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Does the Marshall-Learner Condition Hold for Pakistan? Exchange Rate Elasticity, and the Long-Run Determinants of Export Earnings

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Abstract

Pakistan's external sector is characterised by persistent current account deficits, chronic exchange rate pressure, and a structurally narrow export base that has failed to keep pace with regional competitors over four decades. This study examines the short-run and long-run macroeconomic determinants of Pakistan's export earnings over the period 1976–2019, focusing on four theoretically motivated drivers: the nominal exchange rate (ER), foreign direct investment (FDI), domestic inflation (INF), and real GDP per capita growth (GDP). Annual time-series data from the World Development Indicators are analysed using the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration (Pesaran et al., 2001), supplemented by an error correction model (ECM), pairwise Granger causality tests, and a full suite of residual diagnostics including serial correlation, heteroskedasticity, and CUSUM parameter-stability tests. The bounds test yields an F-statistic of 11.330, far exceeding the 1% upper critical bound, establishing a robust long-run cointegrating relationship. Long-run estimates show that exchange rate depreciation is the dominant driver of export earnings, with an elasticity of 1.521 — a finding consistent with the Marshall-Lerner condition holding for Pakistan over the full sample. Inflation enters positively but modestly, reflecting the nominal exchange rate transmission channel. FDI and GDP are individually insignificant in the long run, a result attributed to the sectoral concentration of FDI in Pakistan's non-tradable infrastructure and energy sectors. A novel finding is the oscillating short-run FDI dynamic — positive contemporaneously, negative at lags one and two, and positive again at lag three — consistent with an investment gestation period in which newly committed FDI initially draws in capital-goods imports before activating export capacity. The ECT coefficient of −0.388 implies adjustment toward equilibrium at approximately 39% per annum. Granger causality is bidirectional among exports, the exchange rate, FDI, and GDP, confirming the interconnected and self-reinforcing character of Pakistan's external sector. Inflation is causally exogenous to all trade variables. The findings carry direct implications for exchange rate management, FDI targeting policy, and export diversification strategy in Pakistan.

Keywords: Export earnings, exchange rate elasticity, FDI gestation dynamics, ARDL cointegration.

Introduction

Pakistan's merchandise export performance presents a striking paradox. Between 1976 and 2019, nominal export earnings rose from approximately USD 1.2 billion to USD 28 billion — a twenty-three-fold increase in absolute terms. Yet over the same period, Pakistan's share of world merchandise exports declined from around 0.18% to 0.13%, and the country consistently ran current account deficits that were financed by a combination of remittances, external borrowing, and periodic IMF programmes. This divergence between absolute growth and relative competitive decline raises a fundamental empirical question: which macroeconomic forces have governed Pakistan's export earnings trajectory, and why has the country's external sector remained structurally fragile despite decades of exchange rate adjustment and foreign investment inflows?

Four macroeconomic variables are theoretically central to this question. The exchange rate is the price signal that directly governs the foreign-currency competitiveness of exports: nominal depreciation reduces the foreign-price of domestic goods, stimulating external demand provided the Marshall-Lerner condition holds (Krugman & Obstfeld, 2015). Pakistan's rupee depreciated from Rs. 10 per US dollar in 1980 to over Rs. 150 by 2019, making exchange rate dynamics central to any empirical account of export performance. Foreign direct investment is theorised to augment export supply through technology transfer, managerial upgrading, and integration into global value chains (Jenkins & Thomas, 2002), yet Pakistan's FDI inflows have been concentrated in non-tradable sectors — energy, telecommunications, and financial services — raising doubts about the export-promoting channel. Inflation erodes cost competitiveness by raising domestic producer prices, though it may also operate through the nominal exchange rate channel to affect rupee-denominated export revenues. Finally, GDP growth proxies the domestic productive capacity that enables export supply expansion.

Several existing studies address components of this question for Pakistan. Khan et al. (2012) examine exchange rate effects on trade using Johansen cointegration over 1980–2009 but use trade balance rather than export earnings as the outcome variable and find no long-run equilibrium between the exchange rate and GDP. Batool et al. (2015) apply ARDL to balance of payments determinants over 1972–2013, confirming an inverse real exchange rate effect on the trade balance, but again do not isolate export earnings as the dependent variable. Rahman (2014) and Yaqub (2016) investigate FDI-growth linkages but treat GDP rather than exports as the outcome of interest. Mansoor and Bibi (2018) apply ARDL to exchange rate and GDP growth over 1980–2016, finding short-run instability but not addressing export earnings directly. No published study simultaneously models the short-run and long-run contributions of exchange rate, FDI, inflation, and GDP to Pakistan's export earnings within a unified cointegration framework over a 44-year horizon.

This paper addresses that gap with four specific contributions. First, it uses export earnings — not the trade balance or GDP — as the outcome variable, providing a more direct test of export competitiveness determinants. Second, it employs the ARDL bounds testing framework (Pesaran et al., 2001), which is uniquely suited to the mixed I(0)/I(1) integration order found in the data and provides both short-run dynamics and long-run coefficients in a single coherent model. Third, the 44-year sample (1976–2019) is the longest used in any comparable Pakistan export study and spans the full post-independence development trajectory including liberalisation, multiple IMF programmes, and the CPEC investment surge. Fourth, it documents and theoretically interprets an oscillating short-run FDI dynamic — a novel finding with direct implications for understanding how capital inflows translate into export capacity in developing economies. The paper is structured as follows. Section 2 develops the theoretical framework and reviews the empirical literature thematically. Section 3 describes the data, model specification, and econometric methodology. Section 4 presents and interprets the empirical results. Section 5 concludes with policy implications, study limitations, and directions for future research.

Theoretical Framework and Literature Review

Theoretical Foundations

Three theoretical strands motivate the empirical model. The export-led growth hypothesis, developed by Balassa (1978) and formalised in the new growth literature by Grossman and Helpman (1991), posits that export expansion drives productivity improvement through dynamic learning effects, scale economies, and competitive discipline imposed by global markets. Under this framework, any macroeconomic variable that enhances export competitiveness — a depreciated real exchange rate, productivity-raising FDI, low inflation — ultimately contributes to sustained income growth. The empirical implication is that identifying the determinants of export earnings is not merely a partial-equilibrium trade question but a growth policy question of first-order importance for a developing economy like Pakistan.

The transmission mechanism from the exchange rate to exports rests on the Marshall-Lerner (ML) condition: a nominal depreciation improves the trade balance when the sum of the absolute price elasticities of export and import demand exceeds unity (Krugman & Obstfeld, 2015). Applied to export earnings specifically, an exchange rate depreciation lowers the foreign-currency price of domestic goods, stimulating foreign demand — provided Pakistan's export basket is price-elastic. The J-curve effect, documented extensively in the trade literature (Bahmani-Oskooee & Ratha, 2004), predicts that the short-run response to depreciation may be negative or muted — as existing

contracts are fulfilled at pre-depreciation prices and import costs rise — before long-run export volumes adjust upward. This theoretical prediction is directly tested by the ARDL's separation of short-run and long-run coefficients in the present study.

The Balassa-Samuelson (BS) framework provides a complementary insight: sustained productivity growth in Pakistan's tradable sector (manufacturing, exports) relative to non-tradables (services, real estate) would generate a secular real exchange rate appreciation that offsets the export-promoting effect of nominal depreciation. The BS framework therefore implies that exchange rate management alone is insufficient — structural transformation toward higher-productivity tradable production is a necessary complement (Balassa, 1964). For FDI, the standard theoretical expectation is that inward investment augments export supply by providing capital, technology, and managerial expertise that host-country firms cannot self-generate (Borensztein et al., 1998). However, this export-promoting channel operates with a lag — the investment gestation period during which capital goods are imported and installed before production capacity becomes export-ready. This gestation dynamic is a central theoretical motivation for examining lagged FDI effects in the empirical model.

Exchange Rate and Export Performance: Evidence

Exchange rate effects on export performance have been studied extensively across both developed and developing economies, with broadly consistent but contextually nuanced findings. Doganlar (2010) uses Engle-Granger cointegration for five Asian economies, including Pakistan, and finds that exchange rate volatility — rather than the level — systematically reduces export volumes, with Pakistan showing among the highest sensitivity. Hall et al. (2010) examine 21 countries using time-varying coefficient and GMM methods over 1980–2006 and conclude that exchange rate instability imposes a significant export cost, particularly for countries with undiversified, commodity-concentrated trade baskets — a description that fits Pakistan closely.

Within the Pakistan-specific literature, evidence is more mixed. Khan et al. (2012) use Johansen cointegration and Granger causality on annual data from 1980 to 2009, finding a long-run equilibrium between exchange rate and trade but detecting no long-run causality between the exchange rate and GDP — suggesting that the trade channel does not reliably transmit exchange rate shocks to aggregate output. Batool et al. (2015) apply ARDL bounds testing to 1972–2013 data and confirm that the real exchange rate has an inverse long-run relationship with the balance of payments, consistent with a deficit-worsening effect of overvaluation. Mansoor and Bibi (2018) report a positive long-run link between the real exchange rate and GDP growth over 1980–2016 but note short-run instability, motivating their call for more stable monetary governance. None of these studies, however, use export earnings as the primary dependent variable — a gap the present paper fills directly.

Critically, the literature is divided on whether the Marshall-Lerner condition holds for Pakistan. Shahbaz et al. (2012) argue that the J-curve effect is present but protracted, consistent with the structural inflexibility of Pakistan's textile-dominated export base. Hussain and Saqib (2013) find that real depreciation has positive but diminishing returns to export growth, suggesting non-linearity in the exchange rate-export relationship that linear ARDL models may not fully capture. These limitations are acknowledged in the present study's limitations section and motivate future non-linear extensions.

Foreign Direct Investment and Export Performance

The FDI-export nexus is theoretically compelling but empirically contested. Borensztein et al. (1998), in a landmark cross-country study, establish that FDI promotes growth — including through export channels — but only when the host country has sufficient human capital to absorb foreign technology. This absorptive capacity constraint is highly relevant for Pakistan, where educational attainment and skilled labour availability remain significant bottlenecks. Jayakumar et al. (2014) examine India's post-liberalisation experience and find that rising FDI inflows are positively associated with export expansion, particularly in manufacturing. In contrast, for Sub-Saharan Africa, Ayanwale (2007) shows that extractive-sector FDI — which dominates in many resource-rich developing economies — does not generate the export diversification and technology spillovers that manufacturing FDI produces.

For Pakistan specifically, the evidence suggests that FDI has not fulfilled its export-promoting theoretical potential. Rahman (2014) finds a positive FDI-growth link over 1981–2010 but notes that consumer price inflation enters negatively, consistent with the argument that high inflation crowds out real productive investment. Yaqub (2016) documents that Pakistan's FDI is concentrated in energy, telecommunications, and financial services — all non-tradable sectors with limited direct export linkages. Hunjar et al. (2014) find that FDI, imports, and exports collectively influence Pakistan's GDP, but cannot isolate the independent export-stimulating contribution of FDI, leaving open the question this paper attempts to answer. The theoretical FDI gestation dynamic — wherein new investment initially imports capital goods (worsening the trade position) before activating production capacity — predicts that lagged FDI coefficients should oscillate in sign, a pattern the present study's short-run ECM results directly confirm.

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Inflation, GDP, and Export Earnings

Inflation operates on export earnings through two competing channels. The cost-push channel — widely recognised in the open-economy macroeconomics literature — predicts that higher domestic prices raise producer costs, eroding price competitiveness and reducing export volumes. This channel is dominant when the nominal exchange rate does not adjust to compensate for the inflation differential, as has often been the case in Pakistan during managed exchange rate episodes. The nominal revenue channel, however, predicts the opposite: when domestic prices rise alongside exchange rate depreciation — as they often do in inflation-prone developing economies — rupee-denominated export revenues may increase even if real export volumes stagnate (Calvo et al., 1995). Disentangling these two channels in an aggregate time-series model requires careful interpretation of the sign and magnitude of the inflation coefficient alongside the exchange rate coefficient — an analytical challenge this paper addresses explicitly.

GDP per capita growth proxies the domestic productive capacity and supply-side factors that underpin export potential. Dritsaki et al. (2004) demonstrate for Greece that GDP growth, trade, and FDI are mutually reinforcing in an open economy, consistent with the export-led growth hypothesis. Akinlo (2004) finds for Nigeria that export expansion is a statistically significant driver of GDP growth while extractive FDI is not — a pattern that resonates with Pakistan's economic structure. Antwi et al. (2013) show for Ghana that FDI positively affects economic performance in the short run but that exchange rate volatility moderates this effect in the long run — highlighting the interaction between FDI, exchange rate stability, and export capacity that motivates including all four variables jointly in a single model.

Literature Gap and Paper's Contribution

The review above reveals three distinct gaps in the existing literature on Pakistan's export determinants. First, most Pakistan-specific studies use either the trade balance or GDP as the outcome variable; none examines export earnings directly as the dependent variable within an ARDL cointegration framework over a sample period exceeding 40 years. Second, no published study documents or interprets the intertemporal oscillation in FDI's short-run effect on exports, despite this being a theoretically predictable feature of the investment gestation process. Third, while several studies acknowledge the mixed integration order of Pakistan's macroeconomic time series, earlier contributions use Johansen cointegration (which requires uniform I(1)) or basic OLS, producing results that may be methodologically inappropriate for the data-generating process. This paper addresses all three gaps: it uses export earnings as the outcome, documents and theoretically anchors the FDI gestation dynamic, and applies the ARDL bounds testing estimator that is valid for the observed mixed I(0)/I(1) integration order. Together, these contributions advance understanding of Pakistan's export competitiveness problem with implications for exchange rate policy, FDI targeting, and export diversification strategy.

Data and Methodology

Data Sources and Variable Definitions

The study uses annual time-series data for Pakistan spanning 1976–2019 (44 observations), obtained from the World Development Indicators (WDI) database of the World Bank — a standard, publicly accessible, and widely used source in the international economics literature. The starting year 1976 reflects the earliest year for which a consistent exchange rate series is available for Pakistan in the WDI following the collapse of the Bretton Woods fixed exchange rate system; the end year 2019 avoids the structural disruption introduced by the COVID-19 pandemic. Table 1 provides variable definitions, measurement units, data sources, and prior usage in the literature.

Table 1: ***Variable Definitions, Data Sources, and Descriptive Statistics***

Variable	Symbol	Definition & Unit	Source	Expected Sign
Export Earnings	EX	Total merchandise exports, current USD (ln-transformed)	WDI	Dependent
Exchange Rate	ER	Official nominal exchange rate, LCU per USD (ln-transformed)	WDI	(+)
Inflation	INF	Annual CPI inflation, % (level form)	WDI	(±)
FDI	FDI	Net FDI inflows, % of GDP (ln of absolute value)	WDI	(+)
GDP per capita growth	GDP	Real GDP per capita growth, % (level form)	WDI	(+)

Note. LCU = local currency units. Inflation and GDP per capita growth are retained in level form because they are rates already expressed as percentages and contain values close to zero.

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Table 2: ***Descriptive Statistics***

Variable	Mean	Std. Dev.	Minimum	Maximum	Skewness
ln(EX)	22.85	1.12	20.91	24.07	−0.14
ln(ER)	3.89	1.04	2.08	5.06	−0.08
INF (%)	8.62	4.97	2.53	26.66	1.47
ln|FDI|	0.32	0.88	−1.84	1.74	−0.43
GDP (%)	2.41	1.82	−1.83	6.07	−0.29

Note. Descriptive statistics computed on the transformed variables used in estimation. INF displays positive skewness reflecting the high-inflation episodes of the late 2000s. GDP per capita growth shows mild negative skewness driven by the 2008–09 global financial crisis contraction. All statistics are based on original WDI data.

Model Specification

The empirical model follows the export supply function tradition established by Goldstein and Khan (1985), adapted to incorporate the four macroeconomic determinants identified in the theoretical framework. The long-run export earnings function is specified as:

$$ln(EX)t = \beta_0 + \beta_1\, ln(ER)t + \beta_2\, INFt + \beta_3\, ln|FDI|t + \beta_4\, GDPt + \varepsilon t \quad (1)$$

where t denotes the year; β_0 is the constant; β_1 through β_4 are long-run slope coefficients; and εt is the stochastic disturbance assumed i.i.d. with zero mean. Based on the theoretical arguments in Section 2, the prior sign expectations are: $\beta_1 > 0$ (exchange rate depreciation raises foreign-currency competitiveness and stimulates demand for Pakistani exports); β_2 ambiguous (cost-push channel predicts $\beta_2 < 0$; nominal revenue channel predicts $\beta_2 > 0$); $\beta_3 > 0$ (FDI augments export supply capacity over the long run, conditional on sectoral targeting); and $\beta_4 > 0$ (domestic output growth expands the productive base from which exports can be drawn). The model is estimated in both long-run and error-correction forms using the ARDL bounds testing framework described below.

Estimation Stratergy

Unit Root and Stationary Tests

The ARDL bounds testing estimator is valid only when no variable is integrated of order two or higher; all series must be I(0) or I(1). Stationarity of each variable is assessed using the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979), which appends lagged difference terms to the Dickey-Fuller regression to eliminate serial correlation in residuals. The ADF is conducted in two specifications at levels — with intercept only, and with intercept and linear trend — and with intercept only at first differences. Lag lengths are selected using the Akaike Information Criterion (AIC). The null hypothesis is that the series has a unit root; rejection implies stationarity. To guard against the well-known size distortions of the ADF in small samples, visual inspection of time-series plots and autocorrelation function correlograms corroborates all formal test decisions.

ARDL Bounds Test for Cointegration

The ARDL bounds testing procedure (Pesaran et al., 2001) tests for the existence of a long-run level relationship through a Wald (F) test on the lagged levels of all variables in the following unrestricted error correction model (UECM):

$$\Delta\, ln(EX)t = \alpha + \Sigma_i\, a_i\, \Delta\, ln(EX)t\text{-}i + \Sigma_j\, b_j\, \Delta\, Xt\text{-}j + \delta_1\, ln(EX)t\text{-}1 + \delta_2\, ln(ER)t\text{-}1 + \delta_3\, INFt\text{-}1 + \delta_4\, ln|FDI|t\text{-}1 + \delta_5\, GDPt\text{-}1 + vt \quad (2)$$

The null hypothesis H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ (no long-run level relationship) is tested against H_1 that at least one $\delta_i \neq 0$. Pesaran et al. (2001) supply two sets of asymptotic critical values — a lower bound assuming all variables are I(0) and an upper bound assuming all are I(1). If the computed F-statistic exceeds the upper critical value, cointegration is established regardless of individual integration orders. If it falls below the lower bound, cointegration is rejected. If it falls between the two bounds, the result is inconclusive. The unrestricted intercept / no-trend specification (Case III in Pesaran et al.) is employed because Pakistan's export earnings display a strong upward trend driven by nominal growth that is captured by the intercept and the trending regressors rather than a deterministic time trend. The optimal ARDL lag structure ARDL(p, q_1, q_2, q_3, q_4) is selected by the AIC across all permissible specifications with maximum lag of 4, consistent with Pesaran and Smith's (1998) guidance for sample sizes around 40–50 observations. All estimation is performed using EViews 11.

Long-Run Coefficients and Error Correction Model

Once cointegration is confirmed, the long-run ARDL coefficients are derived by expressing Equation (2) in levels and solving for the steady-state relationship. The associated error correction model (ECM) then takes the form:

$$\Delta \ ln(EX)t = \alpha_0 + \Sigma_i \ \alpha_i \ \Delta \ ln(EX)t\text{-}i + \Sigma_j \ \beta_j \ \Delta \ Xt\text{-}j + \lambda \cdot ECTt\text{-}1 + vt \quad (3)$$

where X is the vector of regressors, ECTt-1 is the lagged residual from the long-run ARDL relationship, and λ is the speed-of-adjustment coefficient. For valid error correction dynamics, λ must satisfy $-1 < \lambda < 0$ and be statistically significant at conventional levels. Its magnitude indicates what fraction of the previous year's disequilibrium is eliminated within one period. Short-run coefficients on Δ Xt-j capture the immediate, transitory effects of each regressor on export earnings and are the primary channel through which the FDI gestation dynamic is observed and interpreted.

Residual Diagnostics and Structural Stability

Model adequacy is evaluated through a battery of post-estimation tests. Serial correlation in the residuals is assessed using the Breusch-Godfrey Lagrange Multiplier test up to four lags (null: no serial correlation). Conditional heteroskedasticity is examined via the Breusch-Pagan-Godfrey test (null: homoskedastic errors). Structural stability of the estimated coefficients over the sample period is evaluated using the CUSUM and CUSUM-of-Squares tests of Brown et al. (1975), which plot recursive residual statistics against 5% significance bands; any breach of the bands indicates parameter instability. The model selection summary across candidate ARDL specifications is visualised using the AIC-ranked model graph produced by EViews. Because the sample period encompasses acknowledged structural events — the 1998 nuclear sanctions, the post-2001 security environment, and the 2007–08 global financial crisis — the passage of both CUSUM tests provides important empirical evidence that these events did not induce persistent regime changes in the export earnings relationship, though formal breakpoint unit root tests (Zivot & Andrews, 1992) are acknowledged as a priority for future work.

Granger Causality Analysis

The Granger (1969) causality test determines whether lagged values of one variable improve forecasts of another, over and above the latter's own history. Pairwise Granger causality tests between all variable pairs are conducted at two lags, consistent with the Schwarz Information Criterion lag selection for the bivariate VAR systems. Both unidirectional and bidirectional causality patterns are identified and interpreted. Bidirectional causality between exports and GDP is particularly relevant for evaluating the export-led growth hypothesis; bidirectional causality between FDI and exports speaks to the endogenous relationship between investment location decisions and market-access opportunities. The causality analysis is presented as complementary to the ARDL cointegration results and interpreted jointly with the ECM short-run dynamics.

Empirical Results and Discussion

Unit Root Test Results

Table 3 presents ADF unit root test results for all five variables at levels and first differences. The results reveal a mixed integration order that is common in macroeconomic time-series for developing economies and that directly motivates the ARDL bounds testing approach. Inflation (INF) is stationary at level — I(0) — with an ADF statistic of −6.289 ($p < 0.001$), consistent with mean-reverting price dynamics even in a high-inflation economy like Pakistan. All other variables — export earnings, exchange rate, FDI, and GDP per capita growth — are non-stationary at level but stationary at first difference, confirming I(1) processes. The exchange rate achieves stationarity only at the 10% significance level at first difference (ADF = −3.255, $p = 0.088$), reflecting the persistent, near-random-walk trend depreciation of the Pakistani rupee over the sample period. No variable is I(2), satisfying the prerequisite for valid ARDL estimation.

Table 3: ***Augmented Dickey-Fuller Unit Root Test Results***

Sample: Pakistan, 1976–2019

Variable	ADF at Level	p-value	ADF at 1st Diff.	p-value	Integration Order
ln(EX)	-2.004	0.583	-6.113***	0.000	I(1)
ln(ER)	0.486	0.999	-3.255*	0.088	I(1)
INF	-6.289***	0.000	—	—	I(0)
ln|FDI|	-3.647**	0.037	-6.743***	0.000	I(1)
GDP growth	-1.224	0.893	-4.264***	0.008	I(1)

Note. ADF tests conducted with intercept and trend at levels; intercept only at first differences. Lag lengths chosen by AIC. Critical values: I(0) at 1%/5%/10% = −3.588/−2.930/−2.603 (level, without trend). *** p < 0.01, ** p < 0.05, * p < 0.10.

ARDL Model Selection and Bounds Test for Cointegration

The AIC-optimal ARDL specification identified by EViews 11 across all permissible lag combinations (maximum lag = 4) is ARDL(3, 1, 0, 4, 4). This specification includes three lags of the dependent variable — capturing substantial export earnings persistence — one lag of the exchange rate, no additional lag of inflation (entered contemporaneously only), and four lags each of FDI and GDP. The four-lag FDI structure is theoretically consistent with the gestation interpretation: new foreign investment takes approximately one to four years to fully convert from committed capital to operational export capacity in Pakistan's regulatory environment. The overall ARDL model yields $R^2 = 0.996$ and an F-statistic of 444.46 ($p < 0.001$), confirming strong joint significance of all regressors. The Durbin-Watson statistic of 1.679 provides initial evidence against severe serial correlation.

Table 4: ***F-Bounds Test for Long-Run Cointegration***

F-statistic	Significance Level	Lower Bound I(0)	Upper Bound I(1)	Decision
11.330	1%	3.74	5.06	**Cointegration confirmed**
	2.5%	3.25	4.49	—
	5%	2.86	4.01	—
	10%	2.45	3.52	—

Note. Pesaran et al. (2001) asymptotic critical values, Case III (unrestricted intercept, no trend), k = 4 regressors.

The F-statistic of 11.330 decisively exceeds the upper critical bound across all four significance levels considered, establishing robust evidence for a long-run cointegrating relationship among Pakistan's export earnings, exchange rate, inflation, FDI, and GDP. This result is insensitive to the choice of significance threshold and provides a strong empirical foundation for proceeding to interpret long-run and short-run coefficient estimates.

Long-Run Coefficient Estimates

Table 5 presents the long-run ARDL coefficient estimates derived from the level relationship embedded in the ARDL(3, 1, 0, 4, 4) specification. The exchange rate coefficient of 1.521 is positive, highly significant ($p < 0.001$), and exceeds unity — indicating a greater-than-proportionate long-run response of export earnings to nominal depreciation. This finding supports the Marshall-Lerner condition holding for Pakistan over the 1976–2019 period and implies that the persistent rupee depreciation observed over the sample has been net-positive for export earnings. The elasticity of 1.521 is somewhat higher than estimates reported for comparable South Asian economies: for India, Azam et al. (2016) find exchange rate elasticities in the range of 1.1–1.4 for merchandise exports, while Doganlar (2010) reports elasticities between 0.8 and 1.3 for the five-country Asian panel including Pakistan. The comparatively large estimate for Pakistan may reflect the dominant role of USD-invoiced textile exports in Pakistan's trade basket, where rupee depreciation translates directly into higher rupee-denominated receipts from contracted foreign-currency sales.

Inflation enters the long-run equation with a positive coefficient of 0.042 ($p = 0.089$, significant at 10%). This result, which appears counterintuitive given the standard cost-push channel, is interpreted through the nominal revenue lens: in Pakistan's managed exchange rate environment, periods of high inflation have typically coincided with nominal depreciation, generating higher rupee-denominated export revenues even when real export volumes were constrained. The positive long-run inflation coefficient is therefore not evidence that inflation promotes export competitiveness; rather, it captures the joint movement of the price level and the exchange rate in a developing economy where both are influenced by common macroeconomic imbalances (Calvo et al., 1995). Policymakers should not interpret this coefficient as licensing inflationary macroeconomic policy — the exchange rate coefficient is twenty-five times larger, confirming that the dominant channel is price competitiveness through the exchange rate.

FDI and GDP per capita growth are individually insignificant in the long-run relationship ($p = 0.657$ and $p = 0.727$, respectively). The FDI result, while seemingly contradictory to theory, is consistent with the sectoral composition of Pakistan's foreign investment. As documented by Yaqub (2016), the preponderance of Pakistan's FDI during the sample period was directed toward energy generation, mobile telecommunications, and financial services — sectors with negligible direct export linkages. Export-oriented FDI in textiles and light manufacturing, which would generate the expected positive long-run coefficient, has remained limited. The GDP result reflects the possibility

that domestic output growth in Pakistan has predominantly served the domestic market rather than export markets, consistent with the concentrated, low-diversification character of the export basket. The long-run insignificance of both FDI and GDP does not preclude important short-run dynamics, which are examined next.

Table 5: ***Long-Run ARDL Coefficient Estimates***

Variable	Coefficient	Std. Error	t-Statistic	p-value	Interpretation
ln(ER)	1.521***	0.312	4.875	0.000	Strong positive — ML condition holds
INF	0.042*	0.024	1.750	0.089	Nominal revenue channel
ln|FDI|	−0.038	0.085	−0.447	0.657	Insignificant — non-tradable FDI
GDP growth	0.019	0.054	0.352	0.727	Insignificant — domestic orientation
Constant	0.912***	0.202	4.515	0.000	Intercept

Note. Long-run coefficients derived from ARDL(3,1,0,4,4) level relationship. Heteroskedasticity-consistent standard errors. *** $p < 0.01$, * $p < 0.10$ (two-tailed).

Error Correction Model: Short-Run Dynamics

Table 6 presents the short-run error correction model estimates. The error correction term, CointEq(-1), carries a coefficient of −0.388 that is negative, statistically highly significant ($t = -9.063$, $p < 0.001$), and within the theoretically admissible range (−1, 0). This confirms valid error correction dynamics: approximately 38.8% of any deviation from the long-run equilibrium is eliminated within one year. For comparison, Batool et al. (2015) report an ECT coefficient of −0.42 for Pakistan's balance of payments, and Mansoor and Bibi (2018) report −0.31 for the GDP–exchange rate relationship, suggesting that Pakistan's export earnings adjust to equilibrium at a speed broadly comparable to other macroeconomic relationships in the economy. The remaining 61.2% disequilibrium persisting beyond one year reflects genuine structural rigidities: the contractual nature of export agreements, the slow adjustment of production capacity to exchange rate signals, and institutional frictions in Pakistan's trade facilitation environment.

The short-run exchange rate effect is immediate and large: the contemporaneous ΔER coefficient of 2.92×10^8 is highly significant ($p < 0.001$), confirming that exchange rate movements translate rapidly into changes in Pakistan's dollar-denominated export revenues — likely reflecting existing export contracts priced in foreign currency that instantly revalue upon depreciation, before physical export volumes have time to adjust. The most novel and theoretically informative short-run finding is the oscillating FDI dynamic. FDI enters positively and significantly in the current period and at lag three, but negatively and significantly at lags one and two. This sign-reversal pattern is precisely consistent with the investment gestation mechanism articulated in Borensztein et al. (1998): when new foreign investment is committed to Pakistan, the immediate effect is an increase in capital-goods imports — plant, machinery, and equipment — which worsens the net export position in the first and second years following the investment decision. As the installed capacity becomes operational in years three to four, export-oriented production commences and the FDI effect on export earnings turns positive. This three-to-four-year gestation cycle is consistent with documented timelines for greenfield manufacturing investment in South Asian economies (Jayakumar et al., 2014) and provides an important policy insight: FDI inflows should not be expected to boost export earnings immediately, and the short-run current account deterioration associated with new FDI arrivals should not be mistaken for evidence that investment is failing to contribute to Pakistan's external sector.

Table 6: ***Error Correction Model — Short-Run Estimates***

Variable	Coefficient	Std. Error	t-Statistic	p-value
Δ ln(EX(−1))	0.347	0.098	3.541	0.001
Δ ln(EX(−2))	0.415	0.116	3.577	0.001
Δ ln(ER)	2.92×10^8	4.1×10^7	7.122	0.000
Δ ln|FDI|	0.312	0.127	2.457	0.019
Δ ln|FDI(−1)|	−0.581	0.162	−3.586	0.001
Δ ln|FDI(−2)|	−0.804	0.180	−4.467	0.000
Δ ln|FDI(−3)|	0.784	0.195	4.021	0.000
Δ GDP	0.173	0.048	3.604	0.001
Δ GDP(−1)	0.034	0.009	3.778	0.001

Δ GDP(−2)	0.058	0.016	3.625	0.001
Δ GDP(−3)	0.149	0.041	3.634	0.001
CointEq(−1)	−0.388***	0.043	−9.063	0.000

Note. $R^2 = 0.871$. Adjusted $R^2 = 0.789$. F-statistic = 444.46 ($p < 0.001$). Durbin-Watson = 1.679. All significance at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Post Estimation Diagnostics

Table 7 reports the results of all post-estimation diagnostic tests. The Breusch-Godfrey LM test for serial correlation at up to four lags yields a p-value of 0.503, far above the 5% threshold, confirming the absence of residual autocorrelation. The Breusch-Pagan-Godfrey test for conditional heteroskedasticity produces a Chi-square p-value of 0.970, confirming constant error variance (homoskedasticity) and validating the OLS-based ARDL estimator's efficiency. Both CUSUM and CUSUM-of-Squares statistics remain within 5% significance bands throughout the sample, providing evidence that the estimated coefficients are structurally stable — a substantively important finding given that the sample spans the 1998 nuclear sanctions, the post-2001 security shock, and the 2007–08 global financial crisis. The passage of both stability tests suggests that while these events may have altered the levels of Pakistan's export earnings, they did not induce persistent changes in the structural relationships among the variables. This finding is consistent with the resilience of Pakistan's textile export base, which continued to dominate the export composition through all major structural events of the sample period.

Table 7: ***Post-Estimation Diagnostic Test Results***

Test	H_0 Tested	Statistic	p-value	Conclusion
Breusch-Godfrey LM	No serial correlation (4 lags)	$F = 0.839$	0.503	H_0 not rejected
Breusch-Pagan-Godfrey	Homoskedastic errors	$\chi^2 = 0.387$	0.970	H_0 not rejected
CUSUM	Parameter stability	Within bands	—	Stable
CUSUM-of-Squares	Parameter stability	Within bands	—	Stable
Jarque-Bera (normality)	Residuals normally distributed	—	—	Not tested (future work)

Note. CUSUM and CUSUM-of-Squares tests evaluated at 5% significance bands (Brown et al., 1975).

Granger Causality Analysis

Table 8 presents pairwise Granger causality results for all variable pairs. Five substantive patterns emerge. First, exchange rate and export earnings exhibit bidirectional Granger causality (ER → EX: $p = 0.006$; EX → ER: $p = 0.018$). The forward direction (ER → EX) confirms the exchange rate's predictive power for export earnings — consistent with the long-run elasticity estimate. The reverse direction (EX → ER) reflects the well-documented role of export proceeds as a source of foreign exchange supply that moderate's rupee depreciation — a channel that is particularly relevant for Pakistan, where export remittance timing is actively monitored by the State Bank of Pakistan.

Second, FDI and exports exhibit bidirectional causality ($p = 0.006$ and $p = 0.030$), indicating that FDI inflows predict future export earnings (consistent with the gestation dynamic) and that export performance signals market attractiveness that draws further FDI — a virtuous circle whose policy implications are discussed in Section 5. Third, GDP and exports are bidirectionally causal (both $p < 0.001$), providing direct empirical support for the export-led growth hypothesis in Pakistan: export growth predicts GDP growth, and GDP growth predicts future export capacity. Fourth, FDI unidirectionally Granger causes GDP ($p = 0.008$) without feedback ($p = 0.097$), suggesting that FDI contributes to output expansion but that GDP growth alone does not attract further FDI — the investment climate, governance quality, and security environment are dominant pull factors that GDP signals cannot substitute. Fifth, inflation is causally isolated from all trade variables (all $p > 0.20$), consistent with inflation being driven primarily by domestic monetary and fiscal conditions rather than trade dynamics — a finding that supports treating INF as an exogenous conditioning variable in the export function.

Table 8: ***Pairwise Granger Causality Test Results***

Null Hypothesis	F-Statistic	p-value	Decision	Causality Type
ER does not Granger cause EX	5.841	0.006	Reject	Bidirectional
EX does not Granger cause ER	4.387	0.018	Reject	Bidirectional
INF does not Granger cause EX	1.243	0.298	Accept	No causality

EX does not Granger cause INF	1.018	0.370	Accept	No causality
FDI does not Granger cause EX	5.813	0.006	Reject	Bidirectional
EX does not Granger cause FDI	3.874	0.030	Reject	Bidirectional
GDP does not Granger cause EX	8.920	0.001	Reject	Bidirectional
EX does not Granger cause GDP	9.150	0.001	Reject	Bidirectional
ER does not Granger cause GDP	12.480	0.000	Reject	Bidirectional
GDP does not Granger cause ER	7.230	0.002	Reject	Bidirectional
FDI does not Granger cause GDP	5.270	0.008	Reject	Unidirectional
GDP does not Granger cause FDI	2.440	0.097	Accept	FDI → GDP only
FDI does not Granger cause INF	1.620	0.208	Accept	No causality
INF does not Granger cause FDI	0.990	0.380	Accept	No causality

Note. Significance threshold: 5%. Lag length = 2, determined by Schwarz Information Criterion in bivariate VAR.

Conclusions and Policy Implications

This study provides the first ARDL-based analysis of the macroeconomic determinants of Pakistan's total merchandise export earnings over the full 1976–2019 period. Five principal findings emerge. First, a robust long-run cointegrating relationship exists among export earnings, exchange rate, inflation, FDI, and GDP, confirmed by an F-statistic of 11.330 that exceeds the 1% upper critical bound — establishing the external validity of the long-run model. Second, exchange rate depreciation is the dominant long-run driver of export earnings, with an elasticity of 1.521 that exceeds unity and is consistent with the Marshall-Lerner condition holding for Pakistan. Third, inflation exerts a modest positive long-run association with export earnings, reflecting the nominal revenue channel in a managed exchange rate regime, not evidence that high inflation promotes competitiveness. Fourth, FDI and GDP are individually insignificant in the long run, attributable to the non-tradable sectoral concentration of Pakistan's FDI and the domestic-market orientation of GDP growth. Fifth, and most originally, FDI exhibits an oscillating short-run dynamic — positive contemporaneously, negative at lags one and two, positive at lag three — consistent with a three-to-four-year investment gestation cycle in which capital-goods imports precede the activation of export capacity. The ECT coefficient of −0.388 confirms valid error correction at approximately 39% per annum. Granger causality is bidirectional among exports, exchange rate, FDI, and GDP, confirming the export-led growth hypothesis and the mutually reinforcing dynamics of Pakistan's external sector.

Policy Implications

Four concrete policy recommendations flow directly from the empirical findings. They are presented in order of estimated economic impact, with explicit grounding in the coefficient estimates.

First, exchange rate management is the highest-return policy lever for Pakistan's export promotion. With a long-run elasticity of 1.521, a 10% real depreciation of the rupee is associated — all else equal — with a 15.2% increase in export earnings over the long run. The State Bank of Pakistan should resist systematic overvaluation of the nominal exchange rate as an anti-inflation tool, because the resulting export competitiveness loss — compounded by the bidirectional causality between exports and GDP — would suppress economic growth at a cost far exceeding the inflation-reduction benefit. Market determination of the exchange rate, supported by adequate foreign exchange reserves, is the appropriate policy stance.

Second, FDI policy should shift from aggregate volume targets to sectoral targeting of export-oriented manufacturing. The long-run insignificance of FDI and the gestation dynamic documented in the short-run results both point to the same structural weakness: Pakistan's foreign investment has been concentrated in sectors that do not generate export spillovers. A redirection of investment incentives — tax holidays, dedicated special economic zones, streamlined regulatory approval — toward export-oriented manufacturing in pharmaceuticals, light engineering, agro-processing, and IT-enabled services would convert the gestation investment dynamic into a sustained long-run export

driver. This is particularly urgent given the bidirectional FDI-export causality finding: stronger export performance itself attracts further FDI, creating a reinforcing cycle that can be activated by an initial targeted investment push.

Third, inflation management should be pursued through fiscal discipline and monetary credibility rather than through exchange rate overvaluation or capital controls. The positive long-run inflation coefficient, while modest, should not mislead policymakers: the exchange rate is 36 times more powerful as a driver of export earnings (coefficient ratio 1.521 / 0.042). Policies that suppress inflation by overvaluing the rupee achieve a small reduction in the inflation-to-exports channel while incurring a large loss through the exchange rate channel — a fundamentally counterproductive trade-off. The appropriate instrument for inflation control is the SBP's policy rate, deployed within a forward-looking inflation-targeting framework.

Fourth, the bidirectionality of exports and GDP causality makes export diversification a growth strategy, not merely a trade objective. Pakistan's export basket remains concentrated in low-value textile and agricultural commodities with limited scope for productivity upgrading. Policies that promote export diversification toward higher value-added manufactured goods and tradable services — including investment in technical education, R&D incentives, and trade facilitation — will generate secondary GDP growth effects through the export-to-GDP causality channel confirmed in Table 8.

Limitations and Future Research Directions

This study has several limitations that define priorities for future research. First, the empirical strategy relies exclusively on aggregate annual data, which may mask important heterogeneity across Pakistan's export sectors. A disaggregated analysis — separating textiles, agricultural commodities, and emerging manufactured exports — would provide sector-specific elasticity estimates of direct relevance for targeted export promotion policy. Second, the sample ends in 2019, before the COVID-19 pandemic and the post-2020 period of exceptional exchange rate pressure and IMF engagement. Extending the dataset to 2023–2024 would test whether the long-run relationships identified here remain stable in a structurally altered global trade environment. Third, the ADF unit root tests used here are known to have low power in the presence of structural breaks. The acknowledged major events in the sample — 1998 nuclear sanctions, post-2001 security environment, 2007–08 global financial crisis, 2013 BoP crisis — should be formally tested using Zivot-Andrews (1992) breakpoint unit root tests and Bai-Perron (2003) multiple structural break tests. Fourth, the endogeneity between GDP and exports, confirmed by bidirectional Granger causality, means that treating GDP as a strictly exogenous regressor in Equation (1) introduces potential inconsistency. Future work should consider instrumental variable ARDL or structural VAR approaches to formally address simultaneous equation bias. Fifth, the non-linear exchange rate-export relationship suggested by Hussain and Saqib (2013) — diminishing returns to depreciation — could be explored using the nonlinear ARDL (NARDL) decomposition of Shin et al. (2014), which separates the effects of appreciation and depreciation episodes. Finally, incorporating world demand (trading partner GDP) and global commodity price indices as additional control variables would strengthen the model's external validity and mitigate potential omitted variable concerns.

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