RESEARCH ARTICLE

The Human Capital Investment and Economic Growth in Pakistan: Insights from Education and Infrastructure Development

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Abstract: The complex pathways behind positive impact of human capital investment on economic growth have gained considerable focus in recent decades. The investment in education, technology innovation, and skills development play a crucial role in driving sustainable economic development. Despite Pakistan's growing population and investment in education and infrastructure, the economy continues to face challenges in achieving sustainable growth. This research explored the dynamic relationship between education levels (Illiterate, basic and advanced), gross fixed capital formation (GFCF), and economic growth in Pakistan. The relevant data spanning from 2000 to 2024 was derived from Government of Pakistan's statistics. The ARDL cointegration was employed for data analysis. The empirical findings revealed that advanced education and GFCF were significant drivers of economic growth in the long run, whereas illiteracy had adverse impact on real GDP. Notably, the study found that basic education alone was insufficient to stimulate economic growth, and it highlighted the need for more advanced human capital in Pakistan. In the short run, the impact of advanced education and GFCF were mixed. The GFCF appeared to be hindered by inefficiencies in capital utilization. The study's results were robust and reliable as confirmed by diagnostic and stability tests. The findings underlined the importance of policy interventions aimed at reducing illiteracy, enhancing basic education outcomes, expanding access to advanced education, and improving capital formation efficiencies for sustainable economic growth in Pakistan.

Keywords: Human Capital Investment, Illiterate Labour Force, Educated Labour Force, Technology Innovation, Pakistan

Introduction

Pakistan, the world's fifth-largest nation, is a developing country and grappling with a weak economy. An examination of the country's demographic characteristics reveals a significant youth population, with 36% of citizens falling within the 0-14 age bracket and 44% between 15 and 45 years old (GoP, 2023). This youthful demographic presents both opportunities and challenges for policymakers. If harnessed effectively through strategic investments in education, research, and development, the potential of this demographic dividend could be a game-changer for the country's economic trajectory and well-being.

Investing in human capital is widely recognized as a key driver of economic growth and development. Studies by Barro (1991) and Barro and Lee (1993) emphasize the importance of human capital development for economic progress. Human capital investment involves making expenditures on education, health, and skills development, and it ultimately enables the work force to contribute more efficiently and effectively in

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the country's economic development. The enhancement in labour force productivity through human capital investment can have a profound impact on a nation's economic performance (Zaman, 2024).

Education is a cornerstone of human capital development and contributes to economic growth in multiple ways. It equips individuals with the skills and knowledge needed to increase productivity, drive innovation, and adapt to evolving economic demands. The related literature has established a strong positive correlation between education attainment and economic development (Barro & Lee, 2001). However, the Pakistani context presents a paradoxical scenario. Despite an increasing number of educated individuals, the Pakistan continues to struggle with miscellaneous issues e.g. stagnation of economy, high unemployment rates, and a severe brain drain. This raises fundamental questions about the efficacy of education system for its contribution in the economic growth in Pakistan. It highlights the need to investigate the structural barriers that might be impeding the full potential of education.

The education system, progressing from basic to advanced levels, influenced human capital productivity by developing varying levels of knowledge, skills, and creativity in individuals (Driskill & Horowitz, 2002'; Zhou et al., 2021). The differences in education levels, health, and work experience significantly influence labour force participation and employment outcomes (Farid et al., 2012). Therefore, it is essential to examine the impact of education with respect to economic growth in Pakistan. The prioritization of education, health, and skills development is crucial to benefit from Pakistan's youth potential. The creation of a knowledgeable, skilled, and creative workforce is required for driving innovation and productivity and contributing to the country's economic development.

Developing countries like Pakistan need customized approaches to utilize education for economic growth while keeping in view the unique circumstances like demographics, education systems, and labour markets. By understanding these dynamics, Pakistan can create targeted policies to tap its youth's potential. The education sector in Pakistan is struggling with significant challenges, evident in its alarmingly high illiteracy rates which are among the highest in South Asia. The national literacy rate in Pakistan stands at 62.8%, with substantial regional and gender disparities (GoP, 2023). Pakistan's underinvestment in education, outdated curricula, and poor infrastructure hinder human capital development. Economic instability and limited industrial growth have created a shortage of job opportunities, leading to youth frustration and brain drain. The weak labour market that cannot absorb educated individuals (World-Bank, 2019).

The brain drain phenomenon is starkly evident in the statistics in Pakistan. In 2020, nearly 6.3 million Pakistani immigrants were residing abroad, making Pakistan one of the top ten countries with the largest emigrant populations globally and this trend is continued unabated (United-Nations, 2024). Tragically, many seeking better opportunities abroad resort to perilous routes, risking their lives in the process. This highlights the desperation and frustration that drives individuals to take extreme measures in order to flee from their native country.

As posited by endogenous growth theories, the human capital accumulation is expected to drive economic growth in any country (Romer, 1990). However, in Pakistan's case, this relationship appears tenuous due to structural gaps and inefficiencies in the outdated systems. The benefits of education for economic growth are severely compromised due to economy's dependence upon low-skilled labour and an education system which is misaligned with market demands (Ziberi et al., 2022). A thorough investigation is needed to understand how different education levels (illiteracy, basic, and advanced) impact economic outcomes in Pakistan. This insight will inform targeted policies to convert educational achievements into tangible economic progress.

The instant study is meant to examine the impact of education on economic growth in Pakistan. Employing the ARDL approach, both the short-run and long-run relationships between varying education levels and GDP were analysed. The link between education and economic growth has been studied in the

literature in various dimensions, however, there remains a gap in understanding how Pakistan's unique socio-economic conditions influence this relationship. By investigating this relationship, the study seeks to bring forth valuable insights for policymakers, particularly in designing education and labour market policies in Pakistan.

Literature Review

Investing in education system and skills of labour force is key to economic growth. It boosts productivity, innovation, and institutional effectiveness. Human capital investment enhances productivity, fosters innovation, and supports institutional quality, and all of which are critical for economic growth. However, the focus should be on improving education quality to maximize these benefits and it is highly relevant in the context of developing countries. Vinod and Kaushik (2007) showed that the human capital directly boosted economic growth by improving labour productivity. Education and professional skills were essential for increasing the efficiency and output of the workforce. Cinnirella and Streb (2017) concluded that the education and craftsmanship were linked to innovation. Human capital was vital for research and development (R&D), and it accelerated technological change and innovation.

A great deal of literature concluded that human capital enhanced the quality of economic institutions which was crucial for long-term growth. It acted as a mediator between institutional quality and economic development particularly in countries with high institutional quality (Baser & Gokten, 2019; Faria et al., 2016). Even though, some studies found human capital's direct impact on per capita growth rates to be insignificant, it played a positive role in total factor productivity growth and indicated its indirect influence on economic development (Benhabib & Spiegel, 1994). However, the quality of education, rather than mere attainment, was critical for maximizing economic benefits, especially in developing countries. Human capital contributed to reduce income disparities across countries by explaining a significant portion of income differences (Angrist et al., 2021; Hanushek, 2013).

Wei (2008) explored how the human capital in China was linked with its economic growth. It was concluded that human capital influenced the economic growth indirectly through physical capital investment, however, higher education levels played a significant role. This influence of human capital investment was estimated to be quite important as it led to regional growth disparities.

Similarly, an illiterate labour force can negatively influence real GDP in the long run. Increasing the education level of the labour force is positively linked with real GDP growth. The lack of education or insufficient educational investment can hinder the pace of economic growth. A study conducted by Kausar et al. (2024) highlighted a negative association between government education expenditures and economic growth. They suggested that inadequate investment in education limited the potential for GDP growth in Pakistan. The research underscored the importance of investing in education to enhance the skills of the labour force which in turn can positively impact real GDP. An illiterate or undereducated labour force might impede economic growth, therefore, the need for effective educational policies and investments was emphasized.

The relationship between a labour force with advanced education and real GDP is generally positive. It indicates that higher educational attainment within the workforce can significantly boost economic growth. Studies consistently show that any improvement in the educational level of the labour force correlates with an increase in real GDP. For instance, a study by Sharma and Rawat (2024) found that the secondary and higher education levels in India had a statistically significant positive impact on economic growth. Stănilă et al. (2013) conducted data analysis of selected European countries and found that a higher percentage of the labour force with tertiary education was intuitively linked to higher GDP per capita. It was suggested that the advanced education levels contributed positively to economic growth. In another study was conducted by Wolff (2000) for OECD countries. A mixed relationship was found between better education levels and

productivity enhancement. A general trend was observed that higher educational attainment was aligned with increased labour productivity which in turn supported GDP growth.

As per Roson (2022), an increased public expenditure on education led to a multiplier effect on the supply of education services, enhancing productivity, income, and overall economic welfare. However, the relationship between government educational expenditure and productivity can be complex, as it was seen in Turkey by Durmaz and Pabuçcu (2018). The study found that investing in advanced education increased labour productivity and economic growth. Prioritization of higher education and vocational training contributed to a Turkey's economic well-being. Strategic investments in infrastructure, innovation, and financial inclusion drove economic growth due to capital formation. Capital Formation was a key driver of economic growth which positively influenced GDP. Dawood et al.m (2025) found that capital formation significantly impacted the GDP in Pakistan. Diversifying investments beyond oil, particularly in technology, renewable energy, and infrastructure mitigated the risks and supported sustainable growth. In another study conducted by Reddy and Ramaiah (2020) found that capital formation contributed to GDP growth alongside government expenditure and inflation. They highlighted the importance of public investment in productive activities for economic growth.

Similarly, Hussin and Saidin (2012) by analysing the panel data of ASEAN-4 countries such as Indonesia, Malaysia, Thailand and Philippines. They described that GFCF was a significant contributor to GDP growth, however, the impact of GFCF on GDP varied across countries and the Foreign Direct Investment (FDI) was more influential in some cases. Zahir and Rehman (2019) also supported the similar findings that GFCF had a positive impact on GDP and endorsed the role of GFCF in economic development. Ramzan et al.,(2019) studied the data from 1980 to 2015 in 70 selective developing countries. They concluded that GFCF, FDI and broad money supply had a positive impact on GDP. They also highlighted the significance of these factors in driving economic growth strategies. Žarković et al. (2024) conducted a study in the context of both old and new EU member states. They studies data for GFCF, trade openness and government consumption and described that GFCF positively influenced GDP growth.

The relationship between basic education and economic growth is complex. The primary education is crucial, however, its effect on economic growth is limited without quality improvements and investments in higher education. Enhancing educational quality and expanding access to higher education can maximize economic benefits in low-income countries. For instance, research conducted in Greece by Asteriou and Agiomirgianakis (2001) showed that education typically contributed to GDP growth, however, the impact of primary education was less significant as compared with that of higher education. Likewise, a study by Sari and Soytas (2006) that was conducted in Turkey found that the impact of education on GDP varied by level of education attainment. It was observed that primary education had a relatively weaker effect as compared to other higher levels of educational. Goczek et al., 2021) emphasized that education quality, not just duration, pushed economic growth. Cognitive skills, foundational literacy, and high-quality primary and secondary education were the key determinants of economic growth.

Wen (2023) conducted a comprehensive study for the developed and developing countries and studied the relationship between GDP and education attainment. It was found that the relationship between education and GDP was more pronounced in the context of developing countries and indicated significant educational gains as GDP increased. However, this effect appeared to be diminished as the countries became more developed. In this study a ceiling effect of positive relationship of education with GDP growth was noted. Arabi and Abdalla (2013) examined the contribution of human capital for economic growth in Sudan from 1982 to 2009 using a simultaneous equation model. The empirical results revealed that the quality of education was a crucial driver of economic growth. The total factor productivity had a negative effect on both economic growth and human development due to the prevalence of outdated and obsolete technologies.

Addressing inefficiencies in capital formation is key to boost economic development. Effective management and strategic policies can maximize benefits from capital formation. An environment conducive to capital accumulation and efficient resource use can enhance economic growth. Bal et al. (2016) in a study conducted in India showed that the capital formation supported economic development across various regions. Ishfaq et al. (2024) examined the data from 1971 to 2020 related to capital formation and economic development in Pakistan. Economic growth was linked to increased labour force participation, physical and human capital, natural resource utilization, and financial development. They recommended that the policymakers should advised to invest in infrastructure, health, education, and efficient use of natural resources to boost economic growth in Pakistan.

Uneze (2013) investigated how the capital formation contributed towards economic growth in Sub-Saharan Africa and found evidence of bidirectional causality. It was indicated that capital formation drove growth and economic growth. In another latest study by Aslan and Altinoz (2021), this pattern was also observed in the context of Europe and Asia. They found that capital formation and economic growth influenced each other. Chow (1993) established the contribution of capital formation in China for the growth of various sectors such as agriculture, industry, and commerce especially after economic reforms in the country. This highlighted the importance of sector-specific strategies in capital formation. Despite its benefits, capital formation sometimes negatively affected growth if it was not managed properly. For instance, Pasara and Garidzirai (2020) found that inappropriate levels of capital formation hindered growth in some developing countries. It was recommended that fiscal policies needed to be designed for stimulation of the investment and employment to enhance the positive effects of capital formation.

Data and Research Methodology
Variable Description
Based on literature review, the suitable variables were identified which were aligned with the research objectives and provided a robust framework to analyse how education levels and capital formation influenced Pakistan's economic growth. In this study, different education levels i.e. illiterate, basic education, and advanced education were analysed along with fixed capital formation in order to ensure a comprehensive assessment of the key factors influencing GDP growth in Pakistan. All the data series ranging from 2000 to 2024 were derived from secondary data sources of Government of Pakistan which enhanced the reliability and relevance of the analysis within Pakistan's socio-economic context. The basic education level was taken up to matric education or secondary school certification. Any education beyond matric was taken as advanced level of education. The description of the study variables is given as under:

Table1
Variables Description

Variables	Notations	Data-Source
A) Dependent Variable		
Real Gross Domestic Product	RGDP	Economic Survey of Pakistan
B) Independent Variables		
Illiterate Labour Force	ILF	Labour Force Survey of Pakistan
Labour Force with Basic education	BLF	Labour Force Survey of Pakistan
Labour Force with Advanced education	ALF	Labour Force Survey of Pakistan
Gross Fixed Capital Formation	GFCF	Economic Survey of Pakistan

Methodology
The presence of a long-run equilibrium relationship among time-series variables can be examined using various methods, such as the Engle and Granger test, Phillips and Hansen's fully modified OLS procedure, and Johansen's maximum likelihood approach. However, these methods require variables to be integrated

of 1st order, I (1), and may be less robust in small samples or when structural breaks are present. To overcome these limitations, the autoregressive distributed lag (ARDL) approach introduced by Pesaran et al. (1999) and further developed by Pesaran et al. (2001) has gained prominence. The ARDL approach is a popular method for cointegration analysis due to its flexibility and reliability. It can handle variables with different orders of integration and provides consistent long-run estimates.

This study used the ARDL approach and Error Correction Model (ECM) to analyse the impact of labour force education levels (illiterate, basic, and advanced education) and gross fixed capital formation on Pakistan's economic growth. The model description is as under:

$$RGDP = \beta_1 + \beta_2 ILF + \beta_3 BLF + \beta_4 ALF + \beta_5 GFCF + \varepsilon t$$

In this model, RGDP served as the dependent variable while the independent variables included ILF, BLF, ALF, and GFCF. The coefficient β_1 represented the intercept for capturing the baseline level of GDP when all independent variables were zero.

The coefficient β_2 was meant to measure the impact of an increase in the illiterate labour force on GDP. A negative β_2 would suggest that a higher proportion of illiterate workers in the labour force may hinder economic growth. Similarly, β_3 represented the elasticity of GDP with respect to the labour force with basic education, indicating the percentage change in GDP resulting from a 1% increase in this category, assuming other factors remained constant. A positive β_3 would imply that basic education contributed to economic growth.

Furthermore, β_4 quantified the effect of the labour force with advanced education on GDP. A larger positive β_4 would indicate that higher education significantly enhanced economic performance by improving workforce skills and productivity. The coefficient β_5 measured the elasticity of GDP concerning gross fixed capital formation and highlighted the role of capital investment in economic growth. A positive β_5 would confirm that increasing capital accumulation positively influenced GDP. Lastly, the error term ε_t accounted for unexplained variations in GDP that captured the external factors which could not be included in the model. Overall, the expected findings were likely to show that higher education levels and capital investment exerted a strong positive impact on GDP whereas, a larger illiterate labour force may have a negative or minimal effect on economic growth.

The sum of the estimated coefficients i.e. $\beta_2 + \beta_3 + \beta_4 + \beta_5$ would provide insights into the returns to scale in the economy. If this sum equals to one, it suggests a constant returns to scale or in other words, a proportional increase in all inputs e.g. illiterate labour force, labour force with basic education, labour force with advanced education, and gross fixed capital formation would result in an equal proportional increase in the real GDP. For instance, doubling these inputs would lead to a doubling of output while tripling them would result in a tripling of GDP and so on.

If the sum of the coefficients is greater than one, the model would indicate increasing returns to scale. This would suggest that a proportional increase in all inputs would lead to a more than proportional rise in real GDP and it would reflect greater efficiency in resource utilization. In such a scenario, higher investments in education and capital formation would yield higher economic growth. Conversely, if the sum of the coefficients is less than one, it would signal decreasing returns to scale. This implies that doubling all inputs would result in less than a two-fold increase in GDP, possibly due to inefficiencies, diminishing marginal productivity, or structural constraints in economic infrastructure that hinder the optimal utilization of labour and capital.

Empirical Results
Correlation Metrix
The correlation matrix revealed that real GDP (RGDP) exhibited a strong positive correlation with the labour force possessing basic education (BLF), advanced education (ALF), and gross fixed capital formation (GFCF).

In contrast, RGDP was strongly negatively correlated with the illiterate labour force (ILF). Notably, ILF showed a highly negative correlation with ALF (-0.983), suggesting the potential presence of multicollinearity. These findings highlight that education levels and capital formation served as key drivers of economic growth, whereas a higher proportion of illiteracy in the labour force had an adverse impact.

Table 2
Correlation matrix

Variables	RGDP	ILF	BLF	ALF	GFCF
RGDP	1.0000				
ILF	-0.9331	1.0000			
BLF	0.8531	-0.8384	1.0000		
ALF	0.8973	-0.9828	0.7951	1.0000	
GFCF	0.9150	-0.8114	0.8267	0.7507	1.0000

Unit Root Test

The stationarity of the variables was examined using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results, presented in Table 2, indicated that Real Gross Domestic Product (RGDP) was stationary at the level, as both ADF and PP test statistics were significant at the 1% level. However, all independent variables i.e. Illiterate Labour Force (ILF), Labour Force with Basic Education (BLF), Labour Force with Advanced Education (ALF), and Gross Fixed Capital Formation (GFCF) were non-stationary at the level but became stationary after first differencing. This combination of I (0) and I (1) variables supported the use of the ARDL model which effectively handled such data structures and allowed for the examination of both short-run and long-run relationships.

Table 3
Output of Unit Root Test

Variables	At Level		1st Difference	
	ADF	PP	ADF	PP
RGDP	-4.1774 (0.0024)	-4.0574 (0.0033)	-5.8725 (0.0000)	-18.891 (0.0001)
ILF	1.1038 (0.3179)	1.7112 (0.9995)	-6.8831 (0.0000)	-6.9673 (0.0000)
BLF	0.0182 (0.9856)	0.6138 (0.9881)	-5.3358 (0.0000)	-7.1122 (0.0000)
ALF	0.3873 (0.7009)		-8.2104 (0.0000)	-8.1534 (0.0000)
GFCF	-0.0242 (0.9808)	-0.5209 (0.8752)	-6.8831 (0.0000)	-5.5032 (0.0001)

Bound Test

To assess the long-run relationship between the variables, an F-test for cointegration was performed. The results are presented in Table 3. As per analysis results, the F-statistic (21.9783) exceeded the upper critical values at all levels of significance (10%, 5%, 2.5%, and 1%). This provided strong evidence of cointegration and confirmed that the variables maintained a stable long-run relationship. The presence of cointegration validated the application of the ARDL model and allowed for the estimation of both long-run coefficients and short-run dynamics.

Table 4
Bound Test for Cointegration

Test Statistic	Value	Sign	Upper limit	Lower Limit
F-Test	21.9783	10%	2.20	3.09
K		5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Long run estimation of coefficients
The long-run coefficients were estimated from the ARDL model which are presented in Table 4.4.

Table 5
Output of ARDL Long-run (Dependent Variable: RGDP)

Variables	Coefficient	Std. Error	T-Test	Prob.
ILF	-0.0919	0.0247	-3.7189	0.0026
BLF	-0.0076	0.0295	-0.2582	0.0083
ALF	0.1647	0.4116	0.4001	0.0056
GFCF	0.3765	0.0962	3.9121	0.0018
C	16.862	2.6402	6.3867	0.0000

The regression analysis revealed several key findings regarding the impact of labour force education and capital formation on economic growth in Pakistan. Illiterate Labour Force (ILF) had a significant negative impact on Real GDP with a coefficient of -0.0919 (p-value = 0.0026). This indicated that a higher proportion of illiterate workers constrained economic growth by limiting productivity and innovation.

The study revealed contrasting effects of education levels on economic growth in Pakistan. The labour force with basic education had a significant negative effect on real GDP, with a coefficient of -0.0076 (p-value = 0.0083). It suggested that skill mismatch could exist in the labour market. In contrast, the labour force with advanced education had a significant positive impact, with a coefficient of 0.1647 (p-value = 0.0056), revealed an important role of higher education in driving innovation, technological advancement, and productivity gains. The study also found that GFCF significantly increased economic growth, with a coefficient of 0.3765 (p-value = 0.0018), and highlighted the importance of sustained investments in infrastructure, technology, and capital goods. This, combined with the positive impact of advanced education, suggested that investments in these areas may be prioritized because enhancing access to quality education supported economic growth and development. However, the negative effects of illiterate and inadequately skilled labour forces underlined the need for policies which aligned educational outcomes with the requirements of labour market.

Short Run Equilibrium Model
The short-run analysis indicated that Real GDP was significantly influenced by the education levels of the labour force and gross fixed capital formation.

Table 6
Output of ARDL Short-run (Dependent Variable: RGDP)

Variables	Coefficient	Std. Error	T-Test	Prob
D (ILF (-1)	0.0024	0.0071	0.3307	0.3861
D (ILF (-2)	0.0076	0.0083	0.9062	0.0012
D (ILF (-3)	0.0429	0.0096	4.4531	0.0139
D(BLF)	0.0271	0.0091	2.9767	0.0006

Variables	Coefficient	Std. Error	T-Test	Prob
D (BLF (-1))	-0.0182	0.0037	-4.9095	0.0000
D (BLF (-2))	0.0497	0.0052	9.5644	0.0000
D (BLF (-3))	0.0531	0.0068	7.7905	0.0031
D(ALF)	0.0280	0.0072	3.8673	0.5720
D (ALF (-1)	0.0018	0.0315	0.5843	0.1104
D (ALF (-2)	-0.0705	0.0402	-1.7513	0.0209
D (ALF (-3)	0.1223	0.0447	-4.4130	0.0246
D(GFCF)	0.1005	0.0351	-2.5745	0.8659
D (GFCF (-1)	-0.0061	0.0360	-1.7911	0.0013
D (GFCF (-2)	-0.1589	0.0167	-14.0643	0.0277
D (GFCF (-3)	-0.0297	0.0166	-1.7911	0.1035
C	-0.0200	0.0014	-14.0643	0.0000
R-Squared:	0.8458	Adjusted R-Squared:		0.6812
Durbin-Watson:	2.5025			

According to the findings, the Illiterate Labour Force (ILF) had a small but delayed positive impact on Real GDP. It could be due to short-term contributions to economic activity. However, the Labour Force with Basic Education (BLF) showed mixed effects on RGDP. It negatively impacted the economic growth in the first lag but subsequently, exerted a strong positive influence in the second and third lags. This pattern indicated the presence of a time lag in skill utilization where basic education gradually contributed to economic productivity and indicated that foundational education yielded benefits over time.

In contrast, Labour Force with Advanced Education (ALF) had a negative effect on RGDP in the second lag but it ultimately displayed a significant positive impact in the third lag. This finding suggested that the economic benefits of advanced education materialized with a delay. It could have been likely due to the time required for skill development, specialized knowledge acquisition, and absorption into the labour market. Furthermore, Gross Fixed Capital Formation (GFCF) negatively affected RGDP in the short run. This effect was particularly more pronounced in the first and second lags which indicated potential inefficiencies in capital allocation, inadequate investment in productive sectors, or a time lag before investments translated into productive economic outcomes. This finding about GFCF emphasized the complexities involved in capital formation and its effect on economic development.

The model of instant research had strong explanatory power which explained 84.58% of the variation in RGDP (R-squared = 0.8458). The Durbin-Watson statistic (2.5026) confirmed the absence of autocorrelation and ensured the reliability of the analysis results. These findings highlighted the need for targeted policy interventions. To drive economic growth, policymakers should prioritize enhancing the quality and effectiveness of basic education. This can be achieved through reforms that improve teacher training, curriculum development, and infrastructure. The removal of inefficiencies in capital formation was evaluated to be addressed by streamlining regulations, promoting transparency, and encouraging high-growth sector investments. Governments can accelerate economic growth by optimizing the utilization of higher education graduates through strategies like innovation, entrepreneurship, and industry-academia collaborations.

Diagnostic Tests
Model Diagnostics
The out of the analysis of the diagnostic tests are given in the Tane 4.6.

**Table 7**
Diagnostic Test of Model

Problem	Estimation	F. Test	Prob.	Results
Autocorrelation	LM Test	0.8326	0.6125	Accepted Null Hypothesis/ No Autocorrelation
Heteroskedasticity	Breusch-Pagan-Godfrey	0.595271	0.8021	Accepted Null Hypothesis/ No Heteroscedasticity
Specification of Model	Ramsey Reset Test	0.006156	0.9446	Accepted Null Hypothesis/ No Specification error

The diagnostic tests conducted on the model yielded satisfactory results and confirmed reliability and validity of the model. The Breusch-Godfrey test for autocorrelation indicated no significant autocorrelation in the residuals. The Breusch-Pagan-Godfrey test for heteroskedasticity showed no evidence of heteroskedasticity. The Ramsey RESET test also confirmed that the model was correctly specified, with no significant specification errors detected. Overall, these diagnostic tests provided strong evidence that the estimated relationships between education levels, capital formation, and economic growth were statistically trustworthy.

Stability Test
The CUSUM and CUSUM of Squares plots demonstrated the model's stability over time because the cumulative sum of residuals and their squares stayed within the 95% confidence bounds. This indicated no structural breaks or sudden changes in variance, the reliability of the model estimates and robustness for policy implications.

Figure 1
CUSUM and CUSUM of Squares Tests
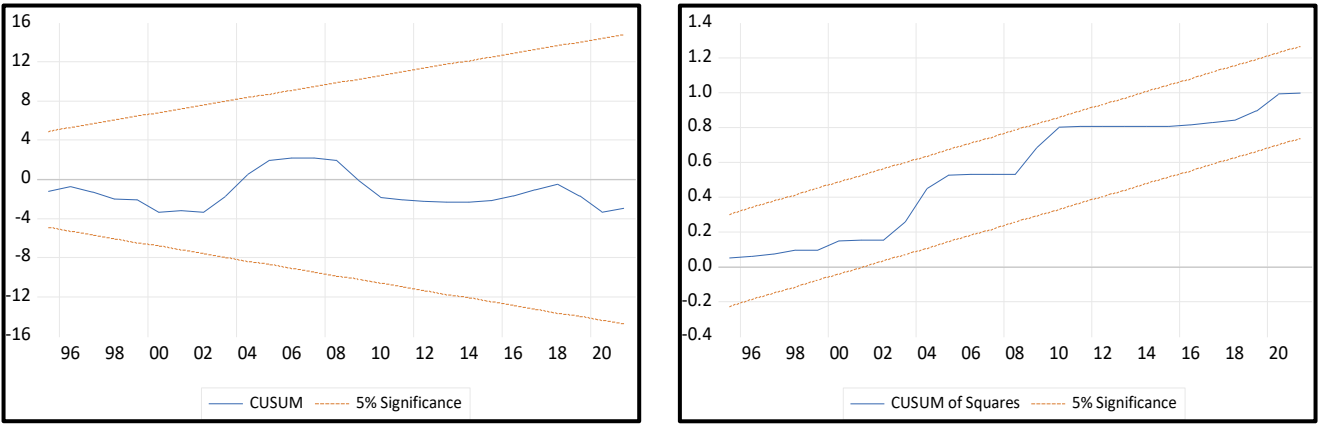
Conclusion
This study used the ARDL cointegration approach to examine the impact of education levels and gross fixed capital formation (GFCF) on Pakistan's economic growth. Key findings include:

In the long run
- Illiterate labour force (ILF) negatively affected Real GDP (RGDP).
- labour force with advanced education (ALF) and GFCF had significant positive effects on RGDP.
- Labour force with basic education (BLF) had a negative and significant relationship with RGDP.

In the Short Run
- Labour force with advanced education and GFCF showed mixed effects, with GFCF negatively impacting RGDP possibly due to inefficiencies.
- Diagnostic and stability tests confirmed the model's reliability and robustness.

Recommendations

The study's findings suggested the following policy implications:

- ▶ Reduce illiteracy and enhance basic education outcomes
- ▶ Expand access to advanced education to strengthen human capital
- ▶ Address inefficiencies in capital formation to optimize its role in economic growth

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