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China's Economic Growth and Pakistan's Growth Performance: The Role of Bilateral Trade and Chinese Foreign Direct Investment, 1990–2022

Author
Mr. Farman Ali Shar
Ph.D. Research Scholar
Department of Economics, Shah Abdul Latif University, Khairpur Mirs
Corresponding author: farmanshar@gmail.com

Co-author
Prof. (R) Dr. Muhammad Saleem Rahpoto
Department of Economics, Shah Abdul Latif University, Khairpur Mirs
Email: saleem.rahpoto@salu.edu.pk

Abstract

China's economic expansion presents opportunities for Pakistan through trade and investment, but the domestic growth benefits of these linkages remain contested. This study examines the relationship between China's economic growth, Chinese foreign direct investment, bilateral trade, and Pakistan's real GDP growth using annual data for 1990–2022. An explanatory sequential mixed-methods approach combines autoregressive distributed lag models and error-correction representations with documentary analysis of bilateral trade agreements and investment policy frameworks.

The reported estimates indicate a positive association between China's economic growth and Pakistan's growth performance, while Chinese foreign direct investment is not statistically significant in the long-run specifications. Bilateral exports are positively associated with Pakistan's growth, whereas imports exhibit a negative association. In the integrated specification, the reported coefficients are 0.932 for China's GDP growth, 8.351 for log exports, and −11.649 for log imports. Because Pakistan's GDP growth enters in levels, the trade coefficients represent changes in the growth rate associated with changes in logged trade flows rather than conventional growth elasticities. The estimated error-correction coefficient of −0.751 indicates substantial annual adjustment towards the estimated equilibrium; however, the integrated model's inconclusive bounds-test result warrants caution in interpreting its long-run estimates.

The documentary analysis situates these findings within concerns about market access, domestic production linkages, and technological absorption. The study contributes a historically extended assessment of Pakistan–China economic integration and highlights the importance of

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export diversification, domestic supplier development, and skills formation in strengthening its potential growth benefits.

Keywords: Pakistan–China economic relations; Economic growth; Chinese foreign direct investment; Bilateral trade; ARDL bounds testing; Absorptive capacity.

1. Introduction

China's economic rise raises an important development question for Pakistan: how can closer engagement with a large industrial economy translate into sustained domestic growth? Access to an expanding market, foreign investment, and improved infrastructure can strengthen productive capacity. Yet these opportunities do not necessarily produce comparable gains across trading partners. Their outcomes depend on what countries exchange, how investment connects with domestic firms, and whether local workers and institutions can absorb new technologies. Pakistan-China economic relations provide a valuable setting in which to examine these conditions.

The institutional foundations of this relationship extend beyond the China–Pakistan Economic Corridor (CPEC). The China–Pakistan Free Trade Agreement (CPFTA), signed in November 2006, entered into force for trade in goods in July 2007 (World Trade Organization [WTO], n.d.). CPEC subsequently broadened the economic relationship through cooperation in energy, transport infrastructure, and industrial development. Pakistan operationalised the revised tariff arrangements under CPFTA Phase II in January 2020 (Federal Board of Revenue [FBR], 2019). These developments brought trade policy and investment cooperation into closer alignment, creating opportunities to examine how bilateral integration relates to Pakistan's growth performance.

For Pakistan, the central concern is the capacity of this engagement to support production, exports, and technological upgrading. A World Bank assessment of CPEC and bilateral trade identifies considerable scope for Pakistan to benefit from improved connectivity and access to Chinese markets. It also finds that infrastructure improvements require complementary changes in the business environment, trade facilitation, and regulatory arrangements if their benefits are to be realised (World Bank, 2019). This distinction matters: investment in connectivity creates an opportunity for productive activity, while domestic economic conditions influence the extent to which firms can use it.

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Trade provides one channel through which these opportunities and constraints interact. Exports can expand demand for domestic production and generate foreign exchange. Imports can supply machinery, intermediate inputs, and technologies that improve efficiency, but they can also intensify competition for domestic producers and increase external financing requirements. Consequently, an increase in bilateral imports cannot be classified as either beneficial or harmful without considering its composition and productive use. The World Bank's assessment finds that some Pakistani sectors faced stronger competition from Chinese imports, while sectors using Chinese intermediate inputs more intensively improved their international competitiveness (World Bank, 2019). These contrasting outcomes make the relationship between aggregate trade flows and economic growth an empirical question.

Foreign direct investment presents a related question. Its contribution to development depends partly on whether foreign enterprises establish supplier relationships, develop workforce skills, and transmit knowledge to the host economy. Borensztein, De Gregorio, and Lee (1998) show that the growth benefits of FDI are associated with the availability of human capital in recipient countries. Their findings provide a basis for examining domestic absorptive capacity when interpreting foreign investment outcomes. In Pakistan's case, the relevant issue is whether Chinese investment is associated with broader growth gains and how domestic capabilities may help explain the relationship. A statistically insignificant FDI coefficient, however, cannot by itself establish the absence of investment benefits or identify the mechanism limiting them.

The institutional setting also deserves attention because investment commitments operate within domestic regulatory and financial arrangements. Shah (2018) examines how CPEC interacts with Pakistan's institutions and highlights concerns relating to transparency, governance, and external economic pressures. This perspective complements trade and investment analysis by drawing attention to the arrangements through which projects are negotiated and implemented. It does not imply that all Chinese capital carries the same risks. Equity investment, intercompany lending, sovereign borrowing, and project finance have different implications and should be distinguished when interpreting the broader economic relationship.

Against this background, the present study examines a specific empirical problem: how are China's economic growth, Chinese FDI, and Pakistan's bilateral imports and exports associated with Pakistan's real GDP growth over 1990–2022? This period places recent corridor-related cooperation within a longer history of economic engagement. It includes years preceding the

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CPFTA and CPEC, allowing the analysis to consider the bilateral relationship beyond the implementation period of any single initiative. The study therefore examines historical macroeconomic relationships rather than estimating the isolated causal effect of CPEC.

The analysis addresses three connected questions. First, is China's economic growth positively associated with Pakistan's growth performance? Second, do Chinese FDI and bilateral trade exhibit distinct relationships with Pakistan's growth in the short and long run? Third, how can documentary evidence on trade agreements, investment arrangements, and domestic productive capabilities inform the interpretation of these estimates? Together, these questions connect the macroeconomic results with the institutional setting without treating documentary explanations as independently established causal findings.

The study uses an explanatory sequential mixed-methods approach. Its quantitative component applies autoregressive distributed lag models and error-correction representations to annual observations for 1990–2022. The subsequent documentary analysis examines relevant bilateral agreements and policy frameworks to contextualise the statistical findings. This combination allows the paper to distinguish between the relationships estimated from aggregate data and the institutional mechanisms that may help explain them.

The paper contributes by bringing China's growth, Chinese-origin FDI, and bilateral trade into a common assessment of Pakistan's growth performance. Distinguishing imports from exports and Chinese FDI from aggregate foreign investment makes the channels of engagement more explicit. Linking the estimates with documentary evidence also helps identify where policy interpretation is supported and where further investigation is needed. The wider relevance extends to developing economies seeking to convert closer engagement with a larger industrial partner into domestic productive capacity. Pakistan's experience offers a context-specific contribution to that debate, rather than a basis for assuming identical outcomes elsewhere.

The remainder of the paper is organised as follows. Section 2 develops the theoretical framework, reviews relevant literature, and presents the research hypotheses. Section 3 describes the data and methodology. Section 4 reports the empirical results, while Section 5 discusses their institutional interpretation. Section 6 presents policy implications, and Section 7 concludes with the study's principal findings and limitations.

2. Theoretical Framework and Literature Review

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2.1 Economic Integration and Domestic Growth

Closer economic integration with a rapidly expanding economy can create opportunities through export demand, investment, and access to productive inputs. Whether these opportunities generate sustained growth depends on the structure of the participating economies and the connections between external flows and domestic production. For Pakistan, the central question is how engagement with China contributes to productive activity, rather than whether bilateral trade and investment have increased.

The dissertation's analytical framework brings together capital accumulation, endogenous growth, structural transformation, and structuralist explanations of international economic relations. These perspectives offer complementary explanations of why external engagement may expand productive capacity while also exposing domestic constraints. They guide the interpretation of the estimated relationships without assuming in advance that integration must produce either convergence or dependence.

2.2 Capital Accumulation and Structural Transformation

Capital accumulation provides a starting point for understanding the potential contribution of Chinese investment. In the neoclassical framework, additional capital raises output per worker, although diminishing returns limit its contribution to sustained growth in the absence of technological progress (Solow, 1956). Foreign investment can supplement domestic resources and expand productive capacity. However, the growth implications depend on how capital is allocated and how effectively it is used. Investment volume alone therefore provides an incomplete measure of its developmental contribution.

New Structural Economics extends this discussion by placing investment within the process of industrial upgrading. Lin (2012) emphasises the relationship between productive structure, factor endowments, and the infrastructure required for competitive industries. From this perspective, improvements in electricity supply, transport, and industrial facilities can support growth by reducing constraints faced by enterprises. Their contribution is strongest when they complement commercially viable production and the capabilities available within the economy. This provides a useful interpretation of Pakistan's engagement with China: infrastructure

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cooperation can support structural transformation, but its effects depend on the response of domestic firms and the suitability of the surrounding policy environment.

These approaches establish a rationale for a positive investment–growth relationship while leaving room for differences across sectors and periods. An investment that improves infrastructure may generate benefits gradually, whereas a manufacturing investment may affect output through more immediate production and supplier relationships. Aggregate FDI estimates capture the combined relationship across these activities; they do not reveal their separate contributions.

2.3 Endogenous Growth and Absorptive Capacity

Endogenous growth theory explains why access to external capital and technology may produce different outcomes across recipient economies. Romer (1990) places knowledge creation and human capital at the centre of sustained growth. Integration into international markets can expand opportunities for learning, but the availability of technology does not ensure that domestic enterprises can adapt and apply it effectively.

Borensztein, De Gregorio, and Lee (1998) provide empirical support for this distinction. Using data for 69 developing countries, they find that the growth contribution of FDI depends on the host economy's stock of human capital. Their findings suggest that foreign investment and domestic capabilities can operate as complements. An economy with stronger skills and learning capacity may obtain greater productivity benefits from an otherwise comparable investment inflow. This literature supports considering human capital when examining Chinese FDI and Pakistan's growth performance. It does not establish that a particular threshold applies to Pakistan without estimating that threshold directly.

For the present study, human capital provides an aggregate indicator of domestic capabilities. Its estimated coefficient can inform discussion of the growth relationship, but it cannot independently establish whether technology transfer has occurred. Likewise, a negative human-capital coefficient would require examination of measurement, specification, and economic context before being interpreted as evidence of a skills mismatch. The theoretical expectation remains that stronger productive capabilities should support growth; the empirical analysis

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assesses whether the observed relationship is consistent with that expectation.

2.4 Trade Integration and Structural Asymmetry

Trade theory identifies several routes through which international exchange can support growth. Exports expand potential markets, while imports provide access to equipment and intermediate inputs unavailable or more costly domestically. At the same time, import competition can impose adjustment costs on domestic producers. The growth consequences therefore depend partly on whether imports complement domestic production or replace activities that could otherwise remain competitive.

Structuralist analysis directs attention to differences in productive structure and technological capacity between trading partners. Prebisch (1950) questioned the assumption that the benefits of technical progress would be distributed evenly through international exchange. His argument also recognised the importance of trade and imported capital equipment for industrial development. Applied to Pakistan–China relations, this perspective raises questions about export composition, technological learning, and the foreign-exchange requirements of expansion. It does not imply that imports are inherently damaging or that bilateral trade balance is a sufficient measure of development.

Hausmann, Hwang, and Rodrik (2007) strengthen the case for examining what an economy exports, rather than export volume alone. Their work associates the income characteristics of a country's export basket with subsequent growth performance. This distinction is relevant to the dissertation's concern with structural upgrading: higher export earnings may support growth without necessarily indicating diversification into more productive activities. Since the reported models use aggregate bilateral exports, their estimates should be interpreted as export–growth relationships rather than direct measures of export sophistication.

The empirical literature on Pakistan–China trade illustrates these competing mechanisms. The World Bank (2019) identifies constraints relating to market access, domestic competitiveness, and trade facilitation. Its assessment also finds different outcomes across Pakistani industries: sectors facing Chinese competition experienced adjustment pressures, while sectors making greater use of Chinese intermediate inputs improved their international competitiveness. This

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evidence cautions against treating all imports as a single developmental category. The present study consequently examines imports and exports separately, while recognising that aggregate coefficients cannot identify the contribution of individual commodity groups.

2.5 Trading-Partner Growth and International Transmission

China's domestic expansion may influence Pakistan through demand for exports, investment activity, and changes in the availability and price of traded goods. Arora and Vamvakidis (2005) find that trading-partner economic performance is relevant to domestic growth. Their analysis provides a basis for including China's GDP growth alongside bilateral trade and investment variables. It also shifts attention from openness alone towards the economic conditions of the partner with which integration occurs.

The expected relationship is positive, but its interpretation requires care. China and Pakistan may respond simultaneously to global demand, commodity prices, and financial conditions. A positive coefficient on China's growth is therefore consistent with international growth transmission, although it does not isolate a China-specific causal shock. Furthermore, when bilateral trade and investment enter the same equation, the China-growth coefficient describes its association conditional on those included variables. It should not be interpreted as the total effect of China's economic rise.

2.6 Investment Arrangements and External Financial Exposure

The dissertation's discussion of an investment–debt nexus reflects a concern that the benefits of external financing may be accompanied by future payment obligations. Horn, Reinhart, and Trebesch (2019) document the scale and characteristics of Chinese overseas lending and highlight gaps in the reporting of external debt. Their findings demonstrate why financing terms, repayment obligations, and the identity of borrowers matter when assessing international capital flows. They do not establish that every Chinese investment creates sovereign debt.

For Pakistan, Shah (2018) draws attention to the interaction between CPEC and domestic institutions, including transparency and external economic pressures. This supports examining the contractual and regulatory setting alongside macroeconomic estimates. However, equity

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investment, intercompany debt, sovereign borrowing, and government guarantees are analytically distinct. An aggregate FDI coefficient cannot determine their separate effects, and the speed of error correction cannot identify debt distress. In this paper, these issues inform the institutional discussion rather than constitute outcomes directly tested by the growth equations.

2.7 Literature Synthesis and Analytical Contribution

The reviewed literature suggests that the growth consequences of Pakistan–China integration depend on the interaction between external opportunities and domestic productive capabilities. Capital accumulation can expand capacity; human capital can support technological absorption; exports can strengthen demand; and imports can generate both productive benefits and competitive pressures. Institutional arrangements influence how these channels operate and how their financial obligations are distributed.

This study brings these considerations into a historically extended assessment covering 1990–2022. Its contribution lies in examining China's growth, Chinese-origin FDI, and bilateral trade within related time-series specifications, followed by institutional interpretation. It does not require an assumption that earlier research ignored these channels. Rather, it provides a focused assessment of their joint relevance to Pakistan's growth performance.

The dissertation's concept of conditional elasticity is retained here as an organising proposition: the benefits of external engagement depend on domestic economic conditions. It is not presented as a separately estimated threshold or interaction mechanism. Whether the reported coefficients are elasticities or changes in the growth rate depends on the transformations used in each equation, as specified in the methodology.

2.8 Research Hypotheses

The theoretical discussion motivates five hypotheses corresponding to the variables included in the reported specifications:

H1: China's real GDP growth is positively associated with Pakistan's real GDP growth.

H2: Chinese foreign direct investment is positively associated with Pakistan's real GDP growth.

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H3: Pakistan's exports to China are positively associated with Pakistan's real GDP growth.

H4: Pakistan's imports from China are negatively associated with Pakistan's real GDP growth, consistent with the structural-constraint argument examined in the dissertation.

H5: Pakistan's human capital is positively associated with its real GDP growth.

The negative import relationship in H4 is a context-specific proposition assessed against competing arguments concerning productive inputs and technology access. Human capital is evaluated in the specification in which it is included. For each hypothesis, the corresponding null is that the relevant coefficient equals zero. Assessment considers the estimated sign, uncertainty, statistical significance, and validity of the underlying specification. An insignificant coefficient is treated as insufficient evidence of the proposed relationship rather than proof that the channel has no economic role.

3.1 Research Design and Scope

This study employs an explanatory sequential mixed-methods design to examine Pakistan's economic growth in relation to China's economic expansion, Chinese foreign direct investment, and bilateral trade. The quantitative component estimates the relationships among these variables using annual time-series data. The subsequent documentary analysis considers the institutional arrangements within which the observed relationships developed.

The sample covers 1990–2022, comprising 33 annual observations before losses arising from lag construction. This period places the expansion of bilateral economic cooperation within a longer historical setting, encompassing years before and after the China–Pakistan Free Trade Agreement and the development of CPEC. The analysis concerns the broader bilateral relationship rather than the isolated causal effect of either initiative.

The econometric specifications are aligned with the variables appearing in the reported estimation tables. Pakistan's real GDP growth is the dependent variable throughout. Human capital enters the extended specification, while separate and combined models examine bilateral trade and Chinese economic growth. Technology transfer, industrial upgrading, and external financial exposure provide interpretive themes for the documentary analysis; they are not treated as

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separately estimated outcomes.

3.2 Data Sources and Variable Definitions

The dissertation identifies the World Bank's World Development Indicators and State Bank of Pakistan publications as principal sources for the macroeconomic and bilateral financial series. It also draws on UN Comtrade, Chinese Ministry of Commerce records, and relevant international and national institutional publications for supplementary information and historical reconciliation. The estimation dataset contains six principal variables, summarised in Table 1.

Table 1. Variables and empirical roles

Variable	Notation	Measurement and transformation	Role in the analysis
Pakistan's real GDP growth	$g_{P,t}$	Annual percentage growth, retained in levels	Dependent variable in all specifications
China's real GDP growth	$g_{C,t}$	Annual percentage growth, retained in levels	Trading-partner growth indicator
Chinese FDI inflows to Pakistan	f_t	Natural logarithm of annual bilateral inflows, recorded in USD millions	Foreign investment indicator
Pakistan's human capital index	h_t	Natural logarithm of the index used in the dissertation	Aggregate domestic-capability indicator
Pakistan's imports from China	m_t	Natural logarithm of annual bilateral imports, recorded in USD millions	Import channel
Pakistan's exports to China	x_t	Natural logarithm of annual bilateral exports, recorded in USD millions	Export channel

Source: Variable definitions and estimation tables in the dissertation.

The distinction between growth rates and monetary flows is important. GDP growth rates remain in their original units, including negative observations. FDI, exports, imports, and the human-capital index enter in logarithmic form. The monetary series are therefore interpreted according to their recorded dollar values; they are not described as real flows unless a documented price adjustment has been applied.

Human capital is an aggregate indicator of domestic capabilities. It does not directly measure technology transferred by Chinese enterprises, firm-level learning, or the strength of domestic supplier relationships. Similarly, aggregate imports include goods with potentially

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different production and consumption uses. Their coefficient cannot independently identify the effects of machinery, intermediate inputs, and finished consumer products.

3.3 Data Preparation and Historical Coverage

The dissertation documents gaps in early China-origin FDI records, particularly during 1990 - 2000. Its baseline reconstruction uses linear interpolation, while an appendix presents an alternative cubic-spline treatment. These reconstructed observations require explicit recognition because they introduce uncertainty beyond ordinary sampling variation. Interpolation supplies a continuous series; it does not recover the unobserved historical flows with certainty.

The analysis consequently distinguishes reported observations from reconstructed values when assessing the investment results. Alternative interpolation methods provide a sensitivity comparison only when the underlying observed data, variable definitions, and estimation specifications remain comparable. Agreement between two reconstructed series cannot, by itself, establish the accuracy of the missing original observations.

Logarithmic transformations require strictly positive underlying values. Missing FDI records, zero inflows, and negative net flows must therefore be distinguished rather than treated as interchangeable. The transformation applies to the positive FDI series represented in the dissertation's estimation dataset. It does not imply that all historical net bilateral flows were necessarily positive.

3.4 Econometric Framework

The autoregressive distributed lag framework accommodates a dependent variable's own history together with current and lagged explanatory variables. It is appropriate for examining dynamic relationships where the included series may have different integration orders, subject to the conditions governing bounds inference. The approach developed by Pesaran, Shin, and Smith (2001) tests for a levels relationship using statistics whose null distributions are nonstandard. It does not permit the unrestricted inclusion of variables integrated of order two.

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For specification r, the general ARDL representation is:

$$\boldsymbol{g_{P,t} = a_r + \sum_{i=1}^{p_r} \phi_{r,i}\ g_{P,t-i} + \sum_{j=1}^{k_r} \sum_{\ell=0}^{q_{r,j}} b_{r,j,\ell}\ z_{r,j,t-\ell} + u_{r,t}.} \quad (1)$$

Here, $\boldsymbol{a_r}$ is the intercept, p_r is the dependent-variable lag order, $q_{r,j}$ is the lag order for explanatory variable j, and $u_{r,t}$ is the disturbance term. The explanatory vector $\mathbf{z}_{r,t}$ differs across the three specifications, and k_r denotes the number of explanatory variables in specification r.

3.5 Model Specifications

Model 1: Growth, investment, trade, and human capital

Model 1 includes China's growth, Chinese FDI, human capital, and bilateral imports and exports:

$$\mathbf{z}_{1,t} = (g_{C,t},\ f_t,\ h_t,\ m_t,\ x_t)'. \quad (2)$$

Its associated long-run representation is:

$$g_{P,t} = c_1 + \theta_{1C} g_{C,t} + \theta_{1F} f_t + \theta_{1H} h_t + \theta_{1M} m_t + \theta_{1X} x_t + e_{1,t}. \quad (3)$$

In Equation (3), $c_1$is the long-run intercept, the θ coefficients describe the conditional long-run relationships, and $e_{1,t}$ represents deviation from the specified relationship.

This specification examines whether Chinese growth and investment are associated with Pakistan's growth after accounting for bilateral trade and human capital. It contains no estimated FDI - human-capital interaction in the reported coefficient table. Accordingly, the human-capital coefficient is interpreted as an independent conditional association rather than an estimated absorptive-capacity threshold.

Model 2: Bilateral trade and growth

Model 2 focuses on bilateral trade:

$$\mathbf{z}_{2,t} = (m_t,\ x_t)'. \quad (4)$$

Its associated long-run representation is:

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$$g_{P,t} = c_2 + \theta_{2M} m_t + \theta_{2X} x_t + e_{2,t}. \quad (5)$$

Here, θ_{2M} and θ_{2X} describe the conditional relationships of imports and exports with Pakistan's growth.

This specification examines imports and exports separately in relation to aggregate growth. It does not directly estimate industrial productivity, export sophistication, or commodity-specific technological spillovers.

Model 3: Combined growth, investment, and trade specification

Model 3 combines China's growth, Chinese FDI, and bilateral trade, excluding human capital:

$$\mathbf{z}_{3,t} = \left(g_{C,t},\ f_t,\ m_t,\ x_t\right)'. \quad (6)$$

Its associated long-run representation is:

$$g_{P,t} = c_3 + \theta_{3C} g_{C,t} + \theta_{3F} f_t + \theta_{3M} m_t + \theta_{3X} x_t + e_{3,t}. \quad (7)$$

Comparison with Model 1 indicates how the reported associations differ when human capital is excluded. Model 3 remains a growth equation: it does not contain a debt ratio or capacity-payment variable and therefore does not directly estimate debt sustainability.

Equations (3), (5), and (7) describe the long-run relationships associated with the dynamic specifications. Their interpretation depends on the evidence supporting a valid levels relationship.

3.6 Integration Properties and Lag Selection

The dissertation uses Augmented Dickey–Fuller and Phillips–Perron procedures to assess integration properties. The reported unit-root table classifies Pakistan's and China's GDP growth as stationary in levels, while the logged explanatory series become stationary after first differencing. The distinction matters because first-differencing every variable before estimating a levels relationship would discard information relevant to the ARDL framework.

The reported estimation procedure considers a maximum lag of two years and uses information criteria to guide lag selection. A maximum permitted lag is distinct from the lag order selected for each variable. Consequently, each results table must identify the complete estimated

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ARDL order and the effective estimation sample.

With only 33 annual observations, parsimony is particularly important. Additional lags reduce residual degrees of freedom and can make coefficients sensitive to specification choices. The availability of an ARDL estimator does not remove these small-sample constraints.

3.7 Bounds Testing and Long-Run Inference

The conditional error-correction representation corresponding to Equation (1) is:

$$\Delta g_{P,t} = \alpha_r + \rho_r g_{P,t-1} + \sum_{j=1}^{k_r} \pi_{r,j} z_{r,j,t-1} + \sum_{i=1}^{p_r-1} \gamma_{r,i} \Delta g_{P,t-i} + \sum_{j=1}^{k_r} \sum_{\ell=0}^{q_{r,j}-1} \delta_{r,j,\ell} \Delta z_{r,j,t-\ell} + u_{r,t}. \quad (8)$$

In Equation (8), Δ denotes the first-difference operator. The coefficient ρ_r applies to the lagged dependent variable, while $\pi_{r,j}$ applies to the lagged level of explanatory variable j. The coefficients $\gamma_{r,i}$ and $\delta_{r,j,\ell}$ capture short-run dynamics. Empty lag sums are omitted where the selected order is zero. Deterministic terms must follow the case used in the actual estimation and critical-value comparison.

The bounds F-test evaluates the joint null hypothesis:

$$H_0: \quad \rho_r = \pi_{r,1} = \cdots = \pi_{r,k_r} = 0. \quad (9)$$

A statistic above the relevant upper bound rejects the null of no levels relationship; one below the lower bound does not reject it. A statistic between the bounds is inconclusive. Critical values depend on the number of explanatory variables, the treatment of intercepts and trends, and the sample-size framework. The dissertation refers to the finite-sample values associated with Narayan (2005); their application requires a matching specification rather than a common critical-value pair across all equations.

Particular caution is necessary because the dependent growth series is reported as stationary. Significant lagged adjustment alone may reflect a degenerate relationship rather than cointegration involving the explanatory variables. The methodological literature therefore

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distinguishes the joint levels test from additional tests needed to assess degeneracy (McNown, Sam, & Goh, 2018). No bootstrap or additional degeneracy test is claimed here unless supported by estimation output. An inconclusive bounds result is retained as inconclusive rather than overridden by an ordinary error-correction p-value.

Where the levels relationship is adequately supported and $\rho_r \neq 0$, the long-run coefficient is:

$$\theta_{r,j} = -\frac{\pi_{r,j}}{\rho_r}. \tag{10}$$

Thus, each long-run coefficient is obtained by normalising the corresponding lagged explanatory-variable coefficient by the coefficient on the lagged dependent variable, with the sign reversed.

3.8 Short-Run Adjustment and Coefficient Interpretation

The error-correction term represents departure from the estimated long-run relationship:

$$ECT_{r,t-1} = g_{P,t-1} - c_r - \sum_{j=1}^{k_r} \theta_{r,j}\, z_{r,j,t-1}. \tag{11}$$

Here, c_r denotes the long-run intercept and $ECT_{r,t-1}$ measures the previous period's deviation from the estimated equilibrium.

Its coefficient describes the adjustment of Pakistan's growth towards that relationship, conditional on the model. A coefficient between −1 and zero is consistent with partial annual correction. It does not independently identify the source of a disturbance, establish debt dependence, or distinguish resilience from vulnerability.

Because GDP growth enters in levels, the estimated coefficients are not uniformly elasticities. A one-percentage-point increase in China's growth is associated with a θ_C-percentage-point change in Pakistan's growth. For a logged explanatory variable **V**, a 1% increase is associated with:

$$\Delta g_P = \theta_V \ln(1.01) \approx 0.01\, \theta_V \tag{12}$$

percentage points. This interpretation applies to the logged trade, investment, and human-capital variables. It distinguishes a change in the growth rate from a percentage change in GDP.

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3.9 Residual Diagnostics and Parameter Stability

The dissertation reports Breusch–Godfrey serial-correlation tests, ARCH tests, residual normality checks, and CUSUM and CUSUM-of-squares assessments. These diagnostics address different aspects of model adequacy and require separate reporting for each specification.

Failure to reject a diagnostic null provides evidence consistent with the tested property; it does not prove that all specification problems are absent. Similarly, stability plots remaining within their critical boundaries indicate no detected instability under those procedures. They do not establish that a particular policy initiative caused no structural change or replace a formal test of a dated break.

3.10 Documentary Analysis and Integration of Evidence

The documentary component follows the dissertation's three principal themes: bilateral market access under CPFTA; production linkages and technological absorption under CPEC and SEZ frameworks; and external financial obligations discussed in SBP and IMF publications.

Documents are interpreted according to their authority and purpose. Treaty provisions establish formal commitments, strategic plans describe intended policy directions, and institutional reports provide assessments of implementation and economic conditions. These forms of evidence are not interchangeable. A stated objective of local sourcing, for example, does not establish that domestic sourcing occurred.

Integration takes place by comparing the econometric findings with relevant documentary evidence, including evidence that complicates the proposed interpretation. This supports discussion of plausible mechanisms without claiming that the documents identify the cause of a particular coefficient. Aggregate time-series evidence, reconstructed historical observations, and the absence of firm-level information remain limits on the conclusions.

4. Empirical Results

The estimates describe a differentiated relationship between Pakistan's growth and its economic engagement with China. China's growth is positively associated with Pakistan's growth in both specifications in which it appears. The FDI coefficients are positive but imprecisely

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estimated, while the strength of the trade relationships varies across models. The following analysis distinguishes these patterns from the stronger causal and institutional claims that aggregate time-series estimates cannot establish.

4.1 Descriptive characteristics

Table 2. Descriptive statistics, 1990–2022

Variable	Mean	Median	Minimum	Maximum	SD	N
Pakistan GDP growth	4.124	4.300	-1.300	7.800	1.970	33
China GDP growth	8.342	8.600	2.300	14.160	2.791	33
Log Chinese FDI	2.809	2.660	-4.605	7.420	4.164	33
Log human capital	0.511	0.569	0.306	0.631	0.108	33
Log imports	8.047	8.046	5.942	9.957	1.403	33
Log exports	6.178	6.235	4.062	8.125	1.377	33

Source: Calculations from the 33 annual observations in the study's data schedule. SD denotes the sample standard deviation. Growth rates are annual percentages; the remaining series are natural logarithms. Calculations use the precision displayed in the data schedule.

Pakistan's growth averages 4.124% and ranges from −1.3% to 7.8%, indicating substantial variation over the sample. China's growth averages 8.342% in the same annual schedule. These averages describe the sample and do not establish that changes in one economy caused changes in the other.

The investment and trade variables also display considerable variation. Logarithmic values must be read in relation to the units of the underlying series: a negative log FDI observation denotes a positive amount below one unit of measurement, rather than necessarily a negative capital flow. Raw-series normality is not a prerequisite for ARDL estimation, and descriptive statistics do not establish parameter stability.

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4.2 Unit-root evidence and bounds testing

Table 3. Reported Augmented Dickey-Fuller results

Variable	Level statistic	First-difference statistic	Reported p-value	Classification
Pakistan GDP growth	-4.332	-	0.0019	I(0)
China GDP growth	-3.883	-	0.0051	I(0)
Log Chinese FDI	-1.290	-7.481	<0.0001	I(1)
Log human capital	-0.199	-7.513	<0.0001	I(1)
Log imports	-0.785	-7.531	<0.0001	I(1)
Log exports	-0.589	-6.733	<0.0001	I(1)

Source: Reported unit-root estimates. For growth rates, p-values refer to levels; for logged variables, they refer to first differences. Values displayed as 0.0000 in the estimation summary are expressed as <0.0001. Separate Phillips–Perron statistics are not reported here.

The reported classifications indicate stationary growth rates and first-difference stationarity in the logged series. They provide no reported evidence of an I(2) variable. These classifications are conditional on the unit-root specifications and should be read with the small sample in mind. In particular, stationarity of the dependent growth rate means that a significant adjustment coefficient alone cannot establish a non-degenerate long-run relationship.

Table 4. Reported ARDL bounds tests

Specification	F-statistic	5% lower bound	5% upper bound	Comparison
Model 1	4.978	3.125	4.608	Above upper bound
Model 2	7.255	4.267	5.473	Above upper bound
Model 3	3.284	2.850	4.049	Inconclusive

Source: Main estimation tables. Comparisons use the reported critical values; their validity depends on matching the deterministic case, regressor count and effective sample size.

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Models 1 and 2 exceed their reported 5% upper bounds, providing preliminary evidence against the joint null of no levels relationship. Model 3 lies between its lower and upper bounds and remains inconclusive. Its long-run coefficients are consequently presented as conditional estimates, rather than as evidence of an established equilibrium relationship. Neither an inconclusive F-test nor a negative adjustment coefficient establishes structural dependence or external financial distress (Pesaran et al., 2001; McNown et al., 2018).

4.3 Long-run coefficient estimates

Table 5. Reported long-run estimates across specifications

Variable	Model 1 coefficient (SE); p	Model 2 coefficient (SE); p	Model 3 coefficient (SE); p
China GDP growth	0.613 (0.285); 0.041	-	0.932 (0.353); 0.0157
Log Chinese FDI	0.308 (0.283); 0.292	-	1.104 (1.488); 0.4668
Log human capital	-93.540 (38.020); 0.026	-	-
Log imports	-2.073 (10.320); 0.843	-8.329 (4.405); 0.0687	-11.649 (4.384); 0.0151
Log exports	12.120 (9.480); 0.220	8.649 (4.515); 0.0653	8.351 (3.551); 0.0290

Source: Main long-run estimation tables. SE denotes standard error; p denotes the reported p-value. The dependent variable is Pakistan's annual real GDP growth in levels. Model 3 has an inconclusive bounds result. Reported precision is retained; these figures are not newly estimated.

China's growth has a positive coefficient in Models 1 and 3, with reported p-values below 0.05. In Model 1, a one-percentage-point increase in China's growth is associated with a 0.613-percentage-point increase in Pakistan's growth, holding the other regressors constant. Model 3 gives a larger conditional estimate of 0.932 percentage points. The common positive sign is consistent with growth linkages, although common global influences and domestic conditions may also contribute to the association.

Chinese FDI is positive in both specifications but is not statistically significant at conventional levels. The estimates do not provide sufficiently precise evidence of a positive

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aggregate long-run relationship. They also do not establish that investment has no economic benefit, operates as disguised sovereign debt, or fails to transmit technology. Differences in investment composition, project gestation and historical data reconstruction remain relevant to interpretation.

Human capital has a negative coefficient of −93.540 in Model 1, contrary to the positive theoretical expectation. With growth measured in percentage points and human capital in logarithms, a 1% increase in the index corresponds to approximately −0.935 percentage points in growth. The magnitude and unexpected sign call for careful assessment of the indicator's construction, co-movement with other regressors and specification sensitivity. The coefficient alone cannot identify a skills mismatch or show that education reduces growth.

The trade estimates consistently assign a negative sign to imports and a positive sign to exports, but their precision changes materially. Neither coefficient is significant in Model 1. Both are significant at 10%, but not 5%, in Model 2. Model 3 reports significance at 5%, subject to its unresolved bounds evidence. The trade findings therefore depend on the specification and should not be described as uniformly robust.

4.4 Economic magnitude and short-run adjustment

In Model 2, a 1% increase in imports is associated with approximately −0.083 percentage points in Pakistan's growth, while a 1% increase in exports is associated with approximately 0.086 percentage points. The corresponding conditional estimates in Model 3 are −0.116 and 0.084 percentage points. These are changes in the growth rate, not percentage contractions or expansions in GDP. The approximations follow the level–log interpretation established in Section 3.

A comparison of the absolute import and export coefficients does not establish the net contribution of trade. Such a calculation would require the observed changes in both flows and the relevant dynamic responses. Nor does the difference between coefficients establish statistical asymmetry without a formal restriction test. Aggregate import estimates cannot distinguish competitive displacement from the productive use of imported equipment and intermediate inputs.

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Table 6. Reported error-correction estimates

Model	ECT coefficient	SE	t-statistic	p-value	Implied annual correction
1	-0.428	0.114	-3.754	0.0010	42.8%
2	-0.816	0.186	-4.385	0.0002	81.6%
3	-0.751	0.154	-4.877	0.0001	75.1%

Source: Main error-correction estimation tables. Correction rates are conditional on a valid equilibrium specification. Reported ordinary p-values are not substitutes for bounds or degeneracy tests.

All three adjustment coefficients are negative. Conditional on a valid equilibrium representation, the estimates indicate correction of approximately 42.8%, 81.6% and 75.1% of the previous period's disequilibrium per year. These figures describe adjustment within different models, rather than direct measures of welfare, financial distress or exposure to a specific bilateral shock. The implied correction in Model 3 remains conditional because its bounds test is inconclusive.

Table 7. Selected reported short-run coefficients for Model 1

Term	Coefficient	SE	t-statistic	p-value
Change in China GDP growth	0.164	0.305	0.536	0.599
Change in log human capital	-93.540	38.020	-2.460	0.026
Change in log exports	-0.336	6.173	-0.054	0.957

Source: Short-run estimation summary. These are selected reported terms, not the complete dynamic equation. "Change" denotes the first difference.

The reported immediate China-growth and export coefficients are not significant at conventional levels. The human-capital change coefficient is negative and significant at 5%. Because the available short-run summary does not list every dynamic term, it cannot establish the cumulative response to a trade or investment shock.

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4.5 Diagnostics and hypothesis assessment

Table 8. Reported residual diagnostics for Model 1

Test	Statistic	p-value	Assessment at 5%
Breusch-Godfrey	1.124	0.342	No rejection of no serial correlation
ARCH	0.856	0.461	No rejection of no ARCH effects
Jarque - Bera	0.861	0.650	No rejection of residual normality

Source: Model 1 diagnostic summary. Test lag orders and statistic types must accompany the full estimation output. These values are not extended to Models 2 and 3.

The reported Model 1 diagnostic probabilities exceed 0.05. This provides no rejection of the tested nulls, although the small sample limits the strength of that evidence. The results do not establish the absence of omitted variables, reverse causality or all forms of heteroskedasticity. No numerical residual-diagnostic results for Models 2 and 3 are inferred from Model 1.

Parameter-stability claims also require model-specific CUSUM and CUSUM-of-squares plots with legible sample dates and critical boundaries. The coefficient tables alone cannot establish stability across the CPFTA or CPEC periods. Accordingly, the hypothesis assessment below is based on the reported estimates and their stated inferential qualifications.

Table 9. Assessment of the research hypotheses

Hypothesis	Evidence	Assessment
H1: Positive China-growth association	Positive in Models 1 and 3; reported $p < 0.05$.	Consistent with H1, conditional on model validity; Model 3 bounds inconclusive.
H2: Positive Chinese-FDI association	Positive but insignificant in Models 1 and 3.	Insufficient evidence to support H2.
H3: Positive export association	Positive in all models; $p = 0.220$, 0.0653 and 0.0290.	Specification-dependent support; Model 2 evidence only at 10%.

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Hypothesis	Evidence	Assessment
H4: Negative import association	Negative in all models; p = 0.843, 0.0687, and 0.0151.	Specification-dependent support; no direct identification of leakage.
H5: Positive human-capital association	Negative in Model 1; p = 0.026.	Positive prediction not supported in the reported specification.

Note: Hypothesis numbering follows Section 2. Reported significance does not establish causality or eliminate uncertainty over the levels relationship.

4.6 Synthesis of the empirical evidence

The clearest reported patterns are a positive China-growth association and an imprecisely estimated FDI relationship. Imports and exports have opposing signs, but their statistical support varies across specifications. The negative human-capital estimate requires further explanation rather than a presumption of harmful educational investment. These findings motivate examination of market access, productive linkages and domestic capabilities in the discussion. Institutional evidence can help assess plausible explanations, while the bounds-test uncertainty and limits of the aggregate data constrain causal conclusions.

5. Discussion

The findings suggest that Pakistan's economic relationship with China comprises several distinct associations whose strength depends on the model specification. China's growth is positively associated with Pakistan's growth, whereas Chinese foreign direct investment (FDI) has a positive but imprecisely estimated coefficient. Exports and imports carry opposing signs, although their statistical significance varies across models. These differences matter because the expansion of bilateral economic activity need not translate uniformly into domestic growth. The discussion therefore considers the channels through which trade and investment might influence Pakistan's productive capacity, while distinguishing these explanations from mechanisms directly established by the estimates.

5.1 China's growth and Pakistan's economic performance

The positive China-growth coefficient is the most consistent significant association across the specifications in which this variable appears. In Model 1, a one-percentage-point increase in

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China's growth is associated with a 0.613-percentage-point increase in Pakistan's growth, holding the included regressors constant. This finding is compatible with the proposition that expansion in a major economic partner can create opportunities for a smaller partner through stronger demand and broader commercial activity. However, because bilateral exports, imports and FDI already enter the equation, the China-growth coefficient cannot be interpreted as the total effect operating through those same channels.

An alternative explanation is that the two economies respond partly to common international conditions. Changes in global demand, financing conditions or commodity markets could influence both growth rates without being fully captured by the included variables. The coefficient consequently identifies a conditional association rather than an isolated Chinese growth shock. Model 3 yields a larger positive coefficient, but its inconclusive bounds result prevents treating this difference as evidence of a stronger established long-run relationship. For Pakistan, the substantive implication is that favourable external growth conditions may offer opportunities whose domestic consequences depend on the country's capacity to participate in that expansion.

5.2 Chinese investment and the conditions for domestic gains

The positive but statistically insignificant FDI coefficients indicate uncertainty about the aggregate growth association over the sample. They do not establish that Chinese investment has no economic value. Investment may generate benefits in particular sectors, locations or periods that an annual national growth equation cannot distinguish. Equally, the positive sign alone is insufficient to demonstrate a reliable growth contribution. The evidence supports a measured interpretation in which the scale of investment and its integration into domestic production are separate questions.

This interpretation is consistent with Borensztein et al. (1998), who find that the growth benefits of FDI depend on the host economy's human capital. Their evidence provides a rationale for examining local capabilities, but it does not demonstrate that the same mechanism explains the estimates reported here. The present specifications contain no FDI–human-capital interaction or estimated threshold. Supplier relationships, workforce training and the diffusion of production practices therefore remain plausible explanations to investigate rather than identified transmission channels. In the Pakistan–China setting, the useful empirical question is how investment connects with domestic firms and workers, alongside how much capital enters the economy.

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The FDI estimates also cannot resolve questions about sovereign debt, repayment obligations or project financing arrangements. Those questions require separately identified financial instruments and contractual evidence. An insignificant FDI coefficient cannot establish that equity investment is disguised lending or that a particular infrastructure programme creates a debt burden. Keeping these categories distinct allows the economic contribution of investment to be assessed without attributing effects to variables that the models do not contain.

5.3 Trade composition and the interpretation of opposing coefficients

The export coefficients are positive in all three specifications, while the import coefficients are negative. Their significance is weaker in the broad specification and stronger in the more restricted models. Model 2 provides evidence at the 10% level, but not at 5%; the stronger significance in Model 3 remains conditional on its unresolved bounds test. The pattern is therefore suggestive of different growth associations for the two trade flows, rather than a uniformly robust demonstration that exports promote growth and imports reduce it.

The positive export association is compatible with several familiar channels, including access to demand, production at greater scale and foreign-exchange earnings. The estimates do not distinguish these channels or identify which products contribute most. Similarly, aggregate imports combine goods with different economic functions. Imported machinery and intermediate inputs can support domestic production, whereas other imports may compete with locally produced goods. Coe and Helpman (1995) provide international evidence linking foreign research and development to domestic productivity through trade-related spillovers. Their findings explain why a negative aggregate import coefficient should not be interpreted as evidence that every category of imports is economically harmful.

For Pakistan, the relevant distinction is between trade expansion and the domestic value added associated with that expansion. Evaluating this distinction would require information on import composition, the imported content of exports and linkages with local suppliers. The present results motivate that inquiry but do not measure displacement, technological learning or net welfare effects. Moreover, comparing the absolute export and import coefficients is not a formal test of asymmetry: the variables can change by different amounts, and the uncertainty surrounding their estimated difference also matters. The evidence therefore does not justify a general conclusion that reducing bilateral imports would necessarily raise growth.

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5.4 Human capital and productive capabilities

The negative human-capital coefficient in Model 1 contrasts with the positive theoretical expectation. Its sign deserves attention, but it should not be read as a causal return to education. A national index may capture changes in measured schooling or skills without fully representing how those capabilities are used in production. Measurement choices, correlated trends among regressors and specification sensitivity could also contribute to the estimate. The large coefficient makes the definition and scaling of the index particularly consequential.

The appropriate interpretation is that the estimated specification does not support the hypothesised positive human-capital association. It does not establish that education depresses growth, that skills mismatch is the cause, or that Pakistan lies below a particular absorptive-capacity threshold. Establishing these mechanisms would require additional indicators or explicit interaction tests. Read alongside the FDI results, the finding directs attention to the relationship between investment and domestic capabilities, while leaving the nature and strength of that relationship open to further investigation.

5.5 National relevance and the international contribution

At the national level, the analysis brings external growth conditions, bilateral trade and investment into a common empirical account of Pakistan's growth performance over 1990–2022. Its contribution lies in showing that these associations differ in precision and sensitivity to specification. This distinction is useful when assessing economic engagement with China: evidence of a positive partner-growth association does not, by itself, establish an equally strong investment effect, and rising trade volumes do not reveal how gains are distributed across domestic activities.

At the international level, the study offers country-specific evidence relevant to the broader question of how a smaller developing economy participates in the expansion of a larger partner. The combination of positive growth co-movement, uncertain FDI estimates and opposing trade coefficients highlights questions about the composition of integration and domestic productive participation. These findings do not establish a general result for other developing countries. They identify relationships that comparative research could test using harmonised data, sectoral information and designs that distinguish external shocks from domestic responses.

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The sample covers different phases of bilateral engagement, but the reported specifications do not isolate the effects of the China–Pakistan Free Trade Agreement or the China–Pakistan Economic Corridor. Attributing a full-sample coefficient to either initiative would require an explicit identification strategy and treatment of other changes occurring over the same period. The paper's contribution is consequently an assessment of aggregate relationships across the study period, rather than a causal evaluation of either policy initiative.

5.6 Scope of inference

The interpretation is bounded by the small annual sample, the aggregate nature of the variables and the uncertainty surrounding the levels relationships. In particular, Model 3's bounds test is inconclusive. Because the dependent growth rate is reported as stationary, significant adjustment coefficients also require care in distinguishing a non-degenerate levels relationship from alternative outcomes. McNown et al. (2018) show why additional testing is needed to address degeneracy in the ARDL framework. The reported adjustment speeds should therefore be understood conditionally, rather than as independent confirmation of cointegration.

Within these limits, the results support a focused conclusion for the discussion: Pakistan's growth is positively associated with China's expansion, while the evidence for individual investment and trade channels is more qualified. Explanations based on domestic capabilities and the composition of trade remain economically plausible, but the present models do not identify them directly. This distinction provides the basis for policy implications that respond to the observed patterns without presenting untested mechanisms as established findings.

6. Conclusion and Policy Implications

6.1 Conclusion

This study examined Pakistan's growth performance in relation to China's economic expansion, bilateral trade and Chinese foreign direct investment over 1990–2022. The reported ARDL estimates reveal distinct associations across these dimensions of economic engagement. China's growth carries a positive and statistically significant coefficient in both specifications in which it appears. Chinese FDI is positively signed but statistically insignificant, while exports and imports have positive and negative coefficients, respectively, with significance varying across models. The negative human-capital coefficient in the broad specification contrasts with the

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theoretical expectation and requires cautious interpretation.

The central finding is that the association between China's expansion and Pakistan's growth is clearer in the reported estimates than the contribution of individual investment and trade channels. This distinction prevents the scale of bilateral engagement from being treated as sufficient evidence of domestic economic gains. It also leaves room for differences in the composition, timing and local integration of trade and investment. These explanations are economically relevant, although the models do not directly identify their operation.

The findings remain conditional on the adequacy of the specifications and the evidence for a valid levels relationship. Models 1 and 2 exceed their reported upper bounds, whereas Model 3 remains inconclusive. Its coefficient estimates therefore cannot establish a confirmed long-run relationship. Likewise, the negative adjustment coefficients do not independently resolve the bounds-test uncertainty or demonstrate economic dependence. The paper's contribution is a differentiated account of the reported growth associations, with explicit recognition of their statistical limits, rather than a causal evaluation of Chinese investment or a specific bilateral initiative.

6.2 Policy implications

The results motivate attention to how external economic engagement connects with domestic production. The following implications are priorities for policy assessment, not interventions whose effects have been estimated by this study. Their implementation would require evidence on costs, feasibility and sector-specific outcomes.

Export development should be assessed through domestic value added as well as gross sales. The positive export coefficients make access to external demand a relevant area for further policy attention, although their statistical support depends on specification. For Pakistan's economic engagement with China, practical areas to evaluate include product standards, market information, logistics and the reliability of export supply. Performance assessment should examine sustained export participation and domestic supplier income alongside the value of exports. The present estimates cannot identify which products or support programmes would deliver the largest gains.

Import policy should distinguish productive inputs from goods that compete with domestic

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output. The negative aggregate coefficients do not support a general presumption in favour of import restriction. Machinery and intermediate inputs may support production and exports, while other categories can have different effects on local firms. A useful policy assessment would examine import composition, domestic substitution possibilities and consequences for downstream producers before selecting an intervention. Blanket restrictions could therefore conflict with the objective of strengthening export capacity; their effects cannot be determined from the aggregate coefficient alone.

Investment assessment should extend beyond the recorded volume of inflows. The imprecise FDI estimates suggest that aggregate annual data provide an incomplete basis for judging investment outcomes. Project evaluation could track local procurement, employment, workforce training and links with domestic enterprises, alongside commercial performance. Such indicators would help assess whether particular investments contribute to productive activity in Pakistan. Financing records should also distinguish equity, reinvested earnings, intercompany lending and sovereign borrowing so that investment performance and public financial obligations are evaluated using appropriate evidence.

Human-capital policy should focus on the connection between capabilities and productive employment. The negative coefficient does not justify reducing education or training expenditure. It instead reinforces the need to examine what the indicator measures and how skills are deployed. Employer-linked training and technical education are potential areas for evaluation, with outcomes assessed through employment, earnings and firm productivity. Whether these measures strengthen the benefits of Chinese investment remains a question for direct empirical testing, since the present models do not estimate that interaction.

Bilateral economic cooperation would benefit from a shared basis for evaluating outcomes. Comparable records of trade composition, investment financing and project performance could support a more transparent assessment of domestic gains. For Pakistan and China, the relevant question is how commercial activity connects with sustained production and market participation. For international development partners, the findings identify a country-specific case for examining these links; they do not establish a policy formula that can be transferred unchanged to other economies.

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6.3 Limitations and future research

The analysis uses a small annual sample and aggregate variables, limiting the separation of sectoral effects, policy changes and common international influences. Historical data reconstruction and the definition of the human-capital measure also affect interpretation. The empirical record requires reconciliation of reported summaries with the underlying estimation output, including lag orders, deterministic terms and critical values. The bounds-test uncertainty, particularly in Model 3, and the reported stationarity of the dependent growth rate warrant additional testing before stronger long-run claims are advanced.

Further research could examine trade by product category and investment by sector and financing instrument. Explicit interaction terms would allow tests of whether human capital conditions the investment-growth association. Designs addressing structural change and common external shocks could help distinguish bilateral effects from broader economic movements. The immediate empirical priority is a reproducible dataset and consistent model output; a longer sample or more complex specification would be useful only if it improves identification and data quality. The findings presented here provide a basis for those investigations while keeping the paper's conclusions within the evidence currently available.

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