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Unravelling Capital Investment Horizons: The Mediating Effect of Exchange Rate Volatility on Macroeconomic-Sectoral Investment Nexus in Pakistan

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Abstract

This study investigates the critical mediating role of exchange rate volatility in the relationship between key macroeconomic indicators and sectoral financial investments in Pakistan from 2014 to 2023. Employing a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to quantify exchange rate volatility and mediation analysis in R, we analyse its effect on investments in green finance, roads/dams, and metro projects. Our results reveal that exchange rate volatility is a significant transmission channel, mediating 70% of the effect of oil prices on investments but only 1% of the impact of Foreign Direct Investment (FDI), underscoring FDI's stabilizing role. Tax rates exert a strong direct negative influence, while stock market growth boosts investments but exacerbates volatility via speculative flows. Sectorally, green finance is highly sensitive to tax policy, roads/dams rely on FDI, and metro projects suffer from political reprioritization. The study contributes a dual-channel investment theory and offers policy recommendations, including oil-hedging mechanisms, renewable energy transitions, and sector-specific FDI facilitation, advocating for integrated macroeconomic-infrastructure planning in volatile emerging markets.

Keywords: Exchange Rate Volatility, Infrastructure Financing, GARCH, Mediation Analysis, Pakistan, Macroeconomic Indicators

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1. Introduction

The macroeconomic landscape of Pakistan between 2014 and 2023 was characterized by significant volatility, shaped by internal policy shifts and global economic dynamics. Persistent fiscal imbalances, volatile external accounts, and frequent political transitions created a challenging environment for sustained investment (Dornbusch, 2020). During this period, macroeconomic indicators—including tax rates, trade balance, foreign direct investment (FDI), stock market performance, and fuel prices—played a pivotal role in influencing economic stability and investor confidence. However, exchange rate volatility emerged as a crucial, yet underexplored, transmission channel through which these macroeconomic shocks impacted sectoral investment decisions, particularly in long-gestation infrastructure projects (Guzman et al., 2018; Nauman & Ahmad, 2024).

Infrastructure development, encompassing green finance, transport systems (metro projects), and public construction (roads and dams), is vital for Pakistan's socio-economic development and resilience. Nonetheless, financial flows to these sectors have been inconsistent, heavily influenced by the broader macroeconomic context and fiscal constraints. A key disruptor has been the intense volatility of the Pakistani Rupee (PKR), especially after the transition to a market-based exchange rate regime in 2019 (IMF, 2023). This depreciation eroded investor confidence, altered the cost-benefit calculus of major projects by increasing the cost of imported capital goods and foreign debt servicing, and introduced significant uncertainty into financial planning (Ahmed et al., 2023; State Bank of Pakistan, 2023). These dynamic positions exchange rate volatility not merely as a symptom of macroeconomic conditions but as a potent mediator that can amplify or dampen the effects of those conditions on investment outcomes (Malik & Ahmed, 2021; Husain, 2018).

While extant literature has extensively documented the direct effects of macroeconomic variables on aggregate investment or growth (Rady et al., 2024), a significant gap exists in understanding the *indirect* mechanisms at play. There is a paucity of research that explicitly models how exchange rate volatility transmits the influence of macroeconomic fundamentals to *sector-specific* financial investments (Munim & Schramm, 2019; Degong et al., 2023). This oversight is particularly pronounced for emerging economies like Pakistan, where currency instability is a persistent feature. Previous methodological approaches often treated volatility as a control variable rather than a dynamic mediating construct, thus failing to capture its nuanced role (Kamal et al., 2012).

This study aims to fill these gaps by investigating the mediating effect of exchange rate volatility on the relationship between macroeconomic indicators (tax rates, trade balance, stock market value, FDI, and fuel prices) and financial investments in three critical sectors: green finance, roads/dams, and metro projects. We employ GARCH modeling to accurately capture the time-varying nature of exchange rate volatility and integrate it into a mediation analysis framework using R.

The study is guided by the following research questions:

1. How do macroeconomic indicators influence infrastructure financing in Pakistan across the specified sectors?
2. What is the nature and extent of the mediating effect of exchange rate volatility on this relationship?
3. How can GARCH modeling be effectively utilized to measure and integrate this volatility into a mediation framework?
4. What are the policy implications of these interactions for Pakistan's fiscal, monetary, and developmental strategies?

Our findings confirm that exchange rate volatility is a powerful mediator. For instance, it transmits a substantial portion (70%) of oil price shocks to the investment sectors but negligible portions of FDI effects, highlighting the latter's resilience. The analysis provides a novel, sector-sensitive understanding of Pakistan's investment dynamics, contributing to academic discourse on financial transmission mechanisms and offering evidence-based strategies for policymakers to de-risk infrastructure financing and enhance macroeconomic resilience

2. Literature Review

2.1 Macroeconomic Drivers of Investment: Theoretical and Empirical Foundations

The relationship between macroeconomic conditions and investment is anchored in key economic theories. Keynesian models emphasize the role of fiscal policy and government spending in stimulating investment through multiplier effects (Dornbusch, 2020). However, in Pakistan, a chronically low tax-to-GDP ratio (9–12%) has severely constrained public investment capacity, increasing reliance on private and foreign capital that is highly sensitive to macroeconomic volatility (Nauman & Ahmad, 2024; State Bank of Pakistan, 2023). This aligns with neoclassical theories (Obstfeld & Rogoff, 1995), which highlight that capital flows are driven by risk-adjusted returns. In Pakistan's case, this creates a paradox: foreign direct investment (FDI), such as that under the China-Pakistan Economic Corridor (CPEC), addresses funding gaps but simultaneously introduces currency mismatch risks, as project revenues in rupees must service dollar-denominated debts (Kousar et al., 2018).

The Mundell-Fleming model provides a framework for understanding how monetary policy and capital mobility transmit shocks through the exchange rate in an open economy (Mendoza, 2019). Pakistan's transition to a market-based exchange rate in 2019 exemplified this, but structural rigidities deviated from textbook predictions. For instance, the theoretical export competitiveness gains from depreciation were negated by the manufacturing sector's heavy reliance on imported inputs, with 40–50% of potential gains eroded by higher production costs (Saqib et al., 2021). This underscores the critical role of exchange rate volatility as a mediating force, amplifying or dampening the intended effects of macroeconomic policies on sectoral investments (Husain, 2018).

Empirical evidence on Pakistan confirms these theoretical tensions. Fiscal policy unpredictability, such as frequent changes in withholding tax rates, has disrupted cash flow projections and increased financing costs for construction projects by 2–3 percentage points (Akhtar et al., 2022; Khan et al., 2022). Furthermore, the nation's persistent trade deficit (averaging 5.2% of GDP from 2014–2023) has placed consistent downward pressure on the currency, directly inflating the cost of import-dependent infrastructure projects (World Bank, 2023). The financing structure of these projects often exacerbates this vulnerability; metro rail systems funded by foreign loans saw debt servicing costs surge by 18% in rupee terms following a 10% depreciation, straining public budgets (Buriro et al., 2023).

2.2 Sectoral Investment Responses and Vulnerabilities

The impact of macroeconomic volatility is not uniform across sectors but is instead filtered through sector-specific vulnerabilities, particularly import dependence and financing structures.

Green Finance: Driven by climate commitments, Pakistan's green finance sector has seen initiatives like the SBP's Green Banking Guidelines and a $500 million green bond (Rehman et al., 2022). However, its growth is hamstrung by high import dependence. Renewable energy projects, relying on imported solar panels and turbines, experienced 20–30% cost escalations during periods of sharp rupee depreciation (Jahangir & Ahmed, 2023). This sensitivity is compounded by high hedging costs (3–5%) for foreign currency liabilities, which erode the profit margins that attract private investment (Rehman et al., 2022).

Transport Infrastructure (Metro Projects): Metro rail and CPEC highway projects are cornerstones of development but are highly susceptible to exchange rate swings. The Lahore Orange Line Metro, for example, faced a 15% budget overrun after the 2019 depreciation due to increased costs of imported rolling stock and signaling systems (Hassan & Liu, 2020). The fundamental mismatch between local-currency fare revenues and dollar-denominated debt obligations creates a persistent financial sustainability challenge for these projects.

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Public Construction (Roads and Dams): Mega-projects like the Diamer-Bhasha Dam exhibit "import intensity asymmetry," where currency depreciation inflates the costs of imported turbines and machinery but provides no offsetting revenue benefits. This led the dam's estimated cost to balloon from $3.5 billion to over $5 billion between 2018 and 2023 (Ministry of Finance, 2023). Similarly, CPEC energy projects faced 15–20% cost overruns due to dollar-linked contracts and imported equipment, transferring foreign exchange liability to the public via higher tariffs or government subsidies (Farooq & Khawaja, 2019).

Table 1: *Documented Sectoral Vulnerabilities in Pakistan's Infrastructure Investment*

Sector	Primary Vulnerability	Empirical Impact	Source
Green Finance	Reliance on imported technology & components	20-30% cost escalation during depreciation	(Jahangir & Ahmed, 2023)
Transport (Metro)	FX-denominated debt for imported capital goods	15% budget overrun on Lahore Orange Line	(Hassan & Liu, 2020)
Public Construction	Import-intensive design (e.g., turbines, steel)	Diamer-Bhasha Dam cost rose >40%	(Ministry of Finance, 2023)

2.3 The Mediating Role of Exchange Rate Volatility: Bridging the Gap

A critical gap in the existing literature is the treatment of exchange rate volatility as a control variable rather than a dynamic mediating mechanism. Volatility is not merely a background condition but a transmission channel that modifies the strength and direction of the relationship between macroeconomic fundamentals and investment outcomes (Munim & Schramm, 2019).

For instance, a positive FDI inflow might signal strong investor confidence, but its translation into actual project completion is mediated by currency stability. If exchange rate volatility is high, it can erode the value of future rupee-denominated returns, increase the cost of imported capital goods, and lead investors to demand a 3–5% higher risk premium, thereby muting the positive impact of the initial FDI (Mohsin, 2018). Similarly, an improvement in the trade balance might strengthen the currency, but its benefit for importing green technology is contingent on stable exchange rate expectations.

Previous research has established that Pakistan's exchange rate exhibits persistent volatility clustering, a phenomenon best captured by Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models (Mohsin, 2018; Abbas & Rehman, 2022). However, few studies have integrated these sophisticated volatility measures into a mediation analysis framework to quantify how much of a macroeconomic indicator's effect is transmitted through this channel.

The conceptual framework for this research is explained below in Figure 1

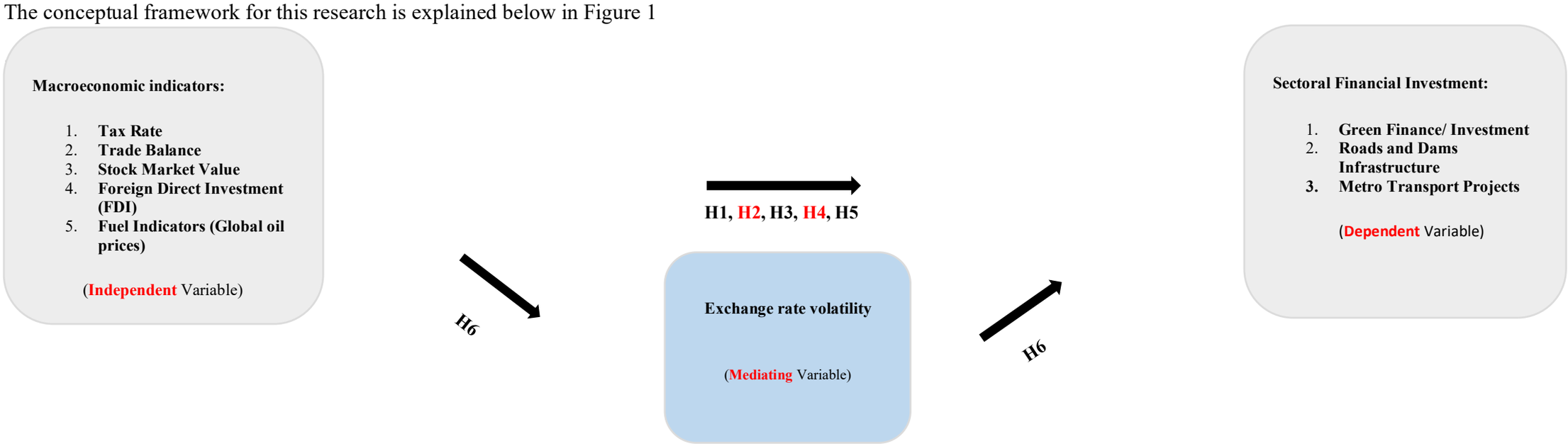

Figure 1*: The Conceptual Framework of Exchange Rate Volatility as a Mediator.*

This study directly addresses this gap. It moves beyond asking *if* macroeconomic indicators affect investment to investigating *how* these effects are transmitted. By modeling exchange rate volatility as a mediator via GARCH, this research quantifies the proportion of the total effect that is channeled indirectly through currency instability, providing a more nuanced and policy-relevant understanding of Pakistan's investment dynamics. This approach is crucial for designing targeted interventions, such as sector-specific hedging instruments or local content policies, that can de-risk infrastructure financing and enhance macroeconomic resilience.

3. Research Methodology

3.1 Research Design and Data

This study employs a **quantitative research design** to analyze the mediating role of exchange rate volatility in the relationship between macroeconomic indicators and sectoral financial investments in Pakistan from 2014 to 2023. The analysis utilizes **monthly secondary data** sourced from the State Bank of Pakistan (SBP), Pakistan Bureau of Statistics (PBS), International Monetary Fund (IMF), and the World Bank.

The methodological approach is executed in three integrated stages:

1. **Measuring the Mediator:** Exchange rate volatility is quantified using a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, which effectively captures the time-varying and persistent nature of currency risk (Bollerslev, 1986; Mohsin, 2018).
2. **Testing Direct Effects:** The direct relationships between macroeconomic indicators and sectoral investments are tested using multiple linear regression (Ordinary Least Squares).
3. **Testing Mediation:** A formal mediation analysis is conducted to decompose the total effect of each macroeconomic indicator into direct and indirect (volatility-mediated) effects.

3.2 Variable Description and Measurement

The variables used in this study, along with their measurements and sources, are summarized in Table 2.

Table 2: *Variable Description, Measurement, and Data Sources*

Variable Type	Variable	Measurement	Source
Independent	Tax Rate	Tax Revenue as a % of GDP	Ministry of Finance (MoF)
	Trade Balance	Net Exports (Current US$)	World Bank (WB)
	Stock Market Value	KSE-100 Index	Pakistan Stock Exchange (PSX)
	Foreign Direct Investment (FDI)	Net Inflows (Current US$)	State Bank of Pakistan (SBP)
	Fuel Prices	Global Brent Crude Oil Price (US$/barrel)	IMF Primary Commodity Prices
Mediator	Exchange Rate Volatility	Conditional Variance (σ^2) from GARCH(1,1) model on PKR/USD returns	Author's calculation based on SBP data
Dependent	Green Finance Investment	Annual Capital Flows to Renewable Energy & Green Projects (US$ Million)	SBP, Ministry of Energy
	Roads/Dams Investment	Public Sector Development Spending on Transport & Water (PKR Billion)	Pakistan Bureau of Statistics (PBS)
	Metro Projects Investment	Capital Expenditure on Urban Transit Systems (PKR Billion)	Ministry of Planning & Development

3.3 Empirical Strategy and Model Specification

The analysis follows a three-step empirical strategy to test the study's hypotheses (H1-H6).

Step 1: Modeling Exchange Rate Volatility (The Mediator)

Exchange rate volatility was modeled using GARCH (1,1) on the log returns of the monthly **PKR/USD exchange rate**:

The model is specified as follows:

$$\boldsymbol{\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2}$$

- ε_t: Residual term.
- σ_t^2: Conditional variance (volatility measure).
- ω: Constant term.
- α: ARCH effect (response to past shocks).
- β: GARCH effect (volatility persistence).

Step 2: Testing Direct Effects (H1-H5)

Multiple linear regressions **(Ordinary Least Squares (OLS) regression)** were used to estimate the direct effects of each macroeconomic variable on aggregated and sector-specific investment outcomes.

$$\textbf{Sectoral Investment}_t = \beta_0 + \beta_1 X_t + \epsilon_t$$

Where:

- Sectoral Investment*:* Sectoral investment at time t
- B_1: Coefficient of interest
- X_t: Macroeconomic variables (tax, trade balance, KSE-100, FDI, oil prices).
- ϵ_t: Error term.

Step 3: Testing Mediation Effects (H6)

The mediating role of exchange rate volatility is tested using a causal mediation analysis framework. The total effect of a macroeconomic variable on investment is decomposed into:

- **Average Direct Effect (ADE):** The effect not transmitted through the mediator.
- **Average Causal Mediation Effect (ACME):** The indirect effect transmitted through exchange rate volatility.

The **proportion mediated** is calculated as ACME/Total Effect, quantifying the share of the total impact that is channeled through exchange rate volatility.

3.4 Software and Estimation

All econometric analyses were conducted in the R programming language. The ***rugarch*** package was used for GARCH modeling, and the mediation package was used for causal mediation analysis (Sales, 2017). Data cleaning and regression analysis were performed using the ***tidyverse*** and ***lmtest*** packages. Robust standard errors were employed in all regressions to correct for heteroscedasticity.

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4. Results and Analysis

4.1 Descriptive Statistics and Trends

The descriptive statistics for the key variables (2014-2023, monthly) are summarized in Table 3. The data reveals significant macroeconomic volatility over the decade. The Pakistani Rupee (PKR) exhibited drastic depreciation, with the exchange rate soaring from a minimum of 97.49 to a maximum of 297.75 PKR/USD, accompanied by high volatility (Mean = 0.025, SD = 0.015). Global oil prices ranged from $18.4 to $122.7 per barrel, highlighting external shocks. Sectoral investments showed divergent patterns: Green Finance was the most variable (SD = 78.32), Roads/Dams investments were consistently the highest on average (Mean = $191.67 Mn), and Metro Projects were intermittent, with some months recording zero investment.

Table 3: *Descriptive Statistics of Key Variables (Monthly, 2014-2023)*

Variable	Mean	SD	Min	Max	N
Corporate Tax Rate (%)	31.08	2.12	29.00	35.00	120
Trade Balance (USD mn)	-223.45	78.32	-358.90	-80.90	120
KSE-100 Index	39,521.67	8,452.14	25,261.03	62,450.76	120
FDI (USD Mn)	165.32	26.81	121.83	214.67	120
Global Oil Price (USD/bbl)	68.12	22.47	18.40	122.70	120
Exchange Rate (PKR/USD)	142.19	55.23	97.49	297.75	120
Exchange Rate Volatility	0.025	0.015	0.010	0.067	120
Green Finance (USD mn)	104.17	78.32	16.67	291.67	120
Roads/Dams (USD mn)	191.67	52.43	135.00	283.33	120
Metro Projects (USD mn)	35.42	37.50	0.00	133.33	120

- **Graphical presentation**

Graphical presentation has been done to see an overview of time series data.

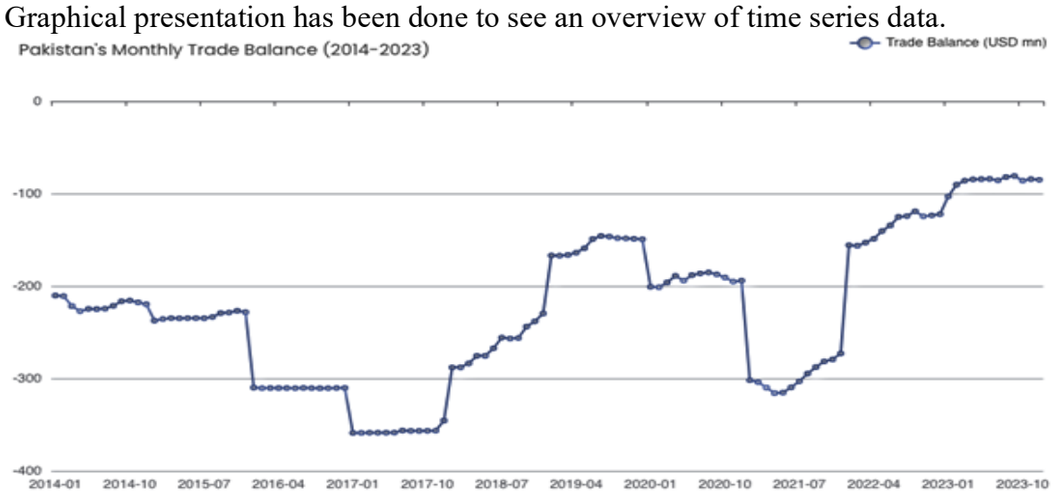

Figure 2: *Pakistan Monthly Trade Balance (2014-2023)*

Figure 3: *Global oil prices over time (2014-2023)*

Figure 4: *FDI position (2014-2023)*

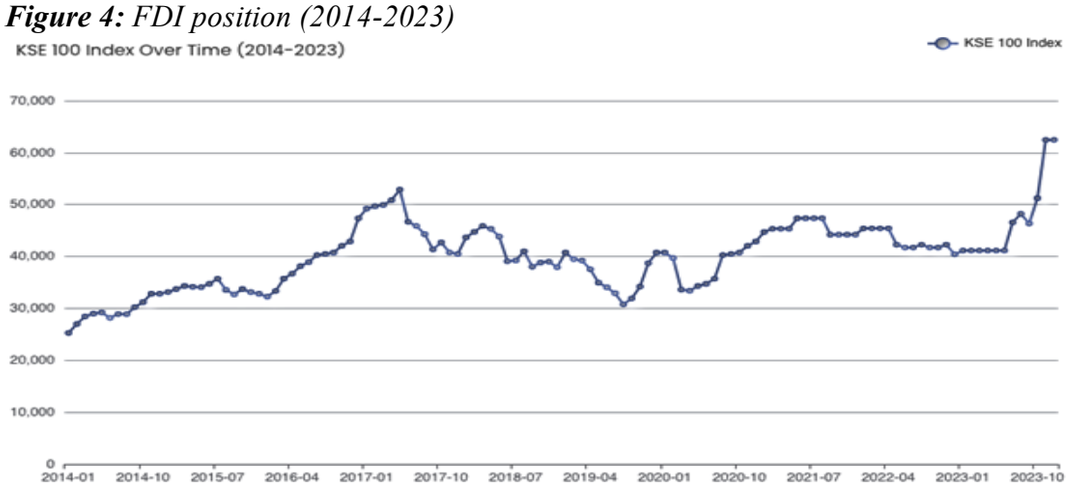

Figure 5: *KSE 100 index over time (2014-2023)*

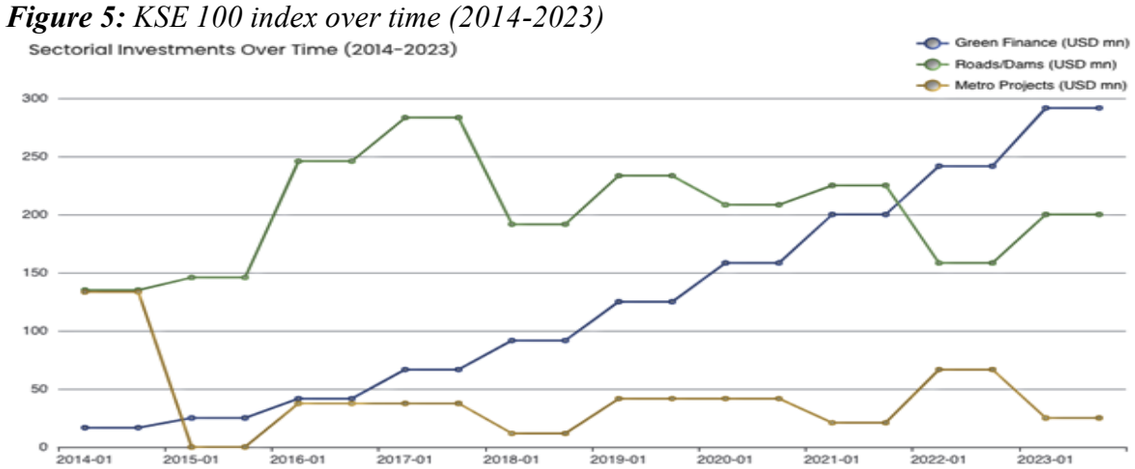

Figure 6: *Sectorial Investment over time (2014-2023)*

4.2 Exchange Rate Volatility Estimation

A GARCH(1,1) model was successfully fitted to the PKR/USD returns to estimate conditional variance ($\sigma^2 t$) as the measure of exchange rate volatility. The model showed high persistence ($\alpha + \beta \approx 0.9$), confirming the clustering of volatility shocks typical of financial time series. The estimated volatility series revealed clear regimes:

- **Low Volatility (2014-2017):** $\sigma t < 0.02$, coinciding with relative macroeconomic stability.
- **High Volatility (2018-2023):** σt spiked to 0.038 during the 2018 balance-of-payments crisis, 0.0395 during the COVID-19 pandemic, and peaked at **0.0675 in September 2023** amid intense political and economic uncertainty.

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Figure 7: *USD/PKR Rate vs. GARCH Volatility (2014–2023)*

Correlation analysis established that this volatility was significantly influenced by key macroeconomic factors. A strong positive correlation was found with global oil prices ($r = 0.58$, $p < 0.001$), confirming that rising energy import costs are a primary driver of PKR instability. A strong negative correlation with the trade balance ($r = -0.51$, $p < 0.001$) further underscores how import-heavy deficits precipitate currency crises.

4.3 Direct Effects of Macroeconomic Indicators (H1-H5)

Regression analysis was employed to test the direct effects of macroeconomic indicators on aggregate sectoral investment. The results, presented in Table 4, reveal significant relationships:

- **Tax Rate (H1):** A significant negative effect was found ($\beta = -2.45$, $p = 0.002$), indicating that a 1% increase in the tax rate reduces sectoral investment by approximately $2.45 million.
- **Trade Balance (H2):** A significant positive effect was confirmed ($\beta = 0.12$, $p = 0.003$), showing that a $1 million improvement in the trade balance increases investment by $0.12 million.
- **KSE-100 Index (H3):** A positive but modest effect was identified ($\beta = 0.003$, $p = 0.003$).
- **FDI (H4):** A strong positive relationship was established ($\beta = 0.45$, $p = 0.003$), where a $1 million increase in FDI inflows leads to a $0.45 million rise in sectoral investment.
- **Global Oil Prices (H5):** The strongest negative effect was observed ($\beta = -0.87$, $p < 0.001$). Each dollar increase in the oil price reduces investment by $0.87 million, highlighting Pakistan's extreme vulnerability to energy price shocks.

Table 4: *Direct Effects of Macroeconomic Variables on Sectoral Investments*

Hypothesis	Predictor	Coeff. (β)	Std. Error	p-value	R^2
H1	Tax Rate (%)	-2.45	0.78	0.002**	0.62
H2	Trade Balance (USD Mn)	0.12	0.04	0.003**	0.41
H3	KSE-100 Index	0.003	0.001	0.003**	0.38
H4	FDI (USD Mn)	0.45	0.15	0.003**	0.35
H5	Oil Price (USD/bbl)	-0.87	0.22	<0.001***	0.58

***p < 0.001, **p < 0.01*

A sectoral disaggregation (Table 5) revealed nuanced drivers:

- **Green Finance** was highly sensitive to **tax rates** ($\beta = -1.20$, $p < 0.001$).
- **Roads/Dams** investment was strongly dependent on **FDI** inflows ($\beta = 0.30$, $p = 0.003$).
- **Metro Projects** showed a unique, modest reliance on the **stock market** ($\beta = 0.002$, $p = 0.010$).

Table 5*: Key Drivers by Investment Sector*

Sector	Key Predictor	Coeff. (β)	p-value	R^2
Green Finance	Tax Rate	-1.20	<0.001***	0.71
Roads/Dams	FDI	0.30	0.003**	0.40
Metro Projects	KSE-100 Index	0.002	0.010*	0.35

***p < 0.001, **p < 0.01, *p < 0.05*

4.4 Mediation Role of Exchange Rate Volatility (H6)

The core of this study was to test the mediating role of exchange rate volatility (H6). The results of the mediation analysis are presented in Table 6.

Table 6: *Mediation Effects of Exchange Rate Volatility*

Path (H6)	ACME	p-value	ADE	Total Effect	Prop. Mediated
a) Tax → Inv.	-0.041	0.039*	-2.51**	-2.55**	16%
b) Trade → Inv.	0.022	0.032*	0.13**	0.15**	15%
c) FDI → Inv.	-0.007	0.108	0.48**	0.47**	1% (NS)
d) KSE → Inv.	-0.002	0.040*	0.004**	0.002**	50%
e) Oil → Inv.	**-0.028**	**0.028***	**-0.89***	**-0.92***	**70%**

ACME: Average Causal Mediation Effect; ADE: Average Direct Effect; NS: Not Significant

The results provide strong evidence for H6, but the extent of mediation varies dramatically by macroeconomic indicator:

1. **Dominant Mediation (70%):** The effect of **oil prices** on investment is overwhelmingly channeled through exchange rate volatility (ACME = -0.028, p = 0.028). This confirms that oil shocks cripple investment primarily by destabilizing the currency.
2. **Partial Mediation (15-16%):** The effects of **tax rates** and **trade balance** are partially mediated, indicating they impact investment through both direct fiscal/revenue channels and indirect volatility channels.
3. **No Mediation (1%): FDI** exhibits no significant mediation effect, suggesting its positive impact on investment is direct and may even help stabilize the exchange rate, acting as a shock absorber.
4. **Speculative Mediation (50%):** The positive effect of the **stock market (KSE-100)** is significantly mediated by *increased* volatility. This counterintuitive finding supports the "hot money" hypothesis, where stock market gains attract speculative capital flows that can increase currency instability, thus mediating the relationship.

- ***4.5 Discussion of Key Findings***

The results confirm that exchange rate volatility is not merely a symptom of macroeconomic conditions but a critical **transmission channel** that significantly alters how these conditions affect investment. The finding that **70% of oil price shocks are mediated by volatility** is particularly crucial for policy, suggesting that oil-hedging mechanisms could be more effective than direct subsidies in protecting infrastructure investments.

The sector-specific results call for a move away from one-size-fits-all investment policies. Instead, targeted approaches are needed:

- **Green Finance:** Stimulated by **tax incentives** and stability.
- **Roads/Dams:** Driven by facilitated **FDI** inflows.
- **Metro Projects:** Require deeper **capital markets** for long-term financing.

The minimal mediation role for FDI underscores its value as a stable source of foreign capital, while the high mediation for the stock market serves as a warning that market growth driven by short-term speculation can inadvertently exacerbate the currency risk it seeks to profit from.

5. Discussion

This study set out to unravel the complex mechanisms through which macroeconomic indicators influence sectoral financial investments in an emerging economy characterized by volatility. Our findings not only confirm significant direct relationships but, more importantly, reveal the **critical and heterogeneous mediating role of exchange rate volatility**. This discussion interprets these results, contextualizes them within the broader theoretical and empirical literature, and elucidates their profound implications for both theory and policy.

5.1 The Primacy of the Mediation Channel

The most salient contribution of this research is the quantification of exchange rate volatility as a transmission channel. The discovery of a **mediation spectrum**—ranging from the negligible effect for FDI (1%) to the overwhelming effect for oil prices (70%)—challenges linear, direct-effect models that dominate the literature on investment in emerging markets (Munim & Schramm, 2019; Kamal et al., 2012).

The finding that **70% of oil price shocks** are mediated through volatility provides robust empirical validation for theoretical work on the "oil-forex-investment trilemma" (Hamilton, 2003; Ratti & Vespignani, 2016). It demonstrates that for an import-dependent economy like Pakistan, an oil price hike is not merely a cost-push inflation event but a **macroeconomic stability crisis**. The shock depletes foreign reserves, triggers currency depreciation, and creates pervasive uncertainty that deters long-term investment commitments. This suggests that policies aimed solely at subsidizing fuel costs are addressing only the symptom (the direct 30% effect) while ignoring the dominant disease: secondary volatility transmission.

Conversely, the **negligible mediation (1%) for FDI** unveils its unique role as a stabilizing force. This result strongly supports the theoretical distinction between stable, long-term FDI and volatile, short-term portfolio flows (Borensztein et al., 1998; Calvo, 1998). FDI, often channeled through bilateral frameworks like CPEC and denominated in foreign currency, appears to bypass domestic currency instability. This grants it a "stability premium," making it the most reliable source of financing for capital-intensive infrastructure projects, a finding with decisive policy implications.

5.2 Reconciling Direct Effects with Theoretical Frameworks

Our results on direct effects largely align with but also refine established theories:

- **Taxation and Investment:** The strong negative direct effect of tax rates supports the neoclassical cost-of-capital theory (Jorgenson, 1962). However, the sectoral disaggregation reveals a critical nuance: green finance is exceptionally tax-sensitive. This suggests that the theory's application must be sector-specific, as the effectiveness of fiscal policy is mediated by a sector's reliance on policy incentives and its stage of market development.
- **Trade Balance and Forex Constraints:** The positive link between trade balance and investment extends the work of Eichengreen and Gupta (2011) by highlighting a **physical forex availability constraint**. In Pakistan's case, the binding constraint on import-dependent projects is not just the price of foreign currency (the exchange rate) but often its outright scarcity.
- **The Dual Nature of Financial Markets:** The positive direct effect of the stock market aligns with Levine and Zervos (1998), who posit that developed capital markets facilitate investment. However, the high mediation effect (50%) revealing a volatility-inducing "hot money" phenomenon (Calvo, 1998) presents a paradox. It indicates that Pakistan's market is in a transitional phase: it provides capital but simultaneously exports instability. This duality calls for a more nuanced view of financial liberalization in emerging economies.

5.3 The Imperative for Sector-Specific Models

A key theoretical advancement of this study is the demonstration that investment drivers are not monolithic. The sectoral analysis **rejects the aggregate approach** of using Gross Fixed Capital Formation (GFCF) as a catch-all variable.

- **Green Finance** operates within a **global policy-environmental complex**, making it highly responsive to domestic fiscal incentives but somewhat insulated from purely domestic macroeconomic cycles.
- **Transport Infrastructure (Roads/Dams)** functions within a **state-FDI nexus**, dependent on bilateral agreements, sovereign guarantees, and long-term capital commitments that are less sensitive to short-term volatility.
- **Metro Projects** exist in a **politico-financial space**, vulnerable to reprioritization and reliant on a mix of concessional loans and capital market sentiment.

This tripartite differentiation necessitates a move away from one-size-fits-all theoretical models toward a more granular, sector-sensitive framework that acknowledges divergent investment logics.

6. Conclusion and Policy Recommendations

6.1 Conclusion

This study provides robust empirical evidence that exchange rate volatility is a critical mediating force in Pakistan's infrastructure investment landscape, fundamentally reshaping the transmission of macroeconomic shocks. The analysis, spanning a volatile decade (2014-2023), yields four central conclusions:

1. **Oil Price Vulnerability is Paramount:** The finding that **exchange rate volatility mediates 70% of oil price effects** on investment is the most significant. It confirms an "oil-forex-investment trilemma" where rising oil imports trigger PKR depreciation, macroeconomic uncertainty, and crippled investment, particularly in fuel-intensive sectors like road construction.
2. **FDI is a Unique Stabilizer:** Foreign Direct Investment (FDI) exhibits a negligible mediation effect (1%), demonstrating its role as a stable, long-term financing source resilient to currency fluctuations. This "stability premium" makes it indispensable for funding Pakistan's infrastructure gap.
3. **Sectoral Drivers are Highly Divergent:** Investment determinants are not monolithic. **Green finance** is highly sensitive to **tax incentives**, **roads/dams** rely on **FDI**, and **metro projects** are susceptible to political reprioritization. This invalidates one-size-fits-all investment policies.
4. **Theoretical Advancement:** The research quantifies a "mediation spectrum," expanding the Mundell-Fleming model by showing how the transmission of macroeconomic shocks is filtered through exchange rate volatility with varying intensity.

In essence, the study establishes that Pakistan's investment challenges are dually structured: they arise from direct macroeconomic pressures and their powerful, indirect propagation through currency market instability.

6.2 Policy Recommendations

Based on these findings, we propose a multi-pronged, sector-sensitive policy framework:

1. Immediate Macro-Stabilization:
   - **Oil Price Hedging:** Implement financial hedging mechanisms (e.g., futures contracts) for a portion of oil imports to immediately mitigate forex market shocks from global price spikes.
   - **Tax Policy Predictability:** Establish multi-year tax guarantees and stable fiscal regimes for infrastructure projects to reduce policy uncertainty that deters investment.
2. Medium-Term Structural Reforms:
   - **Energy Transition:** Accelerate the shift to renewables (solar, wind) to structurally reduce oil import dependence and its associated forex liability. This is the most definitive solution to the oil-forex-investment trilemma.
   - **Export Diversification:** Move beyond traditional sectors and promote exports in IT and pharmaceuticals to earn foreign exchange and alleviate the structural trade deficit that constrains investment.
   - **FDI Facilitation:** Prioritize and streamline FDI, especially in energy and transport, through fast-track approvals, strong contract enforcement, and the development of local currency financing options to de-risk projects.
3. Sector-Targeted Interventions:
   - **For Green Finance:** Design targeted **tax incentives and rebates** (e.g., tax holidays for renewable energy projects) to stimulate private investment.
   - **For Roads/Dams:** Create a favorable environment for **foreign direct investment** through bilateral agreements and investor protection schemes.
   - **For Metro Projects:** Improve **public financial management** and explore innovative financing models like public-private partnerships (PPPs) to shield projects from political budget cycles.
4. Financial Market Development:
   - **Manage Capital Flows:** Implement graduated capital controls and differentiated taxes to curb speculative "hot money" inflows that fuel exchange rate volatility, while encouraging stable FDI.
   - **Develop Local Markets:** Create deep local capital markets for rupee-denominated infrastructure bonds to reduce reliance on volatile foreign financing.

6.3 Limitations and Future Research

This study is not without limitations. The monthly data (2014-2023) may obscure longer infrastructure cycles, and the focus on exchange rate volatility overlooks other potential mediators like political risk or institutional quality. The sectoral analysis, while insightful, could be further disaggregated (e.g., solar vs. wind energy).

Future research should:

- Employ **machine learning techniques** to capture non-linear relationships and complex interactions between variables.
- Incorporate **project-level data** and physical progress indicators to move beyond financial approvals.
- Adopt a **mixed-methods approach** that includes investor surveys to understand the behavioral drivers behind the quantitative trends.
- Expand the **comparative analysis** across other emerging markets to distinguish universal principles from context-specific factors.

Despite these limitations, this study provides a validated blueprint for understanding and addressing infrastructure financing challenges in volatile emerging economies. By demonstrating the critical mediating role of exchange rate volatility, it argues for policy frameworks that simultaneously manage macroeconomic fundamentals and their destabilizing transmission through the currency market.

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