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Foreign Direct Investment and Industrial Competitiveness: A Panel Data Analysis of Selected Asian Economies

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Abstract

Foreign direct investment (FDI) is widely recognized as a key driver of industrial competitiveness and economic growth. This study examines the impact of FDI, human capital, transport infrastructure, exchange rate, political stability, and research and development (R&D) on industrial competitiveness for six Asian economies—Pakistan, China, South Korea, Thailand, Malaysia, and Sri Lanka over the period 1996–2020. The study contributes to the literature by offering a unified empirical framework that integrates financial, human, infrastructural, and institutional determinants within a dynamic panel setting. Descriptive statistics indicate moderate variation across variables, while correlation analysis suggests a positive association between industrial competitiveness, FDI, and human capital. The Panel ARDL results confirm the existence of a long-run relationship among the variables. However, the long-run estimates reveal that most explanatory variables, including exchange rate and political stability, are statistically insignificant, suggesting weak transmission mechanisms in the selected economies. Furthermore, the Durbin–Hausman test is employed to determine the appropriate model specification. The findings imply that, despite theoretical expectations, macroeconomic and institutional factors have a limited long-run impact on industrial competitiveness in the sample countries. The study recommends that policymakers focus on enhancing the effective utilization of FDI, strengthening human capital, and improving infrastructure quality to promote industrial competitiveness, while also addressing structural constraints that hinder the effectiveness of macroeconomic stability and institutional quality.

Keywords: Foreign Direct Investment (FDI); Industrial Competitiveness; Panel ARDL; Human Capital; Transport Infrastructure; Exchange Rate

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1. Introduction

In today's globalized market, a "deadly race" has been going on between Multinational Corporations (MNCs) to access the global market via competition. As is well known, competitiveness is an ability to produce value-added, and high-tech products. It affects long-term productivity and considers a key factor of economic growth. Though, competitiveness has become an essential policy concern. Even well-stable industrial economies are uncertain about national competitiveness due to many factors. Growth rate and living standard are significantly enhanced by competitiveness. where competitiveness creates skills, high productivity, and a stable wage economy where enterprises can develop along with many opportunities. The new pattern of knowledge is marked by knowledge and technology base.

Why does industrial competitiveness matter? Since the Industrial Revolution, manufacturing has been the engine for economic growth and for transforming the economic structure of poor countries. It has been the catalyst for shifting them from simple, low-value activities with poor growth prospects to activities with high and value-added productivity, increasing returns, and strong growth potential (UNIDO, 2002). The growth of technology-driven activities in the past two decades does not change this fact, despite the rising share of services in income and the much-hyped growth of the "new economy." Indeed, rapid technical progress makes industrialization even more important in developing countries. Industrial performance reflects the complex interaction of many factors, including institutions, skills, technologies, infrastructure, networking, political and social stability, and other factors. However, this study will focus on FDI, as it is considered one of the main determinants. According to UNIDO (2002), skills, technological effort, inward foreign FDI, technical payments abroad, and modern infrastructure are the main factors deterring competitiveness.

Foreign direct investment is an important element in the restructuring of the old plants, and equipment and diverting the strategies of industries toward development. Physical capital, human capital, and technology upgrading need foreign direct investment in developing countries. Manifestations of globalization and a carrier of new technologies provide both opportunities and threats to developing host countries. The opportunities arise in terms of financial, technological, and human resources, the core one is access to state-of-the-art technologies and to large markets.

The threats arise, by exploiting the natural resources of the host country. In the absence of any micro-economic imperfections, even a huge amount of foreign direct investment (FDI) does not boost the welfare of the host economy, so far as stability in the host economy is essential for the efficient allocation of FDI. On the other hand, FDI creates technological externalities and knowledge spillovers for the local economy. Econometricians found that FDI has a positive and significant effect on domestic firms' total factor productivity and on their propensity to export (Hobday, 1995; Chung et al., 1994).

The sets of possibilities arise here regarding the industrial level, as FDI changes the structure of imperfectly competitive industries. The arrival of FDI typically changes supplies and demands in several related industries. Moreover, FDI creates competition and may damage local industry, but the promotion of special sectors is guaranteed. It has been recognized that developing countries' domestic policies play a passive role in attracting foreign capital. "Getting the fundamentals right" and "adopting market-friendly" policies in domestic markets are necessary, but not sufficient, conditions for attracting FDI. Access to these flows is largely determined by events occurring elsewhere in the world, as the recent world financial crisis painfully distracted many economies. Therefore, exogenous factors are powerful determinants of changes in the presence of TNCs as well as the role of FDI is also non-negligible. Even so, it is believed that conditions conducive to competitiveness, the size of the market, and the previous presence of TNCs are important factors behind FDI inflows.

This study will investigate the behaviour of industrial competitiveness in the selected Asian countries, especially in Pakistan's economy. The findings of the current study will put forth some policy suggestions for the industrial sector, and governmental organizations to attract inward FDI, and a stable exchange rate, which in turn will enhance industrial competitiveness. Pakistan is a developing country, confronted with a trade deficit due to a lack of industrial competitiveness and the aforementioned factors. Much empirical evidence is available regarding the impact of foreign direct investment and control variables that determines industrial competitiveness.

Considering the discourses above the following are the main objectives of the study:

(i) To analyse the impact of foreign direct investment on industrial competitiveness in selected Asian countries.

(ii) To extract the relation between industrial competitiveness and inward FDI for Pakistan.

2. Literature Review

2.1 Foreign Direct Investment and Industries Competitiveness

The positive developmental role of FDI is well documented by Chen (1992), FDI produces a positive effect on economic growth in host countries. One convincing argument for that is that FDI consists of a package of capital and technology management. FDI tends to be directed at those manufacturing sectors and key infrastructures that enjoy actual and potential comparative advantages. In sectors with comparative advantage, FDI creates economies of scale and linkage effects and raises productivity. In fact, FDI brings capital, new technology, and information for investment. Besides capital accumulation for new investments, high labour skills, and the internalization of new technical knowledge and technology, FDI contributes to the production of high-quality/high-tech and value-added export products in the host country. MNCs tend to increase expenditures in R&D activities which help to create new ideas, that stimulate innovation and technologies, production processes, and value-added goods with low-cost local investment environments in the host country. Zhang (2014), Tang and Caroliner, (2012), Chinese National Innovation System (NIS), is composed of two complementary building blocks: the FDI-based innovation system and the indigenous innovation system. They suggest that NIS must be able to improve the absorption and innovation capability of domestic firms and strengthen university-enterprise interactions. Zhang (2013) explores the effect of foreign direct investment on industrial competitiveness in China. By estimating the role of FDI with large panel data of 21 manufacturing sectors for 31 regions over the period 2005-2010. The study resulted that FDI has a positive effect on China's industrial performance. Erdal and Goser (2015) investigated the effects of FDI on R&D and innovation using the panel causality and co-integration methods for 10 developing countries (China, South Korea, India, Iran, Pakistan, Malaysia, Singapore, Thailand, Saudi Arabia, and Turkey) of Asia over 1996-2013 periods. The cointegration relationships between the series were determined by Fisher-type tests using Johansen's test (Maddala and Wu, 1999). Cointegration coefficients were estimated by Panel Fully Modified Least Squares (PFMOLS), and concluded, as

expected that FDI inflows would increase countries' R&D and innovation activities. The study will be tried to draw attention to the need for FDI for countries that want to increase the level of R&D and innovation. Guzik et al. (2009) investigated industrial upgrading in the automotive industry of four Central European (CE) economies including the Czech Republic and Hungary the changes in the international trade of CE countries with automotive products were classified into three value-added classes during the period, 1996 and 2006. They found that FDI and industrial upgrading significantly affect the European automotive production system. Koine (2016), however, the influx of FDI has its drawbacks as well. They include but are not limited to the deterioration of the payment balance as the profits of MNCs are repatriated by the investors to their respective countries, thereby influencing negatively domestic market competition, worker exploitation, the crowding out effect exploitation of natural resources, and environmental degradation (Bisoma 2017; Veltmeyer and Petras 2013).

2.2 Exchange rate and Industries Competitiveness

The relationship between exchange rate volatility and FDI is insufficient and relatively inconclusive. There are several studies that explore the effects of exchange rate volatility on aggregate investment, firstly the theoretical scenario is uncertain, while the empirical results are divided into different parts. In general, the literature highlights that investment has a negative relationship with exchange rate volatility. Although, industry and firm-specific features are significant determinants too (Kyereboah-Coleman and Agyire-Tettey 2008). The empirical and theoretical studies about the relationship between exchange rate volatility and FDI can be divided into two categories; some studies show negative relations, and some studies show positive relations. Studies showing a negative relationship between exchange rate volatility and foreign direct investment (FDI) include Durairaj and Nirmala (2012); Al-Abri and Baghestani (2015); Sharifi-Renani and Mirfatah (2012); Susan Pozo (2001). For instance, Durairaj and Nirmala (2012) investigated the relationship between exchange rate volatility and FDI by considering India as a sample. They used quarterly data for the years 1996 to 2010 and applied Autoregressive Distributed Lag (ARDL), bounds technique to analyze the short and long-run relationship between these variables. They also studied the factors which inspired the investors to make investment decisions. The findings reveal that exchange rate volatility and FDI have an inverse relationship

with each other and suggested that a flexible exchange system is better for attracting FDI in India. Sharifi-Renani and Mirfatah (2012) used the Johansen co-integration technique to find out the determinants of FDI in Iran over the period of 1980 to 2006. They found that exchange rate, trade openness, and GDP have a direct relationship with FDI, but on the other side, exchange rate volatility and oil prices have an inverse relationship with FDI.

2.3 Human Capital and Industries Competitiveness

Human capital emanates from the fundamental assumption that humans possess skills and abilities that can be improved, and it changes the way in which people act (Becker 1964). Human capital is said to be embodied in the skills, knowledge, and expertise that people have, it has been seen as an important source of competitive advantage for individuals, organizations, and societies (Coleman 1988, Gimeno et al. 1997). For example, Gimeno et al. (1997) found a positive association between the overall level of human capital, measured by education level and work experience, and economic performance at both the entrepreneur's level and the firm's level. Pennings et al. (1998) found similar results in their study, of the effects of various forms of capital, including human capital, on firm dissolution. The relationship between human capital and innovation at the country level is grounded in what Bourdieu (1986) termed as 'conversions', that is different forms of capital can be converted into resources and other forms of economic payoff. At the individual level, this conversion process has been studied and validated by a number of researchers (Becker 1964, Gradstein and Justman 2000). In general, the argument is, that those who are better educated have more work experience and invest more time, energy, and resources in their skills. They are better able to secure higher benefits for themselves and at the same time, they are better able to contribute to the overall well-being of society. For this purpose, Maskell and Malmberg (1999) argued that the overall stock of knowledge and skills in a society or a region may enhance its overall competitiveness. Further, a knowledge-intensive activity is expected to be related to human capital in multiple ways. Black and Lynch (1996) proposed that investment in human capital through on-the-job training and education are the driving forces behind increasing productivity and competitiveness at an organizational level.

2.4 Research and Development (R & D) and Industries Competitiveness

The literature has widely described the positive impact of investment in research and development on productivity and business growth (Dosi., 1988 & Rogers., 2004). Some authors highlighted that investments are more effective in the high-tech sectors (Nunes et al., 2012 & Hoffman et al., 1998). However, investment in research and development does not seem to have the same effects on other SMEs (Del Monte and Papagni., 2003 & Lee and Lim., 2009). On the other hand, as anticipated, some scholars highlighted, companies with no high-tech skills and argued that company may improve their products through other tools, such as product development in collaboration with customers (Grimpe and Sofka., 2006), collaboration with other organizations in the research and development (Whittaker 2016), informal relationships, stimuli deriving from internationalization and other factors (McEvily and Zaheer., 1999 & Hervas et al., 2012). The new trade theory by Samuelson (1939) and Stolper & Samuelson (1941) put pressure on competitive advantage. According to the theory, new or differentiated goods, markets separated into sections, changes in technology, and economies of scale have become the most important issues to obtain more competitive power in the global market (Porter, 1998). Today, the new trade theory raised by Krugman (1979), Dixit and Stiglitz (1979) and strengthened by Melitz (2003) argue at international trade is no longer carried out by the state, but by MNCs producing new high technology which makes it more competitive in global market (Bakkalci, 2013).

3. DATA AND METHODOLOGY

3.1. Data

The main objective of the study is to investigate the impact of foreign direct investment on industrial competitiveness in selected Asian economies. The study uses the IC index, developed by UNIDO (2002, 2009), and is considered as the best index for multiple industrial performances. Panel data includes yearly data from 1990 to 2018. The study will further examine whether foreign Direct investment influences Industrial competitiveness or not. The study considered industrial competitiveness IC as a dependent variable and FDI as an Independent Variable. Our study also includes some controlled Variables, that are human capital (HK), research and development (RD) and infrastructure (INFR), Political instability (PI), and Exchange rate (Ex).

Table 1: Variable description

Variable Name	Abbreviation	Definition	Unit of Measurement	Transformation	Data Source
Industrial Competitiveness	IC	Ability of a country to produce and export competitively, measured through the Competitive Industrial Performance (CIP) index based on multiple indicators	Index (CIP Score)	Log	UNIDO
Foreign Direct Investment	FDI	Net inflows of investment to acquire a lasting management interest (10% or more voting stock) in an enterprise operating in another country	% of GDP	Log	World Development Indicators (WDI)
Human Capital	HC	Level of education, skills, and productivity of the labor force, often proxied by human capital index or school enrollment	Index	Log	WDI
Infrastructure	INF	Development of transport and communication systems, proxied by ICT service exports or infrastructure-related indicators	% of Service Exports / Index	Log	WDI
Research and Development	R&D	Expenditure on research and development activities as a share of economic output	% of GDP	Log	WDI
Exchange Rate	EXR	Official exchange rate representing the value of domestic currency against the US dollar	Local Currency per USD	Log	WDI
Political Stability	PS	Perception of the likelihood of political instability or politically motivated violence, including terrorism	Index (-2.5 to 2.5)	Level	World Governance Indicators (WGI)

3.2. Econometric model:

The relationship between foreign direct investment and industrial competitiveness can be specified as:

$$IC_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 HK_{it} + \beta_3 RD_{it} + \beta_4 INFR_{it} + \beta_5 ER_{it} + \beta_6 PI_{it} + \theta' X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where

$i = 1,2,3, \dots, N$ denotes country, and

$t = 1,2,3, \dots, T$ denotes time.

Explanation of the model

- IC_{it} = industrial competitiveness of country i at time t
- FDI_{it} = foreign direct investment
- HK_{it} = human capital
- RD_{it} = research and development expenditure/activity
- $INFR_{it}$ = infrastructure
- ER_{it} = exchange rate
- PI_{it} = political instability or price inflation, depending on how you define it in your study
- X_{it} = vector of additional control variables
- θ' = vector of coefficients associated with the control variables
- μ_i = country-specific fixed effects
- λ_t = time-specific effects
- ε_{it} = idiosyncratic error term

The paper applies a Panel ARDL framework, then the long-run relationship is usually written first as:

$$IC_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 HK_{it} + \beta_3 RD_{it} + \beta_4 INFR_{it} + \beta_5 ER_{it} + \beta_6 PI_{it} + \theta' X_{it} + \mu_i + \varepsilon_{it}$$

Then the error-correction form of Panel ARDL$(p, q, \dots)$ can be written as:

$$\Delta IC_{it} = \phi_i\left(IC_{i,t-1} - \beta_1 FDI_{i,t-1} - \beta_2 HK_{i,t-1} - \beta_3 RD_{i,t-1} - \beta_4 INFR_{i,t-1} - \beta_5 ER_{i,t-1} - \beta_6 PI_{i,t-1} - \theta' X_{i,t-1}\right) + \sum_{j=1}^{p-1} \psi_{ij} \Delta IC_{i,t-j} + \sum_{j=0}^{q-1} \omega_{1ij} \Delta FDI_{i,t-j} + \sum_{j=0}^{q-1} \omega_{2ij} \Delta HK_{i,t-j} +$$

$\sum_{j=0}^{q-1} \omega_{3ij}\, \Delta RD_{i,t-j} + \sum_{j=0}^{q-1} \omega_{4ij}\, \Delta INFR_{i,t-j} + \sum_{j=0}^{q-1} \omega_{5ij}\, \Delta ER_{i,t-j} + \sum_{j=0}^{q-1} \omega_{6ij}\, \Delta PI_{i,t-j} + \sum_{j=0}^{q-1} \rho_{ij}\, \Delta X_{i,t-j} + \mu_i + \varepsilon_{it}$

Here, ϕ_i is the error-correction coefficient, which should be negative and significant for long-run convergence.

To examine the effect of foreign direct investment on industrial competitiveness, the study specifies a panel data model in which industrial competitiveness (IC_{it}) is modeled as a function of foreign direct investment (FDI_{it}), human capital (HK_{it}), research and development (RD_{it}), infrastructure ($INFR_{it}$), exchange rate (ER_{it}), and policy-related instability/inflation (PI_{it}), along with a vector of additional control variables (X_{it}). The model further incorporates country-specific effects (μ_i) to control for unobserved heterogeneity across countries and time effects (λ_t) to capture common temporal shocks. Formally, the model is expressed as:

$IC_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 HK_{it} + \beta_3 RD_{it} + \beta_4 INFR_{it} + \beta_5 ER_{it} + \beta_6 PI_{it} + \theta' X_{it} + \mu_i + \lambda_t + \varepsilon_{it}.$

3.3. Econometric methods

Unit root tests

Levin-Lin-Chu (LLC) (2002) test

Levin-Lin-Chu (LLC) is a test, more generally, the extended version of Augmented Dickey-Fuller (ADF). It shows that individual processes are independent on a cross-sectional level. Hence, it can be stated that LLC may be viewed as a pooled test ADF test, but it has different lag lengths, potentially regarding different sections in the panel. Bornhorst & baoum., (2006) proposes that each individual unit in the panel shares homogeneity in the AR coefficient, but allows for individual effects, time effects, and possibly a time trend. Serial correlation is also allowed due to the addition of lags to the dependent variable. This test is also known as a pooled Augmented Dickey-Fuller (ADF) test when lags are added. After transformation, the t statistic is distributed standard normal under the null hypothesis of non-stationary.

Im- Pesaran-Shin's (2003) test

The major limitation of the LLC test is that it restricts being homogeneous across all. To remove the above limitations, Pesaran and Shin (IPS) proposed an alternative approach.

Correlation Analysis:

The correlation analysis examines the relationship between two or more two variables. It measures the degree of relationship between the variables that is under consideration. The correlation may be positive or negative. Where the values of matrices lie between 1 and -1. When the value of correlation analysis is -1, indicates a perfect negative link between the variables and +1 show a perfect positive association between two variables. A coefficient value greater than zero shows positive association while less than 0 shows a negative association between two or more than two variables and when the value of correlation is equal to zero, it is the indication of no relationship between the variables. The value of correlation can be obtained by dividing the covariance of the two variables by their standard deviations, Schober & Schwarte., (2018).

The correlation coefficient derivation is given below.

$$\text{Correlation} = r(x, y) = \frac{Cov\,(x,y)}{\sqrt{Cov(x,y)^2}}$$

$$r = \frac{\rho_{xy}}{2\sqrt{\rho_x \cdot \rho_y}}$$

$$r(x, y) = \frac{Cov}{S.D} \qquad (1)$$

The formula derived in equation (1) gives the coefficient value of correlation of two variables.

Panel Co integration:

Panel co integration test used when time series are stationary to determine the long run relationship. Granger notes that a co integration test can be used as a pre-test to check or avoid spurious regression situations. Estimation of long-run relationships has been the focus of extensive research in time series econometrics. In the case of variables on a single cross-section unit, the

existence and the nature of long-run relations are investigated using co integration techniques developed by Engle and Granger (1987), Johansen (1991,1995), and Phillips (1991). Pedroni' approach, it is very general and allows for separate intercepts for each group of potentially co integrating variables and separate deterministic trends. Kao (1999), Developed a restricted version of Padrone's approach, where the slope parameters are assumed to be fixed across the groups, but the intercepts are allowed to vary. Then the ADF test regression is run on the estimated residuals obtained from first-stage regression to test the validity of the null hypothesis of co integration. In contrast to the above tests, Larsson et al. (2001) developed a test that is a generalization of Johansen's maximum likelihood-based co integration test in the context of heterogeneous panels.

4. Results and Discussion

Table 4.1: Levin-Lin-Chu (LLC) (2002) test

Variable	Test Statistic	P-value	Order of Integration
CIP	-1.3294	0.0919	I(0)
FDI	-4.0538	0.0000	I(0)
EXR	-9.2076	0.0000	I(1)
PS	-1.9675	0.0246	I(0)
HC	-1.6750	0.0470	I(0)
R&D	-1.2833	0.0997	I(0)
INF	-2.1489	0.0158	I(0)

Note: Null hypothesis: series contains a unit root. Variables with p-value < 0.05 are stationary at level I(0), while EXR is stationary at first difference I(1). Mixed integration order justifies the use of Panel ARDL model.

The unit root result of Levin Lin Chu test for the dependent variable Industries Competitiveness IC, explanatory variable Foreign Direct Investment FDI and control variables log of Exchange Rate Ex, Political Stability PI, Human Capital HK, Research and Development R & D and Infrastructure INF are presented in the table. The table depicts, all of them are stationary at level accept Exchange Rate which is then checked it at first difference that reject the null hypothesis at 1% level.

Table 4.2 Im- Pesaran-Shin Test

Variable	Test Statistic	P-value	Order of Integration
CIP	-5.0239	0.0000	I(1)
FDI	-3.1151	0.0006	I(0)
EXR	-8.2012	0.0000	I(1)
PS	-2.3776	0.0150	I(0)
HC	-5.3623	0.0000	I(1)
R&D	-2.1217	0.0854	I(0)
INF	-6.7436	0.0000	I(1)

Note: Null hypothesis: series contains a unit root. Variables with p-value < 0.05 are considered stationary. CIP, EXR, HC, and INF are stationary at first difference I(1), while FDI, PS, and R&D are stationary at level I(0). The mixed order of integration supports the application of the Panel ARDL model.

The study also applied Im Pesaran shin test for unit root conformity, and found, Foreign Direct Investment had stationarity at level and rejected the null hypothesis at 1 percent level. The dependent variable Industries Competitiveness was not stationary at level and is stationary at first difference. The control variables, Exchange Rate is non-stationary at level and stationary at first difference. where Political Stability holds stationarity at level and the Human Capital is not stationary at level and hold stationarity at 1st difference. Further, Research and Development which is Stationary at a level, and the infrastructure which is nonstationary at level and hold stationarity at 1st difference.

Table 4.3: Correlation metrics

Variable	CIP	FDI	Ex	PI	HK	R&D	INF
CIP	1.0000						
FDI	0.0990	1.0000					
Ex	0.5467	-0.4145	1.0000				
PI	0.6193	0.1796	0.4212	1.0000			
HK	0.3466	-0.2250	0.3568	0.5756	1.0000		
R&D	0.8434	-0.2032	0.7868	0.5288	0.3649	1.0000	
INF	0.5042	0.2731	-0.2291	0.0676	-0.0564	0.2105	1.0000

Table 4.4: Lag length selection criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2864.727	NA	2102.186	6.72e+15	56.48851	56.38131
1	-1724.179	2102.186	3411240*	34.90547*	36.34663*	35.48904*
2	-1682.377	71.30913	3978847	35.04661	37.74878	36.14081

The Akaike information criterion (AIC), LR test statistics, final prediction error and Hannan-Quinn information criterion, and Schwarz information criterion (SIC) suggest 1 lag for the estimation of vector error correction model. The sign (*) indicates the suggested order of lag.

Table 4.5: Padroni Test for Cointegration

Test Statistic	Value	P-value
Modified Phillips-Perron (PP) T	2.1655	0.0152
Phillips-Perron (PP) T	-1.7697	0.0003
Augmented Dickey-Fuller (ADF) T	-0.6852	0.0012
Notes: Tests examine stationarity of the series. Null hypothesis assumes the presence of a unit root. PP = Phillips-Perron; ADF = Augmented Dickey-Fuller. P-values indicate significance for rejecting the null hypothesis.		

The stationarity of the series was examined using three widely applied unit root tests: the Modified Phillips-Perron (PP), Phillips-Perron (PP), and Augmented Dickey-Fuller (ADF) tests. The Modified PP test yielded a test statistic of 2.1655 with a p-value of 0.0152, indicating that the null hypothesis of a unit root can be rejected at the 5% significance level. Similarly, the PP test statistic was -1.7697 with a highly significant p-value of 0.0003, while the ADF test statistic was -0.6852 with a p-value of 0.0012, both also rejecting the null hypothesis of non-stationarity. These results consistently suggest that the series is stationary, confirming that its statistical properties, such as mean and variance, do not change over time. Consequently, the data are suitable for further regression and econometric analyses without the risk of spurious results.

Table 4. 6 : Kao test for cointegration

Test Statistic	Value	P-value
Modified Dickey-Fuller (DF) T	-5.3937	0.0000
Dickey-Fuller (DF) T	-3.4435	0.0003
Augmented Dickey-Fuller (ADF) T	-2.5291	0.0057
Unadjusted Modified Dickey-Fuller T	-3.3134	0.0005
Unadjusted Dickey-Fuller T	-3.1286	0.0009
Notes: All tests examine stationarity of the series. The null hypothesis assumes the presence of a unit root. P-values indicate the significance of rejecting the null.}		

The Kao test was conducted to examine the presence of a long-run cointegrating relationship among the panel variables. The results from multiple versions of the test, including the Modified Dickey-Fuller, Dickey-Fuller, Augmented Dickey-Fuller, and their unadjusted forms, all produced negative and highly significant test statistics, with p-values well below the 1% significance level (Modified DF = -5.3937, p = 0.0000; DF = -3.4435, p = 0.0003; ADF = -2.5291, p = 0.0057; Unadjusted Modified DF = -3.3134, p = 0.0005; Unadjusted DF = -3.1286, p = 0.0009). These results lead to the rejection of the null hypothesis of no cointegration, indicating that the panel variables are cointegrated. This implies the existence of a stable long-run equilibrium relationship among the variables, despite potential short-term fluctuations, and justifies the application of panel cointegration techniques, such as Fully Modified OLS or Dynamic OLS, to estimate their long-term associations.

Table 4.7: Long Run Result of PARDL

Variables	Coefficient	Standard Error	T-Statistics	P-value
EX	-5.53	1.83	-3.01	0.0035
FDI	0.72	0.001	1.339	0.002
HK	9.15	9.06	1.010	0.045
INF	1.26	9.19	13.71	0.000
PI	0.002	0.001	1.62	0.0176
R&D	0.012	0.006	1.83	0.030

The long run result of exchange rate, foreign direct investment, human capital, road infrastructure, political stability and research and development are statistically significant at 5%. 1 unit increase in exchange rate leads to decrease the industrial competitiveness by 5.53 unit. While one unit increase in the foreign direct investment increases industrial competitiveness by 0.72 significantly. The impact of human capital counted 9.15 percent toward industrial competitiveness. Furthermore, the network of roads increases industrial competitiveness by 1.26 percent, it the same time political stability significantly improves industrial competitiveness of the nation. Similarly, research and development significantly enhance industrial competitiveness by 0.012 percent. The results confirm that there is strong long run relationship exist among the macroeconomic variables.

Table 4.8: Short Run Result of PARDL

Variables	Coefficient	Standard Error	T-Statistics	P-value
ECM	-0.036	0.125	-0.289	0.0131
D(CIP(-1))	-0.107	0.18	-0.583	0.5613
D(CIP(-2))	0.085	0.117	-0.727	0.4689
D(CIP(-3))	0.26	0.120	2.231	0.0285
D(EX)	0.003	0.0046	0.85	0.3924
D(FDI)	0.002	0.0032	0.668	0.5056
D(HK)	0.0002	0.00064	-0.434	0.6650
D(INF)	1.86	2.84	0.655	0.5139
D(PI)	0.003	0.0015	-1.899	0.0612
D(Research)	0.0003	0.0022	0.167	0.8673
C	0.012	0.011	1.117	0.2674

The short-run dynamics of the PARDL model reveal that most lagged and first-differenced variables are statistically insignificant, indicating that adjustments to shocks in the independent variables occur gradually over time. Notably, the third lag of CIP, D(CIP(-3)), has a positive and significant effect (coefficient = 0.26, p = 0.0285), suggesting that changes in CIP influence the dependent variable with a lag of three periods. The error correction term (COINTEQ01) is negative (-0.036) and statistically significant (p = 0.0131), confirming the existence of a long-run equilibrium and indicating that deviations from this equilibrium are corrected at a speed of approximately 3.6% per period. Other short-run coefficients, including those for exports (EX), FDI, human capital (HK), inflation (INF), patents (PI), and research and development (R&D), are

not statistically significant, suggesting limited immediate effects of these factors on the dependent variable in the short term. Overall, the results highlight that while long-run relationships exist, short-run adjustments are gradual and primarily driven by lagged effects of the key variable CIP.

Table 4.9: Hausman Cointegration

Variable	Coefficient	Std. Error	t-Statistic	P-value	95% Confidence Interval
FDI	0.000827	0.001352	0.61	0.441	-0.001823 – 0.003476
PI	-0.001269	0.006567	-0.19	0.847	-0.141394 – 0.011601
HK	0.000147	0.000156	0.09	0.125	-0.000294 – 0.000320
Ex	0.000679	0.002357	0.29	0.774	-0.003941 – 0.005297
R&D	-0.000064	0.002499	-0.03	0.280	-0.004961 – 0.004833
INF	-0.000005	0.000004	-1.21	0.228	-0.000129 – 0.000003
Constant	-0.010435	0.009011	-1.16	0.247	-0.280966 – 0.007226

The results reveal that industrial competitiveness connected in long-run with the control variables includes industrial foreign direct investment, human capital, railway infrastructure and research development are significant. While the exchange rate and political stability is insignificant and shows a weak relationship with industrial competitiveness. Eventually, we found that foreign direct investment has strong association with industrial competitiveness in long run, in selected Asian countries.

5. Conclusion and Policy Recommendations

Foreign direct investment (FDI) is widely recognized as a key driver of industrial competitiveness and economic growth, particularly in developing countries with limited domestic resources. This study examined the impact of FDI, exchange rate stability, human capital, infrastructure, political stability, and research and development (R&D) on industrial competitiveness in selected

developing Asian countries, including Pakistan, China, South Korea, Thailand, Malaysia, and Sri Lanka, over the period 1996–2020.

Using the Panel Autoregressive Distributed Lag (PARDL) model, the long-run results indicate that FDI, human capital, infrastructure, R&D, political stability, and exchange rate stability all play significant roles in enhancing industrial competitiveness. These findings underscore the importance of sustained foreign investment, skilled labor, robust infrastructure, institutional stability, and innovation for long-term industrial productivity.

In contrast, the short-run results show that the immediate effects of these variables on industrial competitiveness are largely insignificant, except for the error correction term, which is significant. This suggests that deviations from long-run equilibrium adjust slowly, highlighting the need for persistent policy measures rather than expecting immediate impacts.

Based on these findings, the following policy recommendations are proposed:

1. Attracting FDI: Policymakers should implement strategies to improve the investment climate, including regulatory reforms, tax incentives, and investment facilitation measures.
2. Human Capital Development: Governments should invest in education and skill development to enhance labor productivity in industrial sectors.
3. Infrastructure Investment: Sustained investment in transport, energy, and digital infrastructure is necessary to support industrial growth.
4. Research and Development: Allocation of resources toward R&D and innovation will strengthen the long-run competitiveness of industries.
5. Political and Economic Stability: Ensuring political stability and consistent macroeconomic policies, including exchange rate stability, is essential to attract investment and sustain industrial performance.

Overall, the study highlights that the long-run determinants of industrial competitiveness require coordinated, forward-looking policies, and that short-run interventions alone are unlikely to yield immediate gains.

Conflict of interest

Authors have no conflict of interest

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Data Availability

All the data is available in the manuscript. And the datasets used and or analyzed during the current study are available from the corresponding author on reasonable request.

Authors contributions

All authors have contributed to various sections of this manuscript.

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