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Impact of human capital, FDI on economic growth: Empirical evidence from MENA region

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ABSTRACT

This study investigates the short- and long-term effects of foreign direct investment (FDI), human capital, capital formation, domestic credit, and inflation on GDP in a panel of MENA countries. It also explores how human capital moderates the impact of FDI on economic growth. Using panel data from 16 MENA countries spanning 1990–2023, the study employs the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model to account for heterogeneity and cross-sectional dependence. Human capital and capital formation have significant positive effects on GDP in both the short and long term. While FDI alone has no significant impact, its interaction with human capital shows a marginally positive effect. Domestic credit slightly hinders growth, and inflation yields mixed results. The findings highlight the essential role of human capital in enhancing the growth benefits of FDI and strengthening long-term economic performance through structural investment. Policymakers should prioritize education and human capital development to fully leverage FDI. Integrated strategies that strengthen institutional readiness and absorptive capacity are key to achieving sustainable growth in the MENA region.

Contribution/ Originality: The originality of this paper lies in its focus on the moderating role of human capital in the FDI–growth relationship within MENA countries, using a CS-ARDL model that accounts for cross-sectional dependence and heterogeneity. Unlike prior studies, it shows that FDI alone does not drive growth, but its effect becomes positive when interacted with human capital, highlighting the critical role of absorptive capacity in leveraging FDI for economic development.

1. INTRODUCTION

Classical and neoclassical models have dominated the study of economic growth in both transition and developed economies, emphasizing the evolution of labor, physical capital, and technology as the primary sources of growth. The classical idea of diminishing returns to capital and the importance of external technological progress were first addressed by the Solow-Swan model. However, these models do not fully account for the long-run observed differences in growth rates across countries, especially in developing countries. Endogenous growth theories began to emerge in the late 1980s and early 1990s, particularly from the works of Romer and Lucas, which identified human capital as an important engine for growth. Endogenous growth models argue that investments in human capital, such as health care and education/training, can increase worker productivity, foster new innovations, and provide positive spillovers that sustain long-run growth.

According to this concept, human capital is seen as both a direct input in the production function and a catalyst for structural change and institutional growth. Economic growth and the accumulation of human capital are strongly and favorably correlated, according to a number of empirical studies, including cross-country panel research. However, this link is often mediated by country-specific factors such as the effectiveness of public investment, institutional quality, and income distribution.

At the same time, foreign direct investment (FDI) has become more well-known in the literature as a key tool for improving productivity, creating jobs, and transferring technology, especially in developing nations. Several studies have emphasized the possible synergies between foreign direct investment (FDI) and human capital, contending that FDI advantages are greatest in nations with a labor force that is adequately skilled (Ahsan & Haque, 2017; Völlmecke, Jindra, & Marek, 2016).

When examining how human capital affects economic growth, an increasing amount of research emphasizes the need to consider health and education. According to Bloom, Canning, and Sevilla (2004) this relationship cannot be fully understood if health is excluded. Education has a favorable impact on East Asian nations' prosperity, according to Li and Liang (2010) albeit this association becomes weaker when health issues are taken into account. Using OECD data from 1971 to 1998, Bassanini and Scarpetta (2001) showed that an extra year of education might increase GDP per capita by approximately 6%.

In light of this, human capital is now widely acknowledged as a critical factor in determining economic development, especially in areas like the Middle East and North Africa (MENA) that are dealing with structural issues. Although a number of the region's nations have implemented significant changes to enhance their educational systems and attract international investment, economic performance has not improved. The conversion of education and investment into long-term growth is nevertheless hampered by structural issues such as youth unemployment, skill gaps, and institutional flaws. Designing successful development policies in the area thus requires an understanding of the distinct and combined effects of FDI and human capital on economic performance.

This study aims to assess the impact of foreign direct investment and human capital on economic growth in the MENA region using panel data econometric techniques. The study includes both investment and educational data in its analysis, providing a comprehensive assessment of the determinants of growth in the region.

The rest of this paper is organized as follows: Section II provides a comprehensive review of the literature on human capital, foreign direct investment, and economic growth. Section III outlines the methodological framework and data sources used in the empirical analysis. Section IV presents and discusses the estimation results. Finally, Section V concludes the study with key policy implications and suggestions for future research.

2. LITERATURE REVIEW

2.1. Human Capital and Economic Growth

Economics has always placed a strong emphasis on economic growth, with both classical and neoclassical models highlighting the contributions of labor force expansion, capital accumulation, and technological advancement (Romer, 1990; Solow, 1956). However, with the introduction of endogenous growth theories, the inclusion of human capital as a fundamental factor influencing long-term growth gained traction. Lucas Jr (1988) and Romer (1990) were among the first to argue that investment in human capital, primarily through education and innovation, could generate sustained economic growth without diminishing returns, differentiating their models from the Solow framework in which technology was considered exogenous.

Human capital, typically measured through indicators such as education, skill levels, and health, is regarded as a key driver of productivity. Mankiw, Romer, and Weil (1992) demonstrated that cross-country differences in output per worker can largely be attributed to disparities in human capital accumulation. Similarly, Hall and Jones

(1999) emphasized the critical role of social infrastructure, especially education systems in supporting capital accumulation and technological diffusion.

In contrast to tangible assets like buildings or machines, human capital is intangible and is obtained through investments in people (Eze, 2022). These investments improve people's capacities, enabling them to innovate, complete challenging tasks, and adapt to shifting market situations. The idea of human capital highlights how crucial it is to maximize employee potential in order to increase productivity, encourage innovation, and achieve sustainable economic growth (Omoniyi, 2018). Countries may raise the general standard of living, reduce poverty, and develop a more vibrant and competitive economy by investing in their human resources.

According to Pelinescu (2015) human capital exerts its influence on economic growth through two primary mechanisms: a level effect, which increases labor productivity and output, and a rate effect, which boosts innovation and the diffusion of technology.

Moreover, Hanushek and Kimko (2000) found a direct link between cognitive skills and economic growth, showing that countries with better schooling achieve better and faster levels of development. In a similar vein, human capital helps countries utilize imported technology and knowledge spillovers, so that less developed countries can "catch" up with advanced economies (Nelson & Phelps, 1966). In particular, absorptive capacity is greater in societies with effective education and training systems (Benhabib & Spiegel, 1994; Teixeira & Fortuna, 2011). Human capital can be viewed, in this reasoning, as both a direct contributor to output and as an intermediary enabling economies to take advantage of globalization and technological change.

The concept of a knowledge-based economy has implications for our understanding of human capital. Powell and Snellman (2004) argue that knowledge and information generation, exchange, and utilization are central to a knowledge economy. Within this economy, human capital serves as the means of production in post-industrial economic growth, which drives productivity through technological advancements and innovation, thereby enhancing competitiveness. This concept is especially relevant to economies transitioning from manufacturing-based to knowledge-based economies.

The connection between economic growth and human capital has been further examined through various empirical research across different economic and geographic contexts. Hanushek (2013) explored the contribution of school achievement and attainment through a panel of developing nations from 1960 - 2000. He found that more time for children in school is not enough, without quality improvement in education. This signifies that educational reforms must prioritize improving outcomes instead of access.

Idrees and Siddiqi (2013) explored total public expenditure in the education sector related to GDP growth with a similar panel of seven developed and seven developing nations, from 1990 - 2006. Findings show a strong linkage between educational expenditures and economic performance in developed nations, whereas developing nations benefited from more "catch-up" impacts, demonstrating the variability of education investment effects by context.

In the Sub-Saharan African context, Glewwe, Maiga, and Zheng (2014) investigated the impact of years of schooling and test scores on per capita GDP between 1960 and 1996. Their panel regression analysis revealed that, unlike in other regions, the returns to education in Sub-Saharan Africa are relatively lower, suggesting that regional-specific challenges hinder the effectiveness of human capital accumulation.

Similarly, Pegkas and Tsamadias (2014) focused on Greece over the period 1960–2009 and employed cointegration and error-correction models to assess the relationship between higher education, physical capital, and growth. Their study confirmed a long-term positive effect of tertiary education on economic growth, highlighting the complementarity between human capital and investment in physical infrastructure.

Cadil, Petkovová, and Blatná (2014) used robust and least squares models to evaluate EU NUTS 2 regions from 2007 to 2011. They investigated the association between employees' university education and GDP growth, but they were unable to establish a clear causal link, suggesting that tertiary education might not be a direct driver of growth in the absence of other factors. Qadri and Waheed (2014) investigated the connection between economic performance and human capital in Pakistan from 2012 to 2016 using supply and demand side equations. Their research, which focused on the importance of higher education spending and its effect on productivity, found a strong correlation between production growth and human capital.

Völlmecke et al. (2016) used a Markov chain approach to examine the relationship between human capital and real GDP per capita using a global panel of 269 regions from 2003 to 2010. Their results support the idea that human capital is a key component of economic transition by demonstrating how FDI inflows and scientific and technological human resources can push areas into higher-income states.

This line of research was expanded to a larger dataset by Ahsan and Haque (2017), who used a dynamic panel threshold model in 126 nations from 1970 to 2012. According to their findings, GDP is positively impacted by average trade, investment, and education, and economic expansion yields greater returns when human capital reaches a particular level.

Kocourek and Nedomlelová (2018) looked at 125 nations between 1999 and 2014 and discovered that capital accumulation, labor productivity, and education at all levels greatly boost growth. Their research on panel data showed that productivity per worker rises with education, especially when accompanied by investments in tangible capital and advantageous macroeconomic circumstances.

Finally, employing System GMM models, Sultana, Dey, and Tareque (2022) demonstrate that in a broad sample of both rich and developing nations, GDP growth is positively impacted by both the health and educational components of human capital. These findings are especially pertinent to MENA nations, where health outcomes and educational changes differ significantly from one another.

2.2. FDI and Economic Growth

For a long time, development economics has centered on the link between economic growth and foreign direct investment (FDI). The neoclassical growth theory asserts that FDI induces innovation diffusion, capital accumulation, and technical transfer all crucial components for sustained and long-run growth (Iamsiraroj & Ulubaşoğlu, 2015; Reiter & Steensma, 2010). Dunning (1993) OLI paradigm son to type of FDI to distinguish between market seeking, resource seeking, and efficiency seeking, emphasizing that each type of FDI may have a varying effect on the development pathway of a host economy. The importance of FDI in the context of developing nations with often limited domestic savings and capital (Farole & Winkler, 2014) is particularly relevant. More than just a financial inflow, FDI can enhance the rate of human capital development, productivity, and export potential as domestic firms establish competitive positions in foreign markets (Makiela & Ouattara, 2018).

FDI often generates positive spillovers due to better management techniques, increased wages, and capacity for technological learning (Malchow-Møller, Markusen, & Schjerning, 2013). Empirical evidence suggests that in many developing countries, FDI is substantial as part of development finance and often exceeds official development assistance (Addison, Singhal, & Tarp, 2013; UNCTAD, 2017). However, Sothan (2017) and Tiwari and Mutascu (2011) have cautioned that under poorly managed FDI processes, FDI could displace domestic firms and restrict local entrepreneurship.

The duality of FDI signals important insights not only in terms of institutional quality and the absorptive capacity of host countries but also governance systems and property rights (Asiedu, 2006; Pineli, Narula, & Belderbos, 2019). In general terms, the theoretical consensus indicates FDI as a viable instrument for economic growth, especially where capital is scarce. The average impacts of FDI can, however, vary depending on the domestic policy environment and the mode of FDI that is attracted.

Empirical research examining the relationship between FDI and economic growth reveals mixed results across countries and time periods. Many researchers have found evidence that foreign direct investment (FDI) helps drive economic performance, especially in developing countries. For instance, the study by Dahal (2024) applied a VECM and concluded that FDI has a long-term, bidirectional impact on economic growth. The study emphasized the role of foreign direct investment (FDI) in contributing to GDP increases, claiming that large inflows of FDI enlarge the economy by facilitating new technology diffusion and job creation, thereby promoting economic growth.

Similar to the aforementioned research, Mohamed, Liu, and Nie (2021) proved a statistically significant long-run association between foreign direct investment (FDI) and economic growth by applying Granger causality and Johansen cointegration tests in the Egyptian context. The results based on FDI indicate that it fosters economic growth in MENA economies over the long term, suggesting a positive relationship between FDI and GDP. Abdouli and Hammami (2017) examined 17 MENA countries in the same region, but utilized a sample period between 1990 and 2012. They found a statistically salient strong and positive relationship between foreign direct investment (FDI) and capital accumulation, which itself helped promote GDP growth. They stated that results were contingent on the institutional and environmental features of each country. In addition, Nicholas (2024) provided a comprehensive panel estimation of fifteen West Sub-Saharan African countries using a VECM method. The analysis revealed that although FDI has a negative and statistically significant effect on economic growth in the short term, it is positive and statistically significant in the long term. This indicates that the short-term losses resulting from absorptive constraints or structural bottlenecks in recipient economies are offset by the overall positive contribution of FDI to economic growth once recipient nations reach a threshold in inflation control, human capital, or financial market maturity.

In contrast, some empirical studies raise concerns about the unconditional benefits of FDI. For example, Khobai et al. (2018) using quantile regression techniques, found that FDI has a limited effect on economic growth in South Africa, particularly at lower quantiles of the income distribution, suggesting that FDI's growth-inducing capacity may not be evenly distributed across the population or economic sectors. Moreover, certain studies highlight that without adequate absorptive capacity, such as skilled labor and supportive institutions, the spillover effects from FDI may remain weak or even crowd out local investment and entrepreneurship (El Hamoudi & Aimer, 2017; Sothan, 2017).

3. EMPIRICAL METHOD

3.1. Model Specification

This study examines how several key macroeconomic variables—namely inflation, domestic loans to the private sector, gross capital formation, foreign direct investment (FDI), and human capital—generally influence economic growth, measured by GDP. Instead of focusing solely on individual growth drivers, this research investigates whether a country's human capital richness moderates the relationship between FDI and growth through an interaction term (HK × FDI). The analysis employs a Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model, which accounts for cross-section dependence (CSD) and heterogeneity by allowing for short- and long-run equilibrium relationships. Additionally, the study uses the Generalized Method of Moments (GMM) to verify the robustness of the results.

Furthermore, Dumitrescu–Hurlin causality tests analyzed the directionality of correlations between variables over the observations. This provides clearer insights by examining the cyclical and structural determinants of GDP. The model's usual functional format is presented as follows:

$$\text{GDP}_{it} = f(\text{FDI}_{it}, \text{HK}_{it}, \text{Capital}_{it}, \text{Credit}_{it}, \text{Inflation}_{it}, \text{HK} \times \text{FDI}_{it})$$

So, two empirical models will be considered in this study:

The first one without the interaction term:

$$\text{GDP}_{it} = \beta_0 + \beta_1\text{FDI}_{it} + \beta_2\text{HK}_{it} + \beta_3\text{Capital}_{it} + \beta_4\text{Credit}_{it} + \beta_5\text{Inflation}_{it} + \epsilon_{it} \quad \text{(Without interaction term)}$$

The second model includes the interaction term:

$$\text{GDP}_{it} = \beta_0 + \beta_1\text{FDI}_{it} + \beta_2\text{HK}_{it} + \beta_3\text{Capital}_{it} + \beta_4\text{Credit}_{it} + \beta_5\text{Inflation}_{it} + \beta_6(\text{HK} \times \text{FDI})_{it} + \epsilon_{it}$$

In the two equations, GDP is the dependent variable, while the explanatory variables capture foreign investment, human capital accumulation, financial development, and macroeconomic stability. In the second equation, the coefficient β_6 is of particular interest, as it measures the complementarity between FDI and human capital.

3.2. Econometric Methodology

3.2.1. Cross-Sectional Dependence Test

Cross-sectional dependency (CSD) testing must be conducted prior to any assessments using panel data to ensure the results are valid and reliable. CSD identification is critical within macro-panel datasets where linkages between cross-sectional units, such as countries, are expected to exist. The Lagrange Multiplier (LM) test, introduced by Breusch and Pagan (1980) can effectively work with the Pesaran (2006) test to accomplish this. The aim of both tests is to identify cross-sectional correlation between units. The reason for taking the results from both tests is to verify the robustness of the results. When CSD is not adequately accounted for, the estimates may be inaccurate or misleading.

The mathematical formulation of the test is given by:

$$\text{CSD} = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2}$$

While the test from Pesaran (2006) is represented as:

$$\text{CSD} = \sqrt{\frac{2T}{N(N-1)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}}$$

In these formulas, T denotes the number of time periods, N is the number of cross-sectional units, and $\hat{\rho}_{ij}$ is the correlation coefficient between the residuals of units i and j. The null hypothesis in both tests states that no cross-sectional dependence is present, while the alternative hypothesis implies the existence of CSD. Rejecting the null hypothesis, therefore confirms the existence of cross-sectional dependence in the panel.

3.2.2. Slope Heterogeneity Test

The slope heterogeneity test, which was conceived by Pesaran and Yamagata (2008) is used to test whether the slope coefficients are homogeneous across countries in a panel dataset. The slope test has several advantages over traditional heterogeneity tests and is considered to provide a more accurate representation of heterogeneity in a panel data setting because it accounts for information about cross-section dependence (CSD) (Khan, Yu, Belhadi, & Mardani, 2020). Identifying heterogeneity is important in panel datasets because assuming homogeneity may lead to poor and invalid results. Given the anticipated dissimilarities in the structures, circumstances, and economies of the panel countries, the slope coefficient for this study will likely differ. In conclusion, testing for slope heterogeneity is a crucial step in justifying the use of heterogeneous panel models such as CS-ARDL.

The following formulas provide a formal definition of the mean slope heterogeneity test:

$$\Delta\widehat{SH} = N \cdot \frac{1}{2} \cdot 2K - \frac{1}{2}\left(\frac{1}{N}\hat{S} - K\right)$$

$$\widehat{\Delta ASH} = N \cdot \frac{1}{2}\left(\frac{2K(T-K-1)}{T+1}\right)^{-1} \cdot \frac{1}{2}\left(\frac{1}{N}\hat{S} - K\right)$$

Where:

- N represents the number of cross-sectional units.
- T represents the time dimension of the panel.

- K represents the number of explanatory variables.
- $\hat{S}$ represents the observed statistic from the slope estimates.

3.2.3. Unit Root Test

In empirical research, the Cross-Sectionally Augmented Dickey–Fuller (CADF) test is frequently used to address problems related to panel data heterogeneity and cross-sectional dependence (CSD). To determine whether a variable is stationary, the CADF test begins with a unit root test. If the test indicates that the series is integrated of order one [I(1)], the analysis can proceed to cointegration testing and long-run modeling. This test is particularly useful in panel data contexts because ignoring CSD can lead to misleading results.

Additionally, the CIPS (Cross-sectionally augmented IPS) statistic is constructed using the CADF technique as its foundation. The CADF specification is represented by the following equation:

$$\Delta Y_{it} = \phi_i \sum_{k=1}^{n} \lambda_k + \zeta_i Y_{i,t-1} + \delta_i \bar{Y}_{t-1} + \sum_{j=0}^{p} \delta_{ij} \bar{Y}_{t-j} + \sum_{j=1}^{p} \lambda_{ij} \Delta Y_{i,t-j} + \varepsilon_{it}$$

The Cross-Sectional Augmented Dickey-Fuller Test technique is based on this equation. It makes it possible for researchers to compute the statistics needed for the CIPS test. Each cross-sectional series' level I(0) and initial difference I(I) are represented by Y_{t-1} and $\Delta Y_{i,t-1}$in this equation.

3.2.4. Cointegration Test

Following the validation of the integration order for the variables through unit root testing, we will apply three panels of the Westerlund panel cointegration test (Westerlund, 2008) to determine the long-run equilibrium relationship among the variables. The Westerlund test of cointegration is a powerful tool for identifying the existence of cointegration when two or more non-stationary series are believed to trend together over time, indicating a stable, long-term connection. Unlike previous tests, the Westerlund test incorporates cross-sectional dependence (CD) and slope heterogeneity (SH) two important features of macro panel data, which provide more accurate and reliable insights into long-run relationships through equilibrium analysis. Ultimately, cointegration indicates that despite short-run fluctuations, the variables tend to follow a common long-run path.

The test statistics are constructed using the following set of equations:

$$G_t = \frac{1}{N} \sum_{j=1}^{N} \frac{\hat{\theta}_j^f}{SE(\hat{\theta}_j^f)}$$

$$G_\alpha = \frac{1}{N} \sum_{j=1}^{N} \frac{T_j^f}{\hat{\theta}_j^f(1)}$$

$$P_t = \frac{\hat{\theta}^f}{SE(\hat{\theta}^f)}$$

3.2.5. Estimation Approach (CS-ARDL Model)

This study investigates how human capital (HK), foreign direct investment (FDI), and the macroeconomic environment promote growth in gross domestic product (GDP) across a set of nations. The common estimation methods of Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) may end up being biased or inefficient because they are not able to accommodate cross-section dependence or slope heterogeneity, and hence, do not fundamentally resolve these issues associated with panel data. The estimates presented in this study use the CS-ARDL (Cross-Sectionally Augmented Autoregressive Distributed Lag) model, which can deal with potential interdependence and differencing in the long-term trend and still provide consistent estimates, both in the short and long run. The specification of the CS-ARDL equation is as follows:

$$GDP_{it} = \alpha_i + \phi_1(GDP_{it-1} - \beta_1 X_{it-1} - \delta_1 G\bar{D}P_{t-1} - \delta_2 \bar{X}_{t-1}) + \sum_{j=1}^{p-1} \gamma_{1j} \Delta GDP_{it-j} + \sum_{j=1}^{q-1} \eta_{ij} \Delta X_{it-j} + \phi_{11} \Delta G\bar{D}P_t + \phi_{21} \Delta \bar{X}_t + \varepsilon_{it}$$

In this equation, GDP is the dependent variable, and X represents the set of explanatory variables: FDI, HK, capital formation, domestic credit, inflation, and the interaction term HK × FDI. The first differences ΔGDP_{it-j} and ΔX_{it-j} capture short-run dynamics, while the error correction term reflects long-run adjustment toward equilibrium. This modeling strategy ensures that both time-series and cross-sectional features of the data are adequately addressed.

3.3. Data Source

This study uses a balanced panel dataset covering the period from 1990 to 2023, compiled from internationally recognized sources. The dataset includes annual country-level observations for 16 MENA countries. It integrates both explanatory and control variables across time and countries. Table 1 presents the description of the variables used in this study as well as their sources.

Table 1. Data description and sources.

Sign	Variables	Measurement	Period	Sources
Key variables				
GDP	Economic growth	GDP (Constant 2015 US$)	1990 – 2023	World bank
FDI	Foreign direct investment	Foreign direct investment, net inflows (% of GDP)	1990 – 2023	World bank
HK	Human capital	Average years of education for 15-64	1990 – 2023	Barro
Control variables				
Capital	Gross capital formation	Gross capital formation (% of GDP)	1990 – 2023	World bank
Inflation	Inflation	Inflation, GDP deflator (Annual% %)	1990 – 2023	World bank
Domestic credit	Domestic credit	Domestic credit to the private sector by banks (% of GDP)	1990 – 2023	World bank

4. RESULTS AND DISCUSSIONS

4.1. Descriptive Statistics

Table 2 presents descriptive statistics of the considered variables. The variable lnGDP shows low dispersion (mean = 25.13, standard deviation = 1.03), indicating stable output across observations. In contrast, lnDomesticCredit is highly dispersed (standard deviation = 25.93), reflecting wide differences in financial development. lnFDI also varies considerably, with negative values suggesting net outflows.

lnCapital and lnHK appear more stable, while lnInflation shows notable variability, ranging from deflation to high inflation episodes. The distributional analysis shows that lnGDP is approximately normal and symmetric, with near-zero skewness (0.0392) and kurtosis close to 2. lnDomesticCredit and lnFDI are right-skewed (0.82 and 1.04), with lnFDI also showing high kurtosis (7.56), indicating heavy tails and potential outliers. Lastly, lnHK is left-skewed (-2.04) with high kurtosis (8.61).

Table 2. Descriptive statistics.

Variable	Mean	Std. dev.	Skewness	Kurtosis
lnGDP	25.130	1.027	0.039	2.003
lnDomesticCredit	31.894	25.934	0.823	3.216
lnFDI	1.339	1.407	1.038	7.565
lnCapital	3.175	0.357	-0.372	2.941
lnInflation	2.816	4.214	5.493	44.654
lnHK	1.931	0.340	-2.043	8.612

4.2. Correlation Analysis

Table 3 presents the correlation analysis between the variables. The analysis indicates that lnGDP is moderately and positively correlated with lnHK (0.31), suggesting that higher levels of human capital are associated with greater economic growth. lnFDI shows a weak positive correlation with lnHK (0.14) but a negative correlation with lnGDP (−0.22), indicating a complex and potentially indirect relationship between foreign investment and economic performance. Additionally, lnHK is strongly negatively correlated with lnInflation (−0.53), emphasizing the role of human capital in promoting macroeconomic stability by potentially reducing inflationary pressures.

Table 3. Correlation analysis results.

Variables	lnGDP	lnDomesticCredit	lnFDI	lnCapital	lnInflation	lnHK
lnGDP	1.00					
lnDomesticCredit	-0.05	1.00				
lnFDI	-0.22	0.09	1.00			
lnCapital	0.11	0.22	0.11	1.00		
lnInflation	-0.07	-0.20	-0.14	-0.06	1.00	
lnHK	0.31	0.25	0.14	0.03	-0.53	1.00

The results confirm that the variables are suitable for regression analysis, as they display low levels of interdependence (refer to Figure 1 for the scatterplot matrix).

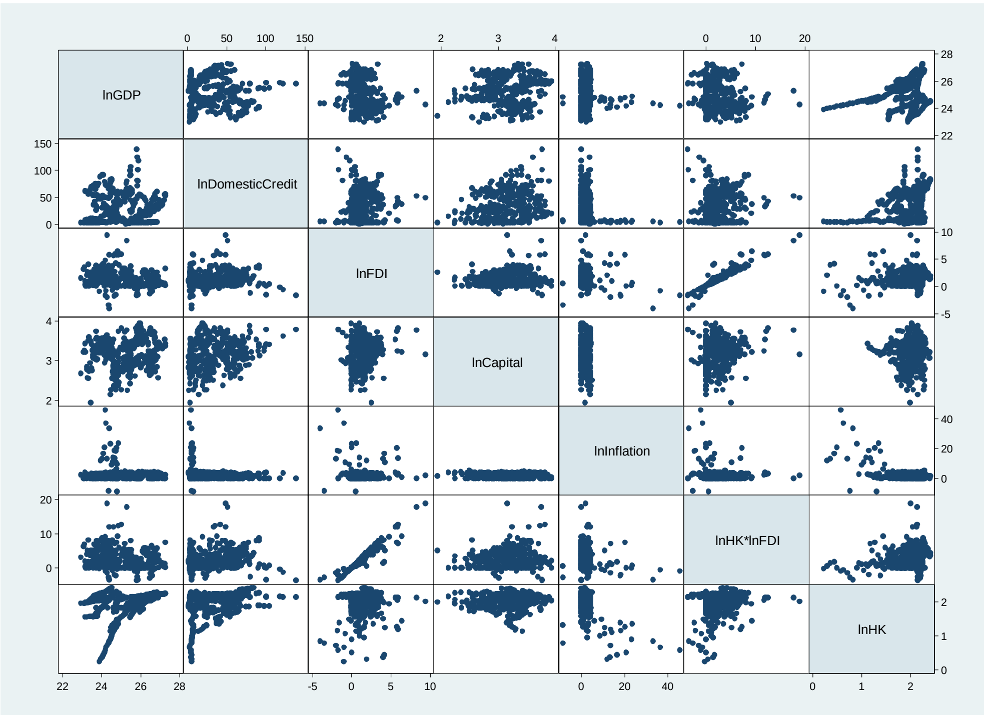

Figure 1. Scatterplot matrix.

4.3. Cross-Section Dependence

Table 4 presents the results of the CD-test. The findings indicate that all variables in the panel dataset lnGDP, lnFDI, lnDomesticCredit, lnCapital, lnInflation, lnHK, and the interaction term lnHKlnFDI exhibit highly significant cross-sectional dependence, with p-values equal to 0.000 for each variable. This suggests that the economic behaviors or shocks affecting one country are not independent of those affecting others, which is typical in macroeconomic panel datasets, especially those involving globalized factors such as investment and credit. Therefore, econometric techniques that assume cross-sectional independence, such as first-generation panel unit root or cointegration tests, may be invalid. Instead, second-generation panel methods that account for this interdependence should be employed (Obradović, Gričar, Bojnec, & Lojanica, 2025).

Table 4. Pesaran's test for cross-sectional dependence results.

Variable	CD-test	p-value
lnGDP	45.715	0.000
lnFDI	13.309	0.000
lnDomesticCredit	14.170	0.000
lnCapital	5.655	0.000
lnInflation	18.162	0.000
lnHK	51.538	0.000
lnHKFDI	14.896	0.000

4.4. Slope Heterogeneity Test

Table 5 shows marginally significant results for the slope homogeneity test, where H_0 posits that the regression slope coefficients are homogeneous across all cross-sectional units in the panel (i.e., all cross-sectional units operate with the same relationship between the independent and dependent variables).

Both the unadjusted delta (14.943) and the adjusted delta (17.568) statistics are highly significant, with p-values equal to 0.000. This leads to the rejection of the null hypothesis, suggesting that the slope coefficients differ significantly across countries or units in the panel.

In practical terms, this means that the impact of the explanatory variables on the dependent variable is not uniform across all countries or groups studied. Therefore, using panel models that assume homogeneity (such as pooled OLS or fixed effects with common slopes) may produce biased results (Pei & Tabish, 2025). It would be more appropriate to use heterogeneous panel models such as CS-ARDL, which will be employed in this study, as they allow for country-specific slope coefficients (Alhashim, Rehman, Ansari, & Ahmed, 2024).

Table 5. Slope heterogeneity test results.

Test	Delta	p-value
Unadjusted	14.943	0.000
Adjusted (adj.)	17.568	0.000

4.5. Unit Root Test

The results from the CADF unit root tests, presented in Table 6, indicate that most variables are non-stationary at the level but become stationary at first difference, implying they are integrated of order one, I(1). The five variables (lnGDP, lnDomesticCredit, lnCapital, lnInflation, and lnHK) exhibit non-stationarity at levels (p-values > 0.05) and stationarity at first difference (p-values < 0.05), confirming their I(1) integration. Conversely, lnFDI and the interaction term lnHKlnFDI are stationary at the level, as evidenced by statistically significant test statistics and p-values < 0.05, indicating I(0) integration. The mixture of integration orders permits the use of estimation techniques such as CS-ARDL, which accommodate both I(0) and I(1) variables without requiring differencing.

Table 6. CADF unit root test results.

Variables	At level		First difference		Decision
	Statistics	p-value	Statistics	p-value	
lnGDP	2.26	0.99	-2.02	0.02	I(1)
lnDomesticCredit	0.48	0.69	-1.68	0.047	I(1)
lnFDI	-2.93	0.00	-5.14	0.00	I(0)
lnCapital	0.99	0.84	-4.36	0.00	I(1)
lnInflation	-1.10	0.14	-5.01	0.00	I(1)
lnHK	1.50	0.93	-5.49	0.00	I(1)
lnHK×FDI	-2.78	0.00	-6.37	0.00	I(0)

4.6. Cointegration Test

To address potential cross-sectional dependence among panel units, this study applies Westerlund's Error Correction Model (ECM) cointegration test, interpreted using bootstrap p-values for greater robustness. Given the heterogeneity across countries, the analysis considers four key statistics: Group-tau (Gt), Group-alpha (Ga), Panel-tau (Pt), and Panel-alpha (Pa). The cointegration results are summarized in Table 7, where the null hypothesis posits no long-term cointegration relationship between the dependent variable (real GDP) and the explanatory variables—inflation, capital formation, FDI, human capital, and the interaction term (FDI × HK). The null hypothesis is rejected for all statistics at the 5% significance level, confirming strong evidence of long-run cointegration. These findings validate a stable long-term relationship between macroeconomic variables and economic development across the two models and the panel of countries.

Table 7. Westerlund cointegration test results.

Statistic	Value	p-value	Robust p-value
Model 1			
Gτ	−6.102	0.000	0.008
Gα	−10.78	0.996	0.007
Pτ	−13.543	0.000	0.000
Pα	−9.871	0.979	0.000
Model 2			
Gτ	−4.565	0.000	0.042
Gα	−7.913	0.981	0.005
Pτ	−16.258	0.000	0.011
Pα	−12.007	0.954	0.000

4.7. CS-ARDL Results

Table 8 presents the results of Model 1. The CS-ARDL estimation reveals both short-run dynamics and long-run relationships between the explanatory variables and economic growth, measured by real GDP (constant 2015 US$). In the short run, the lagged dependent variable (L.lnGDP) is negative and highly significant (–0.5208, $p < 0.01$), indicating partial adjustment and validating the model's dynamic specification. Gross capital formation (lnCapital) shows a positive and significant short-run effect (0.0580, $p < 0.05$), confirming the relevance of physical investment. Inflation, measured by the GDP deflator, negatively influences GDP in the short term (–0.0155, $p < 0.05$), suggesting adverse macroeconomic conditions. Importantly, human capital (lnHK)—proxied by average years of schooling for individuals aged 15 to 64—exerts a significant and positive effect (1.3368, $p < 0.05$), reinforcing the importance of education in fostering immediate productivity gains. The effect of domestic credit to the private sector is marginally significant and negative (–0.0674, $p = 0.094$), while FDI is statistically insignificant in the short run.

The error correction term (–1.5201, $p < 0.01$) is highly significant and negatively signed, confirming a strong speed of adjustment toward long-run equilibrium after short-term shocks.

In the long run, both capital formation (0.0330, $p < 0.05$) and human capital (1.0035, $p < 0.05$) maintain positive and statistically significant impacts on GDP, underscoring their essential roles in sustaining long-term growth. Domestic credit shows a marginally significant and negative effect (–0.0451, $p = 0.051$), which may suggest inefficiencies in financial intermediation. Meanwhile, FDI and inflation do not show significant long-term effects, implying that their influence may be indirect, context-dependent, or nonlinear over time.

Table 8. Results of CS-ARDL - Model 1.

Variable	Coefficient	Std. error	z-stat	p-value
Short-run estimates				
L.lnGDP	-0.5208	0.0886	-5.87	0.000
lnDomesticCredit	-0.0674	0.0407	-1.67	0.094
lnFDI	0.0067	0.0059	1.14	0.256
lnCapital	0.0580	0.0284	2.05	0.041
lnInflation	-0.0155	0.0078	-2.07	0.038
lnHK	1.3368	0.6287	2.13	0.033
Error correction term				
lr_lnGDP	-1.5201	0.0886	-17.16	0.000
Long-run estimates				
lr_lnCapital	0.0330	0.0159	2.07	0.038
lr_lnDomesticCredit	-0.0451	0.0208	-1.95	0.051
lr_lnFDI	0.0061	0.0052	1.16	0.245
lr_lnHK	1.0035	0.4818	2.08	0.037
lr_lnInflation	-0.0118	0.0061	-1.93	0.054

Table 9 presents the results of the second model, the CS-ARDL results indicate significant short- and long-run relationships between the explanatory variables and economic growth (measured by real GDP). In the short run, the negative and significant coefficient of the lagged dependent variable (–0.5253, $p < 0.01$) confirms partial adjustment. Gross capital formation (lnCapital) and human capital (lnHK) show significant positive effects (0.0637, $p = 0.013$ and 1.7603, $p = 0.007$, respectively), indicating their short-term contribution to growth. Inflation negatively affects growth (–0.0133, $p = 0.045$), consistent with inflationary pressures weakening real output. While domestic credit is statistically significant at 10% (–0.0737, $p = 0.082$).

The error correction term (−1.5253, $p < 0.01$) is highly significant and appropriately signed, confirming a strong convergence toward the long-run equilibrium.

In the long run, capital formation (0.0372, $p = 0.011$) and human capital (1.3232, $p = 0.021$) retain a positive and statistically significant impact on GDP, highlighting their structural role in growth. Domestic credit is marginally significant and negatively signed (–0.0434, $p = 0.054$), possibly reflecting inefficiencies or financial market distortions. Inflation continues to show a weak negative association (–0.0098, $p = 0.084$) but lacks statistical significance in the long term.

The interaction term between foreign direct investment (FDI) and human capital (lnHKlnFDI) is positive in both the short run (0.2219, $p = 0.139$) and long run (0.1555, $p = 0.112$), though neither reaches conventional significance at the 5% level.

However, when considering a 10% significance threshold, the long-run interaction effect becomes marginally significant. This suggests that human capital may enhance the growth effects of FDI, meaning countries with higher average education levels are better positioned to absorb and benefit from foreign investment inflows. In other words, FDI alone may not significantly impact economic growth, but its effect can become more pronounced in contexts with stronger human capital endowments.

The results concerning this study support the increasing consensus in the literature that human capital is a key facilitator of financial development, especially when interacting with unfamiliar direct assets (FDI). In line with

Kanval, Abbas, and Rehman (2024) and Khan, Ahmad, and Ijaz (2023), our findings show that while FDI alone can have limited benefits, its impact becomes significantly more certain when combined with strong human capital.

Table 9. Results of CS-ARDL - model 2.

Variable	Coefficient	Std. error	z-stat	p-value
Short-run estimates				
L.lnGDP	-0.5253	0.0873	-6.02	0.000
lnDomesticCredit	-0.0737	0.0422	-1.74	0.082
lnFDI	-0.4301	0.3102	-1.39	0.165
lnCapital	0.0637	0.0258	2.47	0.013
lnInflation	-0.0133	0.0066	-2.00	0.045
lnHK	1.7603	0.6571	2.68	0.007
lnHKlnFDI	0.2219	0.1501	1.48	0.139
Error correction term				
lr_lnGDP	-1.5253	0.0873	-17.48	0.000
Long-run estimates				
lr_lnCapital	0.0372	0.0147	2.53	0.011
lr_lnDomesticCredit	-0.0434	0.0225	-1.93	0.054
lr_lnFDI	-0.3035	0.2003	-1.50	0.133
lr_lnHK	1.3232	0.5726	2.31	0.021
lr_lnHKlnFDI	0.1555	0.0978	1.59	0.112
lr_lnInflation	-0.0098	0.0057	-1.73	0.084

This confirms the act of instruction and abilities in unlocking the filled benefits of outside investment. Similarly, Rahman, Kashem, and Islam (2022) emphasized that human capital is crucial for sustainable, long-term growth in the ASEAN region supporting our view that human capital drives fundamental change. Finally, as highlighted by Jahanger, Usman, Balsalobre-Lorente, and Ahmad (2022) human capital contributes not only to financial productivity but also to the sustainability of growth, especially when combined with global integration and capital inflows.

5. CONCLUSION

This study investigates the short- and long-term effects of foreign direct investment (FDI), human capital (HK), capital formation, domestic credit, and inflation on economic growth (GDP) across a panel of countries over the period 1990–2023. Using the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model, the analysis confirms that human capital and capital formation are critical drivers of economic growth. In contrast, FDI on its own exhibits a weak or insignificant direct impact on growth. However, the interaction between FDI and human capital is marginally significant, indicating that the positive effects of FDI are amplified in countries with higher levels of human capital. Domestic credit shows a negative but marginal relationship with GDP, and inflation displays inconsistent effects across different time horizons.

The findings offer important policy lessons. First, governments aiming to maximize the growth benefits of FDI should focus not only on attracting foreign investment but also on enhancing the quality of their human capital through substantial investments in education, skills development, and research capacity. Policies should emphasize improving the absorptive capacity of the workforce to ensure that incoming FDI translates into productivity gains and technological diffusion. Second, promoting capital formation remains crucial for sustaining long-term growth, highlighting the need for supportive policies such as tax incentives, stable investment climates, and infrastructure development. Finally, improving financial sector efficiency is essential, as excessive or misallocated domestic credit may undermine growth prospects if not directed toward productive sectors.

5.1. Limitations and Future Research Directions

Despite its contributions, this study is subject to certain limitations. First, although the dataset covers a broad period and multiple countries, it does not distinguish between different sectors of FDI (e.g., manufacturing versus services), which may have heterogeneous effects on growth. Second, although human capital is proxied through average years of schooling, this measure may not fully capture the quality dimension of education, such as cognitive skills or technological literacy. Future research could extend this analysis by incorporating sectoral FDI disaggregation, quality-based human capital indicators, and institutional quality measures to better understand how these factors interact with FDI and growth dynamics.

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