

ASYMMETRIC EFFECTS OF MACROECONOMIC VARIABLES ON STOCK MARKET INDICES: EVIDENCE FROM DEVELOPED AND EMERGING ECONOMIES



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ABSTRACT

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Background: Global financial markets are increasingly integrated, yet the response of stock indices to macroeconomic shocks remains poorly understood in its nonlinear dimensions. Most existing studies adopt symmetric linear frameworks that may fail to capture the differential market reactions to positive and negative macroeconomic changes.

Purpose: This study investigates the asymmetric effects of key macroeconomic variables, namely exchange rates, gross domestic product (GDP), and interest rates, on stock market indices across 56 countries classified into 28 developed and 28 emerging economies over the period 2016Q1 to 2024Q3.

Design/Methodology/Approach: This study employs panel Autoregressive Distributed Lag (ARDL) and panel Nonlinear Autoregressive Distributed Lag (NARDL) models estimated through Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effect (DFE) estimators. The Hausman test is applied to determine the optimal estimator. Asymmetry is formally tested using the Wald test. Unit root analysis uses the Augmented Dickey Fuller (ADF) test, and cointegration is verified via the Kao panel cointegration test.

Findings/Result: The NARDL model consistently outperforms the symmetric ARDL specification across all country groups based on Akaike Information Criterion (AIC). Significant long-run asymmetric effects are identified for all three macroeconomic variables. Currency depreciation exerts a larger negative impact on stock indices than appreciation across both country groups. GDP growth positively drives stock markets in developed economies but has no significant effect in emerging markets. Interest rate cuts generate larger stock market responses than equivalent rate increases. In the short run, GDP and interest rate movements display asymmetric effects in emerging economies, while developed markets are more resilient to short-term macroeconomic fluctuations.

Conclusion: Asymmetric quantitative modeling significantly enriches the understanding of macroeconomic transmission mechanisms in financial markets, with critical implications for monetary policy design and investment risk management in both developed and emerging economies.

Originality/Value: This study provides one of the first comprehensive panel NARDL analyses spanning 56 countries across both developed and emerging markets simultaneously over a post-2016 dataset, explicitly testing directional asymmetry in the GDP, exchange rate, and interest rate transmission to stock markets. The findings advance the limited literature that treats these relationships as symmetric.

Keywords:

asymmetric effects, macroeconomic variables, panel ARDL, panel NARDL, stock market index

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INTRODUCTION

The global stock market landscape has undergone profound transformation over the past decade. Accelerating financial globalization, the progressive dismantling of capital controls, and the rapid adoption of digital trading technologies have deepened cross-border market integration, enabling capital to flow instantaneously across geographies in response to macroeconomic signals (Obstfeld and Taylor, 2004). This integration, while expanding investment opportunities, has simultaneously amplified the transmission of macroeconomic shocks across national equity markets, making stock market indices increasingly sensitive to fluctuations in macroeconomic fundamentals at both domestic and international levels. The consequences extend beyond investor portfolios: volatile stock markets disrupt access to equity financing for corporations, distort currency markets, and undermine the confidence of both foreign and domestic investors in the broader economic environment (Neifar, 2020; Dori et al. 2022).

The period from 2016 to 2024 was particularly turbulent for global equity markets, marked by a sequence of extraordinary macroeconomic disruptions. The escalation of the United States-China trade conflict from 2018 onward introduced persistent uncertainty into global supply chains and suppressed business investment sentiment across major economies. The COVID-19 pandemic in 2020 triggered the sharpest synchronized economic contraction since the Great Depression, with global GDP contracting by approximately 3.1% and stock markets in both developed and emerging economies experiencing sharp declines before recovering at markedly different speeds (IMF, 2021). The subsequent global inflationary surge, driven by supply chain dislocations and energy market disruptions following the Russia-Ukraine conflict, compelled central banks across the world to implement the most aggressive monetary tightening cycles in four decades, with cumulative policy rate increases exceeding 400 basis points in many developed economies by 2023. These episodic shocks produced divergent trajectories across developed and emerging stock markets (Figure 1): market-capitalization-weighted indices of emerging economies rose from a normalized base of 100 in 2016 to approximately 158 by 2024, outpacing their developed market counterparts, which reached only around 128 over the same horizon. This divergence, however, conceals substantial within-

period volatility and asymmetric market behavior that aggregate trend data cannot fully capture.

At the heart of stock market dynamics lies the relationship between macroeconomic fundamentals and equity valuations. Three variables have consistently emerged as primary drivers in the empirical literature: exchange rates, gross domestic product (GDP) growth, and interest rates. Exchange rate movements affect corporate profitability directly through import cost channels and export competitiveness, and indirectly through shifts in investor risk perception (Jorion, 1990). GDP growth signals the trajectory of aggregate demand and corporate earnings, serving as a leading indicator of equity market performance (Cochrane, 1991). Interest rates govern the cost of capital and the relative attractiveness of equity versus fixed-income instruments, thereby influencing portfolio allocation decisions across all investor categories (Bernanke and Kuttner, 2005). Together, these three variables shape the macroeconomic environment within which financial markets operate, and their fluctuations generate continuous reassessments of equity valuations by market participants around the world.

The critical yet underappreciated dimension of this relationship is its asymmetric nature. Real-world financial markets do not respond proportionally and symmetrically to positive and negative macroeconomic changes of equal magnitude. Observers of market behavior during the COVID-19 shock noted that stock indices collapsed within weeks in response to contractionary GDP signals, yet their subsequent recovery was gradual and uneven as growth resumed. Similarly, during the 2022 monetary tightening cycle, equity markets reacted far more sharply to interest rate increases than they had risen during the preceding period of rate cuts, revealing a directional imbalance in market sensitivity. These patterns are consistent with the theoretical prediction that investors are loss-averse and respond more intensely to adverse economic signals than to equivalent favorable ones (Kahneman and Tversky, 1979; Baker and Wurgler, 2006). For policymakers and investors, this asymmetry has profound practical implications: a monetary easing of a given magnitude does not produce a mirror-image market recovery relative to the contraction caused by an equivalent tightening, and currency appreciation does not mechanically reverse the damage caused by an equivalent depreciation episode.

The distinction between developed and emerging economies adds a further layer of complexity. Developed markets benefit from deep institutional infrastructure, sophisticated hedging instruments, credible monetary frameworks, and a diversified investor base that tends to respond rationally to macroeconomic signals. Emerging markets, by contrast, are characterized by greater reliance on commodity exports, thinner capital markets, higher policy rate volatility, and greater susceptibility to sudden capital flow reversals triggered by external shocks (Lusha, 2023; Kumar and Dhankar, 2017). These structural differences imply that the same macroeconomic shock, such as a global interest rate increase or a currency depreciation episode, may transmit to stock markets through fundamentally different channels and with different magnitudes depending on whether the economy is developed or emerging. A global analytical framework that treats both groups under a single symmetric model risks masking these structural disparities and generating misleading inferences for both policymakers and investors.

Despite the growing body of evidence on macroeconomic transmission to stock markets, the existing literature contains three important gaps. First, the majority of studies adopt symmetric, linear specifications that implicitly assume positive and negative macroeconomic shocks generate proportional responses, an assumption that behavioral finance theory and empirical market observation consistently refute (Saidi et al. 2021; Shaikh et al. 2023; Polyzos, 2022). Second, most empirical studies concentrate either exclusively on developed markets, where data quality and institutional stability are higher,

or on individual emerging countries, leaving the comparative cross-country perspective systematically underdeveloped (Kalaycioğlu, 2024). Third, existing studies are predominantly based on pre-2016 data that predate the major macroeconomic disruptions of the trade war era, the pandemic shock, and the post-pandemic monetary normalization cycle, all of which generated conditions for testing asymmetric market responses in unprecedented macroeconomic contexts. Addressing these gaps requires a broad, comparative, and explicitly nonlinear analytical approach applied to a contemporaneous and globally representative dataset. This study investigates the asymmetric effects of exchange rates, GDP, and interest rates on stock market indices across 56 economies spanning both developed and emerging country groups over the period 2016 to 2024. Three research objectives guide the inquiry: (1) to determine whether nonlinear asymmetric modeling produces a superior characterization of the macroeconomic-to-stock-market relationship relative to conventional linear symmetric specifications; (2) to identify the direction and magnitude of asymmetric effects, distinguishing the differential impacts of positive versus negative macroeconomic shocks in both the long run and short run; and (3) to characterize how these asymmetric transmission mechanisms differ between developed and emerging economies. The findings carry direct relevance for monetary policymakers seeking to anticipate market reactions to policy signals, for institutional investors constructing risk models that reflect directional sensitivity, and for financial regulators designing circuit-breaker mechanisms that are calibrated to asymmetric market dynamics.

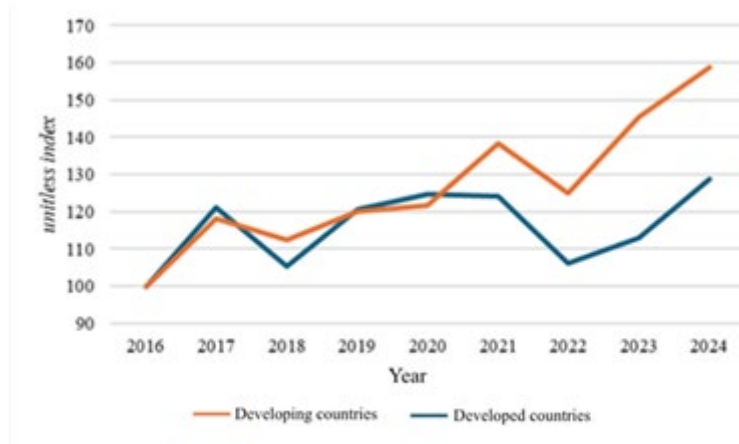


Figure 1. Stock index price movement in developing and developed countries (Investing.com, 2025)

METHODS

This study uses quarterly panel data covering 56 countries (28 developed and 28 emerging), selected based on data availability across all variables, over 2016Q1 to 2024Q3, yielding 1,960 observations. Stock market indices (LNCI) are sourced from Investing.com; nominal interest rates (IR) and exchange rates (LNRER, expressed as local currency units per USD) from CEIC; and nominal GDP (LNGDP) from the International Monetary Fund International Financial Statistics (IFS-IMF). Stock indices, GDP, and exchange rates are transformed to natural logarithms to stabilize variance and facilitate elasticity interpretation. All estimation is conducted in Stata/SC 14.0.

The Arbitrage Pricing Theory (APT) provides the overarching theoretical foundation for this study. Ross (1976) formally demonstrates that the expected return of a financial asset can be represented as a linear function of multiple systematic risk factors:

$$E_i = r_f + \beta_1 F_1 + \beta_2 F_2 + \dots + \beta_n F_n + \varepsilon \quad (1)$$

where E_i denotes the expected return on asset i , r_f is the risk-free rate, β_n represents the sensitivity of the asset to factor F_n , and ε captures idiosyncratic risk. Macroeconomic variables, including exchange rates, GDP, and interest rates, function as the systematic risk factors in this framework, affecting investor expectations and thus asset prices. Unlike the Capital Asset Pricing Model (CAPM), which restricts systematic risk to a single market factor, APT accommodates multiple macroeconomic dimensions simultaneously.

The Dividend Discount Model (Gordon, 1962) provides a complementary micro-level mechanism. The intrinsic value of a stock is expressed as:

$$P_0 = \text{DPS}_1 / (k_e - g)$$

where P_0 is the current stock price, DPS_1 is the expected dividend per share, k_e is the cost of equity, and g is the dividend growth rate. When interest rates rise, k_e increases through the CAPM relation reducing the present value of future dividends and hence stock prices. $k_e = R_f + \beta(R_m - R_f)$ this transmission mechanism creates a direct negative link between interest rate increases and equity valuations, though its magnitude may vary across market development levels.

The Production-Based Asset Pricing Model (Cochrane, 1991) links stock valuations to macroeconomic production fundamentals:

$$P_t = E_t \left[\sum_{i=1}^{\infty} \beta^i \frac{C_{t+i}}{C_t} M_{t+i} \right]$$

where P_t is the current stock price, E_t represents information-based expectations, β is the discount factor, C represents consumption, and M_{t+i} is the marginal return on productive investment. This formulation implies that GDP growth, by raising expected future consumption and firm revenues, should translate positively into stock market performance.

Asymmetric Market Dynamics and Behavioral Finance

The empirical observation that stock markets respond asymmetrically to macroeconomic news is theoretically motivated by Prospect Theory (Kahneman and Tversky, 1979), which establishes the value function:

$$f(x) = \{(x - \lambda x^\lambda)^\alpha, \quad x \geq 0 - \lambda|x|^\beta\}$$

where $\lambda > 1$ indicates stronger sensitivity to losses relative to equivalent gains. Applied to financial markets, this asymmetry predicts that negative macroeconomic shocks generate larger price corrections than positive shocks of identical magnitude. Black (1976) formalizes this through the leverage effect in volatility dynamics, and Baker and Wurgler (2006) extend it empirically through investor sentiment channels.

Behaviorally, negative macroeconomic signals trigger faster and more intense portfolio rebalancing than equivalent positive signals. Byrne et al. (2008) attribute this to cognitive biases including loss aversion, overconfidence, and availability bias. These behavioral mechanisms justify the adoption of nonlinear econometric specifications that explicitly model differential responses to directional changes in macroeconomic variables.

Exchange Rates and Stock Markets

The exchange rate and stock market nexus have generated substantial and contradictory empirical evidence. The Exchange Rate Exposure Theory (Jorion, 1990) predicts that domestic currency depreciation reduces firm profitability through higher import costs

and erodes investor confidence, depressing stock prices. Consistent with this view, Aftab et al. (2021) confirms a significant negative impact of exchange rate movements on emerging market stock indices. El-Diftar (2023) similarly documents significant exchange rate effects on E7 market indices, though with country-specific heterogeneity.

In contrast, Jeyalakshmi et al. (2024) find a positive relationship between exchange rate movements and Chinese stock indices, suggesting that depreciation can boost export-oriented firms listed on domestic exchanges. This sign ambiguity is consistent with the flow-oriented models of Dornbusch and Fischer (1980), which predict that depreciation is expansionary for export-dependent economies, and the stock-oriented models of Frankel (1983), which predict the opposite for capital-account-driven economies.

The asymmetric dimension of this relationship is confirmed by Bhutto (2019) using NARDL for China, finding that post-crisis exchange rate dynamics become asymmetric in the long run. Moussa and Delhoumi (2022) extend this finding to MENA economies, documenting asymmetric short-run effects across Tunisia, Morocco, Egypt, Turkey, and Jordan. Chang et al. (2020) apply Quantile ARDL to confirm strong asymmetric exchange rate effects under heterogeneous market conditions.

GDP and Stock Market Linkages

GDP growth is theoretically expected to drive stock market performance through the production-based asset pricing mechanism. Cochrane (1991) establishes this link formally, and empirical confirmation is provided by Kaushik and Kumar (2023) for India, Kushwaha et al. (2023) for BSE SENSEX, and Najjand et al. (2022) for the Iraqi stock exchange. Bunjaku (2024) provides long-run evidence that GDP growth positively predicts index fund returns across international equity markets.

However, a prominent counterview exists. Siegel (1998) and Ritter (2012) argue that GDP growth does not necessarily translate into shareholder returns, as capital expenditures required for growth dilute per-share earnings. Mora Ros (2018) documents that US GDP growth and S&P 500 returns have diverged substantially over extended periods. Hsu et al. (2022) specifically find that GDP volatility does not predict emerging market stock returns, suggesting that factors such as foreign capital flows and monetary policy are more decisive in these markets.

Interest Rates and Equity Valuations

The negative theoretical relationship between interest rates and stock prices is well established through discount rate mechanics. Bernanke and Kuttner (2005) provide rigorous empirical confirmation for the United States, finding that unexpected Federal Reserve rate increases significantly depress equity prices. Hassan et al. (2024) extend these findings to ASEAN-5 countries, while Hardia and Rezeki (2023) confirm long-run negative effects of central bank rate increases on Indonesian equity prices.

Asymmetric interest rate effects are documented by Moussa and Delhoumi (2022) in the MENA region, with stock markets being more responsive to rate cuts than to equivalent rate increases. For developed markets, Jarunde (2024) observes that rate increases can be associated with rising stock indices when interpreted as confidence signals in a recovering economy, suggesting that the sign of the interest rate effect may reverse depending on business cycle context. Guenich et al. (2022) confirm asymmetric investor sentiment responses to interest rate changes across OECD countries.

Panel ARDL Model

The panel ARDL framework of Blackburne and Frank (2007), building on Pesaran and Shin (1997), models dynamic heterogeneous panels with potentially nonstationary variables:

$$y_{it} = \sum_{j=1}^p \lambda_{ij} y_{i,t-j} + \sum_{j=0}^q \delta'_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it}$$

where y_{it} is the dependent variable (stock index), X_{it} is the vector of macroeconomic regressors, λ_{ij} are autoregressive parameters, δ'_{ij} are distributed lag parameters, captures cross-sectional fixed effects, and μ_i is the error term.

Panel NARDL Model

The NARDL model of Shin et al. (2014) decomposes each macroeconomic regressor into partial sums of positive and negative changes:

$$x_t^+ = \sum_{j=1}^t \Delta x_j^+ = \sum_{j=1}^t (\Delta x_j, 0)$$

$$x_t^- = \sum_{j=1}^t \Delta x_j^- = \sum_{j=1}^t (\Delta x_j, 0)$$

The nonlinear asymmetric cointegration equation is then:

$$y_t = \beta^+ x_{it}^+ + \beta^- x_{it}^- + u_{it}$$

where β^+ and beta β^- are long-run asymmetric parameters.

The model formulation used in this study refers to Algoni and Ivrendi (2024), who analyzed the symmetric and asymmetric impacts of interest rates, taxes, exchange rates, oil prices, and gold prices on the Turkish stock market (BIST100). This was followed by research conducted by Sek et al. (2023), which examined how global commodity prices and the productivity of each agricultural sub-sector can contribute to economic growth, and whether these effects are symmetric or asymmetric. This was further refined by research by Ceylan and Ceylan (2023), which analyzed the symmetric and asymmetric relationships between macroeconomic variables and stock prices in Fragile Five countries. Furthermore, this study used only two models: ARDL and NARDL, with short-term and long-term perspectives. Furthermore, this study used 56 countries as research objects, where these countries were divided into two groups: developed and developing countries. The models used are as follows:

Model 1 (symmetric ARDL) all countries

$$\begin{aligned} \Delta \ln CI_{it} = & \alpha_{0i} + \partial_{1i} IR_{i,t-1} + \partial_{2i} \ln GDP_{i,t-1} + \partial_{3i} \ln RER_{i,t-1} \\ & + \beta_{4i} DT_{i,t-1} + \sum_{j=1}^{p1} \beta_{1ij} \Delta IR_{i,t-j} + \sum_{j=0}^{p2} \beta_{2it} \Delta \ln GDP_{i,t-j} \\ & + \sum_{j=0}^{p3} \beta_{3it} \Delta \ln RER_{i,t-j} + \varepsilon_{it} \end{aligned}$$

Model 2 (symmetric ARDL) developed and developing countries

$$\begin{aligned} \Delta \ln CI_{it} = & \alpha_{0i} + \partial_{1i} IR_{i,t-1} + \partial_{2i} \ln GDP_{i,t-1} \\ & + \partial_{3i} \ln RER_{i,t-1} + \sum_{j=1}^{p1} \beta_{1ij} \Delta IR_{i,t-j} + \\ & \sum_{j=0}^{p2} \beta_{2it} \Delta \ln GDP_{i,t-j} + \sum_{j=0}^{p3} \beta_{3it} \Delta \ln RER_{i,t-j} \\ & + \varepsilon_{it} \end{aligned}$$

Model 3 (asymmetric NARDL) all countries

$$\begin{aligned} \Delta \ln CI_{it} = & \alpha_i \lambda_{i,t-1} + \rho CI_{i,t-1} + \theta_{i1}^+ IR_{i,t-1}^+ + \theta_{i2}^- IR_{i,t-1}^- \\ & + \theta_{i3}^+ \ln GDP_{i,t-1}^+ + \theta_{i4}^- \ln GDP_{i,t-1}^- + \theta_{i5}^+ \ln RER_{i,t-1}^+ \\ & + \theta_{i6}^- \ln RER_{i,t-1}^- + \sum_{i=1}^{p-1} \phi_{ij} \Delta CI_{i,t-i} + \\ & + \sum_{i=0}^{q-1} \pi_{ij1}^+ \Delta IR_{i,t-i}^+ + \sum_{i=0}^{q-1} \pi_{ij1}^- \Delta IR_{i,t-i}^- \\ & + \sum_{i=0}^{q-1} \pi_{ij2}^+ \Delta \ln GDP_{i,t-i}^+ + \sum_{i=0}^{q-1} \pi_{ij2}^- \Delta \ln GDP_{i,t-i}^- \\ & + \sum_{i=0}^{q-1} \pi_{ij3}^+ \Delta \ln RER_{i,t-i}^+ + \sum_{i=0}^{q-1} \pi_{ij3}^- \Delta \ln RER_{i,t-i}^- \\ & + \pi_{4it} DT_{i,t-j} + \varepsilon_{it} \end{aligned}$$

Model 4 (asymmetric NARDL) developed and developing countries

$$\begin{aligned} \Delta \ln CI_{it} = & \alpha_i \lambda_{i,t-1} + \rho CI_{i,t-1} + \theta_{i1}^+ IR_{i,t-1}^+ + \theta_{i2}^- IR_{i,t-1}^- \\ & + \theta_{i3}^+ \ln GDP_{i,t-1}^+ + \theta_{i4}^- \ln GDP_{i,t-1}^- + \theta_{i5}^+ \ln RER_{i,t-1}^+ \\ & + \theta_{i6}^- \ln RER_{i,t-1}^- + \sum_{i=1}^{p-1} \phi_{ij} \Delta CI_{i,t-i} + \sum_{i=0}^{q-1} \pi_{ij1}^+ \Delta IR_{i,t-i}^+ \\ & + \sum_{i=0}^{q-1} \pi_{ij1}^- \Delta IR_{i,t-i}^- + \sum_{i=0}^{q-1} \pi_{ij2}^+ \Delta \ln GDP_{i,t-i}^+ \\ & + \sum_{i=0}^{q-1} \pi_{ij2}^- \Delta \ln GDP_{i,t-i}^- + \sum_{i=0}^{q-1} \pi_{ij3}^+ \Delta \ln RER_{i,t-i}^+ \\ & + \sum_{i=0}^{q-1} \pi_{ij3}^- \Delta \ln RER_{i,t-i}^- + \varepsilon_{it} \end{aligned}$$

The long-run asymmetric multipliers are recovered $\beta^+ = -\theta^+/\rho$ and $\beta^- = -\theta^-/\rho$.

Estimation Strategy and Asymmetry Testing

Three estimators are compared: Mean Group (MG), which allows full parameter heterogeneity across panels; Pooled Mean Group (PMG), which constrains long-run coefficients to be homogeneous while permitting short-run heterogeneity; and Dynamic Fixed Effect (DFE), which imposes homogeneity in both dimensions. The Hausman test is applied sequentially (PMG vs. MG, then MG vs. DFE) to select the most efficient consistent estimator. PMG is preferred under slope homogeneity in the long run, while MG or DFE are selected when significant parameter heterogeneity exists.

Stationarity is assessed using the panel Augmented Dickey-Fuller (ADF) test. Panel cointegration is tested using the Kao (1999) procedure, which is robust to panels with more than seven variables, unlike the Pedroni approach. Optimal lag length is determined by minimizing the Akaike Information Criterion (AIC).

Formal testing of long-run and short-run asymmetry employs the Wald test with null hypotheses $H_0 = \beta^+ = \beta^-$ (long run) and $H_0: \sum_{it}^q \phi_{it}^+ = \sum_{it}^q \phi_{it}^-$ (short run). Rejection of H_0 confirms asymmetric effects and validates the NARDL framework over the linear ARDL specification.

The interest rate differential between country groups is economically significant: emerging market average policy rates of 5.75% contrast with developed market rates of 1.48%, reflecting the persistent use of higher rates in emerging economies to anchor inflation expectations and attract foreign capital (Hassan et al. 2024). These structural differences underscore the importance of analyzing the two groups separately rather than pooling observations.

RESULTS

Descriptive Statistics

Table 1 presents summary statistics for all variables across the full sample and by country group. Substantial heterogeneity is evident. Emerging market stock indices display a mean of 12,084.85 with a standard deviation of 17,523.43, substantially larger than the developed market mean of 6,294.51 (SD: 7,294.42). This reflects the high-growth, high-volatility profile characteristic of emerging financial markets documented by Kumar and Dhankar (2017). Exchange rate heterogeneity is similarly pronounced, with emerging market rates averaging 843.11 local currency units per USD compared with 56.63 for developed economies, reflecting deep structural differences in monetary regimes and purchasing power.

Unit Root and Cointegration Results

Table 2 reports ADF panel unit root test results for all countries. LNCI and LNRER are nonstationary at levels but achieve stationarity at first difference, confirming integration of order one I (1). LNGDP and IR achieve stationarity at levels in most specifications, consistent with mixed-order integration. All partial sum decompositions for the NARDL model (LNER+, LNER-, LNGDP+, LNGDP-, IR+, IR-) are nonstationary at levels but stationary at first differences, satisfying the conditions for NARDL estimation as specified by Shin et al. (2014). Table 3 reports ADF panel unit root test results at first difference for both developed and emerging country groups.

Table 1. Descriptive statistics of research variables

Variable	Obs	Mean	Std Dev	Min	Max
All Countries					
Stock Index	1.960	9.189.68	13.727.13	50.06	84.299.78
Exchange Rate	1.960	449.87	1.985.98	0.70	16.329.39
GDP (USD million)	1.960	6.83	3.71	6.38	3.279.593.500
Interest Rate (%)	1.960	3.62	4.31	-0.79	27.25
Developed Countries					
Stock Index	980	6.294.51	7.294.42	304.91	40.369.44
Exchange Rate	980	56.63	223.14	0.70	1.396.37
Interest Rate (%)	980	1.48	2.48	-0.79	20.00
Emerging Countries					
Stock Index	980	12.084.85	17.523.43	50.06	84.299.78
Exchange Rate	980	843.11	2.744.61	0.71	16.329.39
Interest Rate (%)	980	5.75	4.69	0.00	27.25

Note: *, **, *** denote significance at 10%, 5%, and 1% respectively.

Table 2. Panel ADF Unit Root Test Results (All Countries)

Variable	Level Stat	Prob	First Diff Stat	Prob	Order
All Countries					
LNCI	101.06	0.762	707.01	0.000***	I (1)
LNRER	122.51	0.234	673.40	0.000***	I (1)
LNGDP	390.40	0.000***	2329.32	0.000***	I (1)
IR	150.10	0.010**	262.88	0.000***	I (1)
LNER+	18.07	1.000	679.94	0.000***	I (1)
LNER-	34.04	1.000	612.71	0.000***	I (1)
LNGDP+	13.02	1.000	1897.97	0.000***	I (1)
LNGDP-	13.91	1.000	1706.56	0.000***	I (1)
IR+	34.29	1.000	342.12	0.000***	I (1)
IR-	22.97	1.000	322.59	0.000***	I (1)

Note: *, **, *** denote significance at 10%, 5%, and 1% respectively. All partial sum decompositions are I (1).

Table 3. Panel ADF unit root test results at first difference: developed and emerging countries

Variable	Developed Countries		Emerging Countries		Integration Order
	Statistic	Prob	Statistic	Prob	
DLNCI	363.48	0.000***	343.52	0.000***	I (1)
DLNRER	334.59	0.000***	338.80	0.000***	I (1)
DLNGDP	1154.09	0.000***	1175.24	0.000***	I (1)
DIR	112.39	0.000***	159.49	0.000***	I (1)
DLNER+	352.22	0.000***	327.72	0.000***	I(1)
DLNER-	316.99	0.000***	295.73	0.000***	I (1)
DLNGDP+	935.88	0.000***	962.09	0.000***	I (1)
DLNGDP-	892.50	0.000***	814.07	0.000***	I (1)
DIR+	131.48	0.000***	210.65	0.000***	I (1)
DIR-	104.75	0.000***	217.83	0.000***	I (1)

Note: D prefix denotes first difference. ***, ** denotes significance at 1% and 5%. All variables are I (1) at first difference for both country groups.

The Kao panel cointegration test confirms significant long-run relationships for all models and across all country groups, as presented in Table 4. All *p-values* equal 0.000 for ARDL models and 0.000 or 0.001 for NARDL models, decisively rejecting the null of no cointegration at the 1% significance level. The Kao procedure is preferred over the Pedroni test in this study because it remains valid for models with more than seven variables, a constraint that would otherwise render the Pedroni test unreliable for the NARDL specifications. Optimal lag structures selected by AIC are (1,1,1,1) for ARDL and (2,1,1,1,1,1,1,1,1,1) for NARDL. The confirmed cointegration across all groups validates the error correction interpretation of both models and establishes that stock markets maintain a stable long-run equilibrium relationship with exchange rates, GDP, and interest rates.

Estimator Selection: Hausman Test

Table 5 presents Hausman test results for estimator selection. For the ARDL model, PMG is preferred for the full sample and emerging economies, while the DFE estimator is selected for developed economies based on sequential Hausman testing (PMG vs. MG: $p = 0.014$; MG vs. DFE: $p = 0.041$). For the NARDL model, PMG is selected for all three country groups, as Hausman statistics fail to reject the null of long-run slope homogeneity. These results imply that the long-run transmission of macroeconomic variables to stock indices follows a common structural pattern within each country group, while short-run dynamics remain heterogeneous.

Table 4. Kao panel cointegration test results

Model	Country Group	Test Statistic	Prob
ARDL	All Countries	-9.0649	0.000***
NARDL	All Countries	-6.1246	0.000***
ARDL	Developed Countries	-8.7051	0.000***
NARDL	Developed Countries	-6.8429	0.000***
ARDL	Emerging Countries	-4.9163	0.000***
NARDL	Emerging Countries	-3.6744	0.000***

Note: ***, ** denotes significance at 1% and 5%. H0: no cointegration. All models reject H0 at the 1% significance level.

Table 5. Hausman test results for estimator selection

Model	ARDL		NARDL	
	PMG vs MG	MG vs DFE	PMG vs MG	MG vs DFE
All Countries	0.5116	-	0.7448	-
Developed	0.0136**	0.0408**	0.4712	-
Emerging	0.5444	-	0.0760*	-

Note: **, * denote significance at 5% and 10%. A significant Hausman statistic indicates rejection of the more restricted estimator.

Model Comparison: ARDL versus NARDL

Model selection based on AIC unambiguously favors the NARDL specification. For the full sample, AIC improves from -4,620.40 (ARDL) to -5,036.12 (NARDL). For developed economies, the improvement is from -2,442.51 to -2,504.87, and for emerging economies from -2,138.33 to -2,368.87. These differences exceed conventional threshold margins and indicate that the nonlinear asymmetric specification captures systematic variation in stock market behavior that the linear model cannot accommodate. The superior NARDL performance is consistent with findings by Chang et al. (2020) and Moussa and Delhoumi (2022), who similarly document that linear ARDL specifications underfit stock market data relative to their asymmetric counterparts.

Error correction terms (ECT) are negative and statistically significant at the 1% level across all models, confirming the validity of the long-run cointegrating relationships and the existence of mean-reverting dynamics. For the NARDL, speed of adjustment is -0.413 for the full sample, -0.427 for developed economies, and -0.413 for emerging economies, implying that approximately 41% to 43% of quarterly deviations from the long-run equilibrium are corrected within one period. These adjustment speeds are substantially faster than those reported in bilateral NARDL studies, likely reflecting the efficiency of larger panel datasets in capturing average dynamic behavior.

Long-Run Asymmetric Effects

Table 6 consolidates the main NARDL estimation results. Long-run Wald tests confirm asymmetric effects for all three variables across all country groups, with the exception of short-run exchange rate symmetry.

Exchange Rate Asymmetry

In the long run, currency depreciation (positive LNER change, i.e., domestic currency weakening against USD) significantly reduces stock indices across all country groups, while currency appreciation has a smaller but also negative effect through different transmission channels. For the full sample, the depreciation coefficient is -1.693 versus the appreciation coefficient of -0.522, indicating that a 1% depreciation reduces stock indices by 1.693% while a 1% appreciation raises indices by only 0.522%. The asymmetric pattern is similar for developed markets (-1.434 vs. -0.920).

These findings are consistent with the Exchange Rate Exposure Theory (Jorion, 1990) and align with Bhutto (2019) for China and Moussa and Delhoumi (2022) for MENA countries. The dominant negative effect of depreciation across all groups reflects that import cost inflation, reduced foreign investor confidence, and heightened uncertainty outweigh any export competitiveness gains. This is particularly relevant for countries with high commodity import dependence, where depreciation is directly transmitted to production costs.

Table 6. Estimation results of long-term and short-term asymmetric relationships and influences

Variable	All Countries		Developed		Emerging	
	Coef	Prob	Coef	Prob	Coef	Prob
Long-run Coefficients (NARDL)						
LNER+	-1.6931	0.0000***	-1.4337	0.0000***	-0.8015	0.0690*
LNER-	-0.5224	0.0000***	-0.9198	0.0000***	0.3269	0.0000***
LNGDP+	0.3553	0.0000***	0.5005	0.0040***	0.2465	0.2940
LNGDP-	-0.0336	0.8200	-0.1669	0.3520	0.1499	0.5550
IR+	0.0317	0.0000***	0.0403	0.0000***	0.0061	0.2990
IR-	-0.0780	0.0000***	0.0798	0.0000***	-0.1276	0.0000***
Short-run Coefficients (NARDL)						
Δ LNCI (-1)	-0.0531	0.1120	-0.0708	0.0530**	-0.1819	0.090**
Δ LER+	-0.1403	0.6060	0.2272	0.6720	-0.9007	0.0000***
Δ LER-	-0.5369	0.0570**	-0.8013	0.1130	-0.5614	0.0400**
Δ LNGDP+	-0.4953	0.0000***	-0.5562	0.0010***	-0.2883	0.0570*
Δ LNDGP-	0.5456	0.0000***	0.6292	0.0000***	0.3592	0.1580
Δ IR+	-0.0120	0.4860	-0.0038	0.9060	-0.0301	0.0090***
Δ IR-	0.0855	0.0000***	0.0227	0.3320	0.1020	0.0010***
DT	0.0029	0.0001***				
C	5.9760	0.0000***	1.1953	0.0300**	6.6574	0.0000***
Wald Test for Asymmetry						
WLRER (LR)		0.0000***		0.0304**		0.0000***
WLRGDP (LR)		0.0000***		0.0000***		0.0731*
WLRIR (LR)		0.0000***		0.0000***		0.0000***
WSRGDP (SR)		0.4501		0.3191		0.3568
WSRIR (SR)		0.0000***		0.0001***		0.0894**
Model Fit						
AIC	-5,234.31		-2,655.72		-2,447.81	
ECT	-0.413***		-0.427***		-0.413***	

Note: ***, **, * denote significance at 1%, 5%, and 10%. WLRER, WLRGDP, WLRIR are Wald tests for long-run asymmetry; WSRGDP, WSRIR are Wald tests for short-run asymmetry.

Emerging markets exhibit a distinct pattern: both depreciation and appreciation reduce stock indices (coefficients: depreciation -0.802, appreciation +0.327 but negative directional impact on the index level). This dual-directional negative sensitivity reflects structural vulnerabilities specific to emerging economies. Depreciation elevates import costs and triggers capital flight, while appreciation reduces export competitiveness for commodity-exporting firms that dominate many emerging market indices. This finding contrasts with the developed market pattern and is consistent with Aftab et al. (2021) and Kilic et al. (2023), who document that emerging market stock indices are particularly exposed to exchange rate volatility regardless of direction.

In the short run, exchange rate effects are significant only for emerging markets, where both appreciation and depreciation reduce stock indices within the

quarter (appreciation: -0.901, depreciation: -0.561). No short-run asymmetry is detected in any country group (Wald tests insignificant), consistent with the finding by Wibowo (2021) that developed market investors prioritize long-run fundamentals over short-run currency movements. The larger coefficient magnitude in the short run for emerging markets reflects their structural exposure to external shocks, limited hedging instrument availability, and higher sensitivity to capital flow reversals.

GDP Asymmetry

Long-run GDP results diverge sharply between developed and emerging economies. For developed markets, GDP growth exerts a significant positive effect on stock indices (coefficient: 0.501), while GDP contraction is statistically insignificant. This pattern is described as positive news asymmetry by Soroka (2006)

and is consistent with the efficient market hypothesis (Fama, 1991): markets quickly incorporate positive economic signals in the form of rising GDP into equity prices, while contractions may be anticipated through leading indicators and are therefore already partially priced.

For emerging markets, neither GDP growth nor contraction significantly influences stock indices in the long run, a finding that challenges the conventional wisdom of a strong GDP-to-market link. This result aligns with Ritter (2012), who argues that GDP growth does not automatically translate into shareholder returns, and with Hsu et al. (2022), who find that GDP volatility is a poor predictor of emerging market equity returns. In these economies, stock markets represent a smaller fraction of overall economic activity, and growth is frequently driven by sectors such as informal commerce, public investment, and subsistence agriculture that are poorly represented in market capitalization. This structural decoupling between GDP and equity markets in emerging economies suggests that factors such as monetary policy stances, foreign portfolio flows, and commodity prices exercise greater influence on index performance.

In the short run, GDP dynamics display a counterintuitive pattern across all groups: GDP growth reduces stock indices in the same quarter (full sample: -0.495; developed: -0.556; emerging: -0.288), while GDP contraction is associated with index increases (full sample: +0.546; developed: +0.629). This short-run reversal is consistent with the counterintuitive response mechanism identified by Meng et al. (2022) and Harsanico and Sugiyanto (2021): growth signals trigger expectations of monetary tightening and inflationary pressures, which depress equity valuations in the short run. Conversely, contractionary signals prompt anticipation of expansionary monetary responses, supporting market recovery. This asymmetric short-run behavior is confirmed by Wald tests for all country groups.

Interest Rate Asymmetry

Interest rate results reveal the most pronounced asymmetry and the sharpest divergence between developed and emerging economies. For the full sample and emerging economies, interest rate cuts significantly raise stock indices (full sample: -0.078, i.e., a 1% rate cut raises indices by 7.8%; emerging: -0.128, i.e., 12.76%

increase). Rate increases also positively affect stock indices in the full sample (coefficient: 0.032), though with a smaller magnitude. This differential confirms that rate cuts generate disproportionately larger market responses than equivalent rate increases, consistent with the loss aversion mechanism of Kahneman and Tversky (1979) and the sentiment model of Baker and Wurgler (2006).

Developed markets exhibit a fundamentally different pattern: both rate increases (coefficient: +0.040) and rate cuts (-0.080) are statistically significant, but the directional interpretation reverses relative to standard theory. Rate increases in developed markets are associated with rising stock indices, while rate cuts correspond with index declines. This finding supports the interpretation by Jarunde (2024) and Bernanke and Kuttner (2005) that in mature financial systems with well-anchored expectations, rate increases signal economic strength and policymaker confidence in the recovery trajectory, boosting investor sentiment. Conversely, rate cuts in developed markets may signal economic weakness or deflationary risk, generating pessimistic investor sentiment.

In the short run, interest rate effects are significant only for emerging economies. Rate increases reduce stock indices (-0.030) while rate cuts have the opposite effect (+0.102). Developed market indices are insensitive to short-run interest rate changes, consistent with Chen et al. (2022), who attribute this to stronger monetary policy credibility and more efficient expectations formation in developed markets. Both the full sample and emerging economies exhibit significant short-run interest rate asymmetry by Wald test.

Country-Level Heterogeneity

The PMG estimator permits short-run coefficients to vary across countries, revealing important within-group heterogeneity. For developed markets, Sweden and Israel exhibit negative stock market responses to exchange rate appreciation, in contrast to the positive aggregate pattern. This reflects the currency denomination effect: Swedish and Israeli multinationals earn substantial foreign currency revenues that are worth less when converted to a stronger domestic currency, reducing reported earnings and equity valuations (Baeriswy et al. 2024). For emerging markets, Kazakhstan and Botswana show positive stock market responses to currency depreciation, opposite

to the aggregate emerging market pattern, likely due to the dominant weight of commodity export firms in these indices that benefit from improved international price competitiveness (Ilalan and Pirgaip, 2019).

In Ireland, GDP contraction is associated with rising stock indices in the short run, consistent with the well-documented divergence between Irish GDP (inflated by multinational profit booking) and domestic economic conditions (McCarthy, 2012). France exhibits a positive short-run stock market response to rate cuts, contrasting with the aggregate developed market pattern and reflecting stronger monetary policy transmission through household credit channels in the French economy. These country-level findings reinforce the importance of allowing for cross-sectional heterogeneity in short-run dynamics, as imposed by the PMG estimator.

Policy Implications

The asymmetric transmission documented in this study carries direct implications for monetary and fiscal policy design. For emerging economy central banks, the finding that rate cuts generate substantially larger stock market responses than rate increases implies that monetary easing should be communicated carefully to avoid being interpreted as a distress signal. The larger exchange rate sensitivity in emerging markets suggests that foreign exchange reserve management and hedging instrument development should be prioritized to buffer external shocks.

For developed market policymakers, the positive stock market response to rate increases underscores the importance of clear guidance. Markets in developed economies appear to interpret rate increases as confidence signals rather than tightening shocks, provided communication is transparent. The GDP-to-market decoupling in emerging economies implies that market development policies, including expanding the range of listed companies, improving investor protection, and deepening financial literacy, are necessary preconditions for GDP growth to effectively support equity market performance.

For investment practitioners, the asymmetric dynamics documented here suggest that portfolio risk models relying on symmetric volatility assumptions will systematically underestimate downside risk in emerging markets during currency depreciation episodes and

during positive GDP surprise events in developed markets. Incorporating directional asymmetry into factor models aligned with the APT framework would improve risk-adjusted performance measurement.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study provides comprehensive evidence that macroeconomic transmission to stock market indices is fundamentally asymmetric, with critical differences between developed and emerging economies. Three principal conclusions emerge from the panel NARDL analysis of 56 countries over 2016Q1 to 2024Q3.

First, the nonlinear NARDL specification consistently outperforms the symmetric ARDL model across all country groups based on AIC, confirming that linear frameworks inadequately characterize financial market dynamics. Second, long-run asymmetric effects are statistically significant for exchange rates, GDP, and interest rates in developed markets, and for exchange rates and interest rates in emerging markets. Currency depreciation exerts a disproportionately larger negative impact than appreciation across all groups, consistent with loss aversion in investor behavior. GDP growth drives developed market indices positively but has no significant long-run effect in emerging economies, reflecting structural decoupling between economic growth and listed market capitalization. Interest rate cuts generate larger stock market responses than rate increases globally, while developed markets uniquely exhibit positive reactions to rate increases interpreted as economic confidence signals. Third, short-run asymmetry is more prominent in emerging than in developed markets, with GDP and interest rate movements displaying significant directional asymmetry in emerging economies while developed markets exhibit greater resilience to short-term macroeconomic fluctuations.

Recommendations

These findings support the following policy and research recommendations. Monetary authorities in emerging economies should accompany interest rate and exchange rate interventions with transparent forward guidance to prevent adverse misinterpretation of policy signals. Emerging market governments should

prioritize structural financial market development to strengthen the GDP-to-equity transmission mechanism. Future research should investigate the role of institutional quality, financial openness indices, and commodity price exposure as moderators of asymmetric macroeconomic transmission. Incorporating crisis period indicators and testing for structural breaks in asymmetry parameters would extend the analytical framework. Additionally, sectoral panel NARDL analysis could uncover heterogeneity in asymmetric sensitivity that is masked by aggregate index-level estimation.

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