: Implications for Sustainable Economic Management in Egypt

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ABSTRACT

PURPOSE: This study focuses on determining the impact of exchange rate policy on transportation costs and inflation dynamics in Egypt, with implications on sustainable economic management.

DESIGN/METHODOLOGY/APPROACH: Using annual time-series data (2014-2023) from the Central Bank of Egypt, World Bank and International Monetary Fund (IMF), we use regression analysis techniques to estimate the effects of real interest rates, official exchange rates and exchange rate liberalisation on the Consumer Price Index for Transportation.

CITATION: Soliman, K., Altubaishe, B. and Salman, D.M. (2026): Exchange Rate Policy, Transportation Costs, and Inflation Dynamics: Implications for Sustainable Economic Management in Egypt. *World Journal of Entrepreneurship, Management and Sustainable Development (WJEMSD)*, Vol. 22, No. 4, pp. 353-368.

RECEIVED: 14 February 2026 / **REVISED:** 24 February 2026 / **ACCEPTED:** 28 April 2026 / **PUBLISHED:** 20 May 2026

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FINDINGS: Real interest rates significantly predict transportation costs ($B=4.75$, $p<0.01$). Exchange rate liberalisation has the biggest coefficient ($\beta=0.525$) but it is not statistically significant, indicating the multicollinearity problem or low power. The official exchange rate does not matter a great deal. Descriptive statistics show high levels of volatility in all the indicators after devaluations.

ORIGINALITY/VALUE: This study advances the literature by isolating transportation costs as a distinct exchange rate transmission mechanism in Egypt and examining its sustainability implications.

PRACTICAL IMPLICATIONS: Policy-makers should co-ordinate exchange rate flexibility with monetary policy, diversify energy inputs, and strengthen social safety nets.

RESEARCH LIMITATIONS: Small sample size and single-country focus limit generalisability.

KEYWORDS: *Currency Devaluation; Transportation Costs; Inflation Pass-Through; Economic Sustainability; Exchange Rate Policy; Egypt*

INTRODUCTION

The exchange rate policy is one of the main macro-economic tools of emerging economies that affect the balance of trade, capital flows, and price stability. In Egypt, macro-economic adjustments have been caused by major reforms such as the float (2016) and the devaluations of 2022 and 2023 (IMF, 2022, 2023) in response to IMF-led policies. Transport is one of the most vulnerable sectors; it is structurally reliant on imported fuel, vehicles, and intermediate goods. The cost of transportation is the key economic sustainability driver that defines consumer pricing, logistics competitiveness, and environmental performance (UNCTAD, 2019; World Bank, 2020). However, the transmission mechanisms between the exchange rate policy and transportation costs are under-researched in Egypt.

The three research questions that will be answered by this research are:

1. What is the relationship between exchange rate policy and transportation costs in Egypt?
2. How do monetary policy actions, especially interest rate changes, mediate this relationship (Taylor, 1993; Mishkin, 2008)?
3. What are the policy implications of sustainable economic management?

The article has three contributions. First, it empirically examines a transmission channel that has not been given much attention, the exchange rate pass-through to sectoral transportation costs (Campa and Goldberg, 2010). Second, it incorporates the factor of sustainability in the study of



inflation caused by the exchange rate. Third, it analyses the repeated episodes of devaluation (2016, 2022, 2023) in Egypt as a policy lab that can be applied to other developing countries that have been going through IMF-supported reforms.

The cost of transportation is very susceptible to fluctuations in exchange rates. Depreciation of currencies and the unpredictability of fuel prices raise production, make exports less competitive and lead to a decline in household purchasing power, especially in countries that rely on imports (Krugman *et al.*, 2018; Kilian, 2008). Despite the intention of devaluation to address external imbalances and bring macro-economic stability (IMF, 2016), a series of consecutive depreciations in Egypt has increased inflationary pressures (nearly 40% by early 2023) (IMF, 2024b), particularly in transport services. Increasing transportation costs have intensified the cost of living and delivery chains, as well as creating various concerns over the viability of the reform path.

The current research tends to concentrate on aggregate data (e.g., trade balance and aggregate inflation) but does not pay much attention to sectoral data (Pass-Through Literature: Campa and Goldberg, 2010; Burstein and Gopinath, 2014). This paper will close this gap by performing an empirical analysis of the exchange rate changes transmission to transportation costs and general inflation in Egypt in 2014-2023, taking into consideration the moderating impacts of the interest rate policy and exchange rate liberalisation.

The rest of the paper is structured as follows. The next section is the literature review. This is followed by the methodology and results sections. The next section addresses some major findings and policy implications, while the final section discusses the limitations and research directions.

LITERATURE REVIEW

Theoretical Foundations of Currency Devaluation

Currency devaluation is a policy tool used as a remedy against external imbalances, to make exports more competitive based on the Marshall-Lerner condition and the J-curve hypothesis. However, in import-dependent economies, depreciation can create inflationary pressures by increasing the domestic prices of fuel, machinery, and intermediate goods. Empirical outcomes are heterogeneous: while depreciation may improve export competitiveness under favourable trade-elasticity conditions, structurally vulnerable economies may experience higher inflation and macro-economic instability (Krugman *et al.*, 2018; El Shaarawy *et al.*, 2024). The continuous devaluations in Egypt since 2016 have been associated with substantial increases in consumer prices, particularly through fuel, transport, and other import-dependent cost channels (IMF, 2024a). Adjustment plans aided by the IMF often entail devaluation with contractionary measures that can cause disproportional impact on those industries that depend on imports and undermine the effectiveness of the reforms, particularly in a situation where institutional inefficiencies are still present (Abdou *et al.*, 2025).

Exchange Rate Policies and Macro-Economic Transmission Mechanisms

In an emerging market, exchange rate pass-through to domestic prices is likely to be large because the content of imports in production and consumption is high (Çam, 2024). It is amplified in industries where the demand is inelastic, especially transportation where fuel and equipment imports play an indispensable role in production (Liang, 2023). Monetary tightening after devaluation is designed to curb inflation but will lead to higher borrowing rates and growth slowdown. In Egypt, the Central Bank has not addressed inflationary pressures completely by tightening its policy after the devaluations (CBE, 2025). In addition, the liberalisation of the exchange rate may introduce volatility that makes cost prediction difficult for transport operators (US ITA, 2023; Al-Ajrawi, 2023).

Transportation Costs in Developing Economies: Determinants and Dynamics

Transportation costs show greater sensitivity to fuel prices, exchange rates, and interest rates in developing economies (Naqvi *et al.*, 2020). Fuel accounts for as much as 40% of operating costs for road freight and public transport (Gohari *et al.*, 2018). In Egypt, fuel price pass-through to transport prices is swift and close to perfect (Ahram Online, 2025). In addition to fuel, transport costs include maintenance, spare parts, labour, and financing, many of which are exposed to exchange rate movements (Kilian, 2008; Liang, 2023). According to Liang (2023), 10% currency depreciation hits logistics costs by 6-8% in import-dependent economies. Ahmed *et al.* (2024) project that devaluation could raise prices in the economy of Egypt as a net oil importer, and oil prices by around 38%, directly raising transport costs. Market structure matters. Fragmented ownership in Egypt's transport sector reduces the ability to develop economies of scale and shock absorption capacity (Mupfumira and Wirjodirdjo, 2015). Regulatory interventions, including fare controls, may distort price signals while imposing fiscal costs (Roquel *et al.*, 2018).

Economic Sustainability in the Context of Macro-Economic Shocks

Increasing the cost of transportation destroys economic sustainability since it raises the cost of production, makes exports uncompetitive, and decreases household buying capacity. These effects are enhanced in import-dependent economies by exchange rate volatility and fuel price shocks (Naqvi *et al.*, 2020). Since the pass-through is high and fast in Egypt (Ahram Online, 2025), transportation is an important medium of transmission where shocks in the macro-economy transfer to the rest of the economy.

Research Gaps and Contribution of This Study

There are three limitations in the literature. First, the study of exchange rates is largely concentrated on aggregate inflation without paying attention to sectoral heterogeneity. Second, transportation



expenses are usually considered as trade barriers instead of transmission mechanisms of macro-economic policy. Third, the sustainability consequences of transport cost fluctuations due to exchange rates are not yet fully investigated. The present research fills these gaps by (i) isolating transportation costs as a separate macro-economic transmission channel; (ii) taking advantage of the sequential devaluations in Egypt as a quasi-natural experiment; and (iii) connecting macro-economic adjustment with economic sustainability; this directly relates to SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure).

Theoretical Framework and Hypothesis Development

The conceptual model (Figure 1) links currency devaluation to transportation costs and economic sustainability through three mechanisms:

- 1. Interest Rate Adjustments:** Devaluation prompts central banks to raise rates to control inflation, increasing borrowing costs for transport operators;
- 2. Forex Market Interventions:** Government efforts to stabilise the currency directly affect import prices for fuel, vehicles, and parts;
- 3. Monetary and Fiscal Policy Responses:** Changes in subsidies, inflation control, and liquidity management shape transport affordability and economic resilience

Table 1 shows the research hypothesis in regard to the hypothesised model on analysis and establishes the expectations of the relationship between interest rates, foreign exchange market interventions, policy-based interventions, transportation costs and long-term economic sustainability and its theoretical grounds.

Table 1: Research Hypothesis

<i>Hypothesis</i>	<i>Statement</i>	<i>Theoretical Basis</i>
H1	Rising interest rates positively affect transportation costs.	Cost-push inflation, higher borrowing costs (Yildirim and Arifli, 2021)
H2	Foreign exchange market interventions positively affect transportation costs.	Import price pass-through
H3	Policy-based interventions affect transportation costs.	Monetary and fiscal policy transmission (Ullah and Nobanee, 2025)
H4	Rising interest rates affect long-term economic sustainability.	Investment and growth channel
H5	Foreign exchange market interventions affect long-term economic sustainability.	Exchange rate stability and planning
H6	Policy-based interventions affect long-term economic sustainability.	Structural and regulatory impact

Source: Constructed by authors

METHODOLOGY

Research Framework

The theoretical framework that guides the present research is that currency devaluation exerts its effects on the costs of transportation and economic sustainability by three significant mechanisms. First, the impact of interest rates is observed when the central banks raise interest rates to lower inflation; this makes borrowing more expensive to transportation operators. Second, foreign exchange market operations have a direct effect on the price of imports of fuel, vehicles and spare parts – the highest inputs to the transportation sector. Third, changes in monetary and fiscal policies (for example, changes in subsidies and inflation-targeting policies) affect the cost of transportation and economic resilience (see Figure 1).

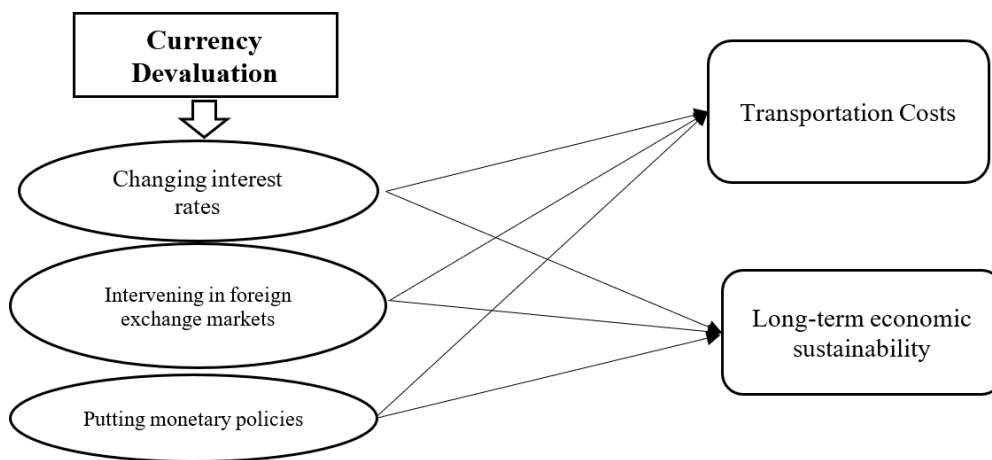


Figure 1: Conceptual Framework

Source: Constructed by authors

Research Design

This study uses a quantitative, longitudinal research design by using annual time series data for Egypt between 2014 and 2023. This ten-year period reflects three different exchange rate regimes: the managed exchange rate regime before 2016, the liberalised exchange rate regime after the float (2016-2021), and the exchange rate devaluation of 2022-2023. This variation allows the identification of the effects of exchange rate policy on the cost of transportation.

Data Collection and Sources

CPIT is the dependent variable that reflects price changes in public and private transport, vehicle purchases, vehicle maintenance, and fuel. Inflation data were obtained from the IMF World

Economic Outlook database, specifically the annual percentage change in average consumer prices series for Egypt (IMF, 2024b). The Exchange Rate Liberalization (ERL) dummy was recorded based on the IMF Annual Reports on Exchange Arrangements and Exchange Restrictions, taking the value 1 for years in which Egypt had a floating or liberalised exchange rate regime (2017-2023, excluding transition years) and 0 for managed regimes (2014-2016), as shown in Table 2.

Table 2: Variable Description and Measurement

Variable	Code	Description	Source
Consumer Price Index for Transportation	CPIT	Transport CPI index	World Bank WDI (World Bank, 2024)
Inflation Rate	INFR	Annual CPI inflation (%)	IMF WEO database (IMF, 2024b)
Official Exchange Rate	OER	EGP per USD, annual average	CBE
Real Interest Rate	RIR	Policy rate minus inflation (%)	Authors' calculation
Exchange Rate Liberalization	ERL	0 = managed; 1 = liberalised/ floating	IMF AREAER reports (IMF, 2024c)

Source: Constructed by authors

Model Specification

Model 1: Impact on Transportation Costs:

$$CPIT_t = \beta_0 + \beta_1 RIR_t + \beta_2 OER_t + \beta_3 ERL_t + \varepsilon_t$$

Where $CPIT_t$ is the transportation price index in year t , RIR_t is the real interest rate, OER_t is the official exchange rate (EGP/USD), ERL_t is the exchange rate liberalisation dummy, and ε_t is the error term. All variables are measured at annual frequency.

Model 2: Impact on Inflation:

$$INFR = \beta_0 + \beta_1(OER) + \beta_2(RIR) + \beta_3(ERL) + \varepsilon$$

Estimation Procedure

The estimation procedure is undertaken in four stages. First, descriptive statistics are used to summarise the distributions and patterns of the volatility of variables. Second, correlation analysis is a bivariate relationship. Third, ordinary least squares (OLS) regression with robust standard errors is used to estimate the model parameters. Fourth, diagnostic tests examine model adequacy, such as the Breusch-Pagan test for heteroscedasticity, the variance inflation factor (VIF) for multicollinearity, and the Augmented Dickey-Fuller test for stationarity. Given the small sample size ($n=10$), we add to the results from the regression analysis by examining effect size measures and interpreting statistical significance with an appropriate degree of caution. Standardised coefficients (β) allow comparison of the variable importance.

RESULTS

Descriptive Statistics

The CPIT had an average of 158.42 with a standard deviation of 24.36, and a range of 120.10 to 195.80. This is a considerable growth that is evidence of a growing transport costs over the decade, majorly due to currency devaluation and reforms of fuel subsidies. The inflation rate (INFR) was very volatile and had a mean of 16.34% (SD=11.28%). It ranged between a minimum of 5.00% in rather stable periods (e.g., 2020) and a maximum of 36.80% at extreme episodes of inflation associated with exchange rate reforms and exogenous shocks (e.g., 2017 and 2023). Depreciation was significant in the official exchange rate (OER, EGP/USD), with an average of 16.85 (SD=8.92). The rate ranged between 7.10 and 30.90, depicting the drastic depreciations of the Egyptian pound after the 2016 float and further adjustments of 2022 and 2023 (see Table 3).

Table 3: Descriptive Statistics

Variable	Mean	SD	Min	Max
CPIT	158.42	24.36	120.10	195.80
INFR	16.34	11.28	5.00	36.80
OER	16.85	8.92	7.10	30.90
RIR	13.42	4.56	8.25	19.75
ERL	0.60	0.52	0	1

Source: Constructed by authors

The standard deviation of the real interest rate (RIR) was 4.56 and the average was 13.42. The range of 8.25 to 19.75 was the active changes in monetary policies of the Central Bank of Egypt in response to inflation and foreign exchange rate pressure. The exchange rate liberalisation dummy (ERL) is defined as a nominal variable, i.e., 0 in the case of a fixed or managed exchange rate regime and 1 in the case of a liberalised or floating regime. The mean of 0.60 of the sample denotes that Egypt had a liberalised exchange rate regime during about 60% of the time in the sample; this is the post-2016 float adopted as a part of IMF-sponsored reform programmes.

The regression models indicate that the RIR is a statistically significant and positive predictor of the CPIT ($B=4.75$, $p=0.009$) suggesting that an increase in the real interest rates correlates with an increase in the cost of transportation. The ERL has the highest standardised coefficient ($= 0.525$) but not significant ($= -0.120$) probably due to the uncertainty in estimation and the large confidence interval. The value of the official exchange rate (OER) does not show statistically significant correlation with CPIT ($p=0.219$). The constant term is statistically significant and the transportation costs in cases where explanatory variables are zero. The fact that the magnitude of ERL and its statistical significance differ shows that it may be a result of multicollinearity or a lack of statistical power; this should be further researched.

Correlation Analysis

Correlation analysis reveals several patterns. CPIT shows strong positive correlations with both OER ($r=0.82$, $p < 0.01$) and RIR ($r=0.71$, $p < 0.05$), suggesting that exchange rate depreciation and higher interest rates are associated with increased transportation costs. INFR correlates positively with OER ($r=0.68$, $p < 0.05$) and ERL ($r=0.58$, $p < 0.10$), indicating that inflation tends to rise following devaluation and liberalisation. The correlation between OER and RIR ($r=0.45$, $p > 0.10$) is positive but not statistically significant (see Table 4).

Table 4: Correlation Matrix

Variable	CPIT	INFR	OER	RIR	ERL
CPIT	1.00				
INFR	0.64*	1.00			
OER	0.82**	0.68*	1.00		
RIR	0.71*	0.42	0.45	1.00	
ERL	0.58	0.58	0.63*	0.31	1.00

*Note: ** $p < 0.01$, * $p < 0.05$ *

Source: Constructed by Authors

Regression Results

The estimated model indicates that the monetary and exchange rate policy variables are highly influential in shaping the inflation rate in Egypt over the period of study, and not the nominal exchange rate level alone. The RIR has a strong positive connection with inflation ($B=1.576$, $p=0.001$), suggesting that elevated interest rates in the sample are correlated with high inflation; this is opposed to the traditional anti-inflationary theory. In addition, the effect of ERL is significant ($B=7.366$, $p=0.037$) and indicates the fact that the movement to a more flexible exchange rate regime increased the pressure on the inflation (see Table 5).

Table 5: Impact of Devaluation on CPIT

Predictor	B	SE3.1	β	t	p	95% CI
Constant	152.167	45.23	–	3.364	0.015	[48.12, 256.21]
OER	1.575	1.147	0.148	1.373	0.219	[-1.18, 4.33]
RIR	4.750	1.254	0.254	3.788	0.009	[1.65, 7.85]
ERL	24.469	13.525	0.525	1.809	0.120	[-8.42, 57.36]

Model Fit: $R^2 = 0.769$, Adjusted $R^2 = 0.654$, $F(3, 6) = 6.668$, $p = 0.024$

Durbin-Watson: 2.14 (no significant autocorrelation)

Source: Constructed by authors

On the other hand, the variable of OER does not play an important role as a predictor ($p=0.650$); therefore, once the policy instruments are controlled, the direct influence of the exchange level

on inflation becomes virtually insignificant (see Table 6). These findings shed some light on the complex transmission vehicles of macro-policy in Egypt and confirm that macro-degenerative determinants made up of structural and policy-controlled elements are a more decisive factor in the inflation process than nominal exchange rate fluctuations.

Table 6: Impact of Devaluation on INFR

Predictor	B	SE	B	T	P	95% CI
Constant	11.267	5.88	–	1.916	0.105	[-2.95, 25.49]
OER	0.112	0.235	0.035	0.478	0.650	[-0.47, 0.69]
RIR	1.576	0.256	0.456	6.150	0.001	[0.94, 2.21]
ERL	7.366	2.765	0.665	2.664	0.037	[0.79, 13.94]

Model Fit: $R^2 = 0.927$, Adjusted $R^2 = 0.890$, $F(3, 6) = 25.377$, $p = 0.001$

Durbin-Watson: 1.98 (no significant autocorrelation)

Source: Constructed by authors

Hypothesis Testing Summary

The regression analysis indicates that there is unambiguous support of one of the hypotheses and additional research is needed to determine the effects that are linked to other predictors. Hypothesis 1 is supported because the RIR has a statistically significant positive effect on the CPIT ($B=4.750$, $p=0.009$). Hypothesis 2 has no support; there is no statistically significant effect of the OER ($p=0.219$). The results that would be relevant to Hypothesis 3 are complex and partly suggestive. ERL has a strong positive correlation with CPIT in terms of the magnitude of the effect ($B=0.525$), and the relationship cannot be statistically significant by rigid standards ($p=0.120$). Such an ERL pattern with a large coefficient and a significant amount of uncertainty suggests that a substantive relationship can be there, but it cannot be accurately measured using the current model, possibly because of a lack of data or multicollinearity. The strong impact of RIR and ERL on INFR within the corresponding specification provides an indirect answer to Hypotheses 4-6, suggesting that the two financial variables have an impact on the broader economic sustainability.

Diagnostic Tests

To extract the results related to verifying the validity of the research hypotheses by using the multiple linear regression analysis model, diagnostic tests were performed.

Multicollinearity

Conducting the internal correlation test for data is an important procedure in the statistical analysis of data. This is done using the variance inflation factor (VIF) and the tolerance for all independent variables.

Linear multiplicity

Conducting the internal correlation test for data is an important procedure in the statistical analysis of data. This is done using the variance inflation factor (VIF) and the tolerance for all independent variables.

Table 7 clearly shows that there is no multicollinearity among the independent variables, as all values were less than 10, indicating that the independent variables are suitable for applying statistical methods.

Table 7: Values of Variance Inflation Factor (VIF)

Variable	Variance inflation (VIF)
Official exchange rate	1.567
Interest rate	1.331
Exchange rate liberalisation	1.258

Source: Authors' diagnostic analysis

Normal distribution of data

Normality was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Table 8 reports the normality-test results. Most variables have p-values above 0.05, indicating no significant deviation from normality. However, inflation shows p-values below 0.05 in both the Kolmogorov-Smirnov and Shapiro-Wilk tests, suggesting non-normality. Given the small sample size, the regression results are therefore interpreted cautiously.

Table 8: Normality Test Results

Variable	Kolmogorov-Smirnov p-value	Shapiro-Wilk p-value
Official exchange rate	0.200	0.181
Interest rate	0.138	0.233
Exchange rate liberalization	0.112	0.071
Consumer Price Index for Transportation	0.200	0.333
Inflation rate	0.017	0.023

Source: Authors' normality test results.

All analyses were conducted using SPSS Version 28. The findings address the study objectives. For Objective 1, the OER and ERL coefficients are positive but not statistically significant ($p=0.219$ and $p=0.120$, respectively), suggesting that exchange rate effects on transportation costs may operate indirectly or may be difficult to detect with the limited sample size. For Objective 2, the RIR coefficient is positive and significant ($p=0.009$), indicating that interest-rate adjustments are an important transmission channel through which exchange rate pressures affect transportation costs.

DISCUSSION

The insignificant impact of the official exchange rate on CPIT could be because of subsidy buffers, controlled pricing structures or measurement errors in the dataset. It can also be a sign that indicates that the unregistered parallel market rates, which are not captured in the current analysis, have more impact on the cost of transportation than the official rates. Abdou *et al.* (2025) highlights the need for transparent governance in transport policy implementation to ensure devaluation does not undermine sustainable transport goals. These findings impact substantially on economic sustainability: increased costs of transportation are reducing global competitiveness, inflating logistical spending, and unfairly loading susceptible groups, compromising the long-term viability.

POLICY IMPLICATIONS

This research paper provides specific policy guidelines that can help enhance economic stability and sustainability. The main priorities are:

- diversifying energy and transport supply by relying on local renewable sources and electric public transport to eliminate exposure to shocking imports of fuels;
- strengthening social safety nets, such as targeted subsidies or cash transfers, to cushion vulnerable households through transport-driven inflation;
- implementing a flexible exchange rate regime, in tandem with fiscal and monetary policy, to eliminate disruptive devaluations; and
- encouraging local vehicle and parts production to eliminate import dependency.

Devaluation can help exports, but unless structural changes are implemented in the energy, logistics, and production sector, it can lead to an increased cost of transport, inflation, and social pressure. Railways, ports, and integrated logistics corridors are also required to be strategically invested in to reduce costs and develop trade resilience.

LIMITATIONS AND FUTURE RESEARCH

There are significant limitations of this study. This is limited to the small sample (10 annual observations), limiting the statistical power and generalisability. The binary exchange rate liberalisation (ERL) dummy is an oversimplified complex regime. There can be bias brought about by omitted variables, including world oil prices, geopolitical shocks, and COVID-19. The time-series and long-term analysis are constrained by the short time span. Finally, as the research is limited to one country, this restricts comparison with other developing economies.

Future Research Directions

This research has several avenues for future research. First, analysis of panel data in more than one country would increase the external validity and statistical strength. Second, breaking down transport statistics at the sub-sector level (freight, public transit, aviation) may show disparate effects. Third, quantitative results would be incorporated with the use of qualitative approaches, e.g., the interviews with transport companies. Fourth, a longer time horizon and more frequent data (monthly or quarterly) would be more appropriate to short-run dynamics. Finally, structural modelling tools such as the vector auto-regression (VAR) might help explain dynamic relationships among the macro-economic variables in the long run.

CONCLUSIONS

This research includes empirical evidence that shows that the devaluation of currency in Egypt had a great impact. The limitation of statistical power and generalisability is due to the small sample (10 annual observations). The binary exchange rate liberalisation (ERL) dummy is a simplified version of the complex regimes. Missing variables such as world oil prices, geopolitical shocks and COVID-19 can be biased. The time-series and long-term analysis is constrained by the short time span. Finally, the single country concentrate limits the applicability to other developing economies.

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