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Economic Growth Determinants in Pakistan: An Empirical Analysis Using ARDL Model

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Abstract: *The objective of this study is to examine the determinants that affect Pakistan's economic growth. The study examines the causal relationship between economic determinants and growth from 1972 to 2021. Key determinants in the model include physical capital stock, employed labour force, bank credit, human capital, exports, and imports. Autoregressive Distributed Lag (ARDL) model was used to fulfil the research objectives. The study found long-term co-integration between the variables. Both physical capital and human capital were found to be statistically significant, positively affecting economic growth. Thus, both are complimentary to economic growth rather than substitutes. The study noted that employed labour force, bank credit, exports, and imports did not affect economic expansion. It suggests that neither import substitution nor export promotion is effective in achieving sustainable growth in the period of study. Furthermore, an increase in the employed labour force is not sufficient for economic growth after controlling for the effect of human capital. Results suggest that improvement in infrastructure and human capital productivity are essential to achieve sustainable growth.*

Key Words: Economic Growth, Physical Capital, Human Capital, Bank Credit, ARDL

Introduction

A rise in the value of production of goods and services in a region within a particular time period is referred to as economic growth. The most widely used metric for economic growth is percentage change in Gross Domestic Product (GDP). The study of economic growth has evolved, giving rise to various theories and models aimed at explaining its determinants and dynamics. In Pakistan, economic growth has acquired significant attention from policymakers and economists alike. The country's economic performance has witnessed wide fluctuations, characterized by periods of rapid growth and moments of stagnation. As a result, the analysis of economic growth in Pakistan holds critical importance for policymakers, investors, and the overall nations' progress amidst the repeated boom-bust cycles faced by the economy.

The neoclassical theory of economic development, initially introduced by Robert Solow in the 1950s, is widely recognized as one of the earliest and most influential theories in the field of economic growth (Solow, 1956). The theory identified capital accumulation and technology as essential factors for the progress in driving economic growth. The neoclassical growth theory narrates that an increase in capital stock and improvements in technology can lead to sustained economic growth. Subsequently, Romer (1990) introduced another significant theory of economic growth known as the endogenous growth theory. This theory concluded that human capital and innovation both are key factors in driving economic growth. Contrary to exogenous growth theory, this theory claimed that technological change is endogenous, not exogenous. Investment decisions and policies can influence technological progress. This theory considered human capital and research and development as essential factors for enhancing the economic growth rate.

In addition to these theories, other factors have been identified to influence economic growth as well. For instance, Barro (1997) has demonstrated through empirical research that various factors, including initial levels of education, life expectancy, reduced fertility rates, decreased expenditures of government,

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good governance, controlled inflation rates, and progress in terms of trade, have the potential to positively impact the economic growth rate. Furthermore, integration into world markets and the size of the population alone are not sufficient to generate growth.

This study aims to assess the influence of physical capital, labour force, and human capital using an augmented Solow growth model. Additionally, the research incorporates other variables deemed more pertinent to long-term growth. Given the limited focus on factors crucial for sustained growth, particularly in the context of Pakistan in recent literature, this study seeks to address this gap. By analysing the drivers and determinants of economic growth, policymakers can formulate effective strategies to address weaknesses and foster growth in specific sectors. A growing economy directly impacts poverty reduction by creating jobs, raising incomes, and improving living standards. For businesses and investors, economic growth analysis serves as a vital tool in making informed decisions about investments and expansion. Moreover, it guides fiscal and monetary policies to support growth while managing inflation and stability. Efficient resource allocation is facilitated by identifying high-growth sectors and optimizing economic output. Additionally, analysing trade patterns and the balance of payments aids in understanding the country's external position. Long-term planning is enabled by assessing structural challenges and opportunities for sustainable growth, promoting stability and resilience.

Furthermore, economic growth analysis plays a key role in enhancing social development indicators like education and healthcare. It also helps identify regional disparities and allows targeted policies to promote balanced regional development. Ultimately, by understanding its global competitiveness, Pakistan can position itself better in the international arena, attracting foreign investment and trade opportunities. In summary, the comprehensive analysis of economic growth in Pakistan contributes to informed decision-making and fosters long-term economic prosperity for the nation.

Research Objective

This research aims to examine how physical capital, the workforce, and human capital affect economic growth by using an augmented Solow growth model. Additionally, the study includes other important factors for long-term growth.

1. To assess the impact of physical capital on economic growth.
2. To assess the impact of labour force on economic growth.
3. To assess the impact of human capital on economic growth.
4. To assess the impact of bank credits on economic growth.
5. To assess the impact of export on economic growth.
6. To assess the impact of import on economic growth.

Literature Review

Solow (1956) argues that for progress in economic growth, physical capital is the key factor. Later, Mankiw et al. (1992) found a significant role of human capital in addition to physical capital in driving economic growth. These studies gave a theoretical framework and are still considered viable to understand the concept of economic growth.

In empirical studies, one research was conducted by Ding et al. (2021) to examine the various phases of sustainable economic growth. They also compared the effects of human capital and physical capital as part of their research. The investigation's findings showed that human capital had a greater influence on economic growth than did physical capital. This study emphasized how important it is to spend money on human capital because it is the main engine of long-term economic growth. Wu & Wu (2022) conducted a similar kind of study, and they concluded that human capital accumulation will eventually be the main factor for economic growth progress.

In empirical studies on Pakistan, the study examined the relationship between human capital and economic growth during the period spanning from 1960 to 2003 in the context of Pakistan. It has been established, according to the findings of the study and the estimates that were produced from it, that human capital contributed to a proportion that was much less than 20% of the claimed growth in Pakistan's GDP per capita. However, it can be argued that these outcomes can be attributed to the

implementation of insufficient human capital policies, which have had a detrimental effect on economic progress (Abbas et al. 2012).

Asghar et al. (2012) find that economic growth is significantly influenced by physical capital, which includes infrastructure, machinery, and equipment. They discovered that physical capital significantly and positively affects Pakistan's GDP growth. Investments in physical capital fuel economic growth because they increase output and productivity. Munir and Arshad (2018) investigated economic growth in the context of Pakistan, and they found positive and statistically significant impact of human and physical capital on economic progress. Thus, the theoretical narrative emphasizes investments in physical and human capital, which matches these results.

Another empirical inquiry that looked at the effect of physical and human capital was carried out by Sarwar et al. (2021). They investigated the various levels of education and the effects that each had on Pakistan's economic expansion. According to the findings of the study, having more years of schooling is statistically significant for economic growth. The authors shed light on the significance of obtaining quality education as a means to achieve economic success. Haider et al. (2021) emphasized the significance of a prolonged absence of formal education, noting that it may lead to a shortage of qualified human resources, thereby affecting future economic growth.

In empirical studies taking disaggregated data, Javed (2021) explored the association between investment in infrastructure and the expansion of the economy in Pakistan, taking into account both the economy as a whole and certain sectors in particular. The author performed a comparative analysis of several different types of investments in infrastructure. This research introduced a distinction between public and private investment, as well as investments in particular sub-sectors, including power, highways, and telecommunications. The study used the fully modified ordinary least squares technique in order to overcome the issue of reverse causality. The FMOLS technique was also used to assess the long-term association between infrastructure investments and economic progress. The study concluded that public and private investments in infrastructure are positively and statistically significant for expansion in the economy but with different magnitudes. These results support the claims of exogenous and endogenous economic models.

It is important to note that public infrastructure investment, in comparison to private infrastructure investment, typically has a more significant influence on the outcomes in different situations. The findings of the research have major policy implications in terms of measuring the effects of policies that are aimed at specific sectors and fostering a conducive policy climate to attract private investment. The substantial investment of public funds towards the improvement and modernization of infrastructure, which is being carried out in conjunction with China, is a primary factor that led to the selection of Pakistan as the primary subject of the research.

The employment level within a specific market exerts a substantial influence on the pace of economic expansion. The presence of a skilled and efficient labour force enhances aggregate production levels and serves as a catalyst for potential economic expansion. In another investigation, Asghar et al. (2012) examined the relationship between the employed labour force and the amount of output. The analysis reveals a significant positive correlation between Pakistan's economic growth and the proportion of its labour force that is employed. According to the study's findings, implementing public policies aimed at increasing labour productivity and expanding job options may have positive effects on the economy's expansion. In other regional studies, Gonzalez et al. (2022) examined Philippine economic growth indicators in depth. Their thorough analysis revealed a strong positive association between labour and economic growth. This correlation highlighted the importance of labour dynamics in national economic growth. The analysis highlighted the complex relationship between labour dynamics and the economy, notably in the Philippines. Khan et al. (2023) investigated the impact of the Foreign Direct Investment (FDI) and employment in Pakistan. Using 30 years of annual data from 1990 to 2019, sourced from the World Development Indicator website, the study employs unit root tests (ADF and PP) and the ARDL bound test approach. The results indicate a positive long-term and short-term relationship between increased FDI, gross capital formation, and industrialization with employment opportunities in Pakistan. Conversely, gross domestic income, economic growth, and population growth show a negative association with

employment opportunities in both the long and short term. Robust analysis using the fully modified OLS approach supports these findings. The study concludes with policy recommendations to boost FDI inflow and employment opportunities in Pakistan.

Large-scale investment projects depend on bank credit. The credit helps businesses expand and invest in new ideas, which boosts economic growth. Bank credit and economic growth in Pakistan are complicated. Bank credit and economic growth have been extensively studied. In their seminal study, Rajan and Zingales (1998) undertake a comprehensive analysis of the relationship between financial dependency and economic growth. Financial development, particularly bank credit, was found to boost economic growth. Levine (1997) explores the evolution of the financial system and how it affects economic growth. The author places a strong emphasis on the beneficial relationship between the financial system's organization and overall economic prosperity. Countries with effective legal systems and robust financial markets prefer to grow enterprises that use external finance (Demirguc-Kunt and Maksimovic, 1998). Alzyadat (2022) investigated the correlation between the maturity structure of bank lending and economic growth in Saudi Arabia. The study found that long-term lending by commercial banks boosts economic growth. The study implies that long-term bank financing is essential for economic growth.

Datta (2021) examines the link between commercial bank loans and per capita gross domestic product in Pakistan by means of a regional panel data analysis. The study's conclusions indicate that there is a considerable connection between bank loans and economic growth. This indicates that the provision of financial resources by banks contributes to the progression of the economy by easing the accumulation of savings and boosting the creation of capital. The allocation of loans to different private sectors significantly influences Pakistan's economic growth. This study aimed to analyze the levels of economic growth in Pakistan at both the sectoral and sub-sectoral levels, with a specific focus on the relationship with credit in the banking sector. The study utilized time series data spanning from 1982 to 2017 (Majeed and Iftikhar, 2021). The authors claim that the distribution of loans among various private sectors significantly affects overall economic growth. Additionally, proponents contend that the banking sector is vital in promoting economic development in developing nations like Pakistan.

Literature in growth theory posits that human capital—the labour force's knowledge, skills, and education—drives economic growth. Human capital boosts growth more than physical capital. Mankiw et al. (1992) used cross-country analysis to evaluate how human capital affects economic growth. According to the study conducted by Bils and Klenow (2000), there is a positive correlation between the level of school enrolment in a country and growth in its per capita GDP. Abbas (2001) also confirms that human capital affects economic development. According to Mujahid et al. (2014), Pakistan's economic growth depends on education enrolment, health, and physical capital. Awan et al. (2021) emphasize the significance of the accumulation of human capital and its influence on the living standards of nations. This study integrates macroeconomic research with microeconomic research to include all secondary benefits of economic growth, such as physical capital investment and technology adoption. The socio-political drive to improve education in emerging nations prompted this study. The educational system rarely meets economic needs. The research revealed that there is a significant relationship between human capital and economic growth.

Contemporary literature on economic growth suggests that trade openness boosts the economy. Trade and economic growth have been extensively studied in the empirical literature. Dollar and Kraay (2004) discovered that globalization and trade had positively influenced economic growth and reduced poverty. Sachs et al. (1995) examine globalization and economic growth. The study investigates how trade liberalization, economic development, and instances of economic crisis are related to one another. The relevance of trade liberalization in the overall process of globalization was highlighted by the research findings.

Ali and Rafiq (2019) explore how trade liberalization affected Pakistan's economy. The researchers utilized the trade-to-GDP ratio as a proxy variable to ascertain the level of trade openness in the economy. The study found that trade liberalization between 1972 and 2016 did not affect Pakistan's economic growth. Authors opined that liberalization, export promotion, and diversification policies only benefit economies with a trade advantage and high competitiveness. In an empirical study, economic growth and trade openness in Lesotho were examined by Malefane and Odhiambo (2019). They concluded that the economy

grew with trade openness, and it led to a reduction in poverty. Nonetheless, several empirical studies examining the relationship between trade openness and economic growth have come up with mixed results, especially in the context of emerging economies with unstable development patterns. Notably, [Burger et al. (2009), Santos et al. (2006), and Majumder et al. (2020)] have made contributions to this collection of literature.

In summary, the theoretical aspects of our study focus on physical capital, the employed labor force, and human capital, which are concepts drawn from established models like Solow growth (1956) and the Augmented Solow growth models (1992). However, empirical review has revealed that factors such as bank credit, exports, and imports are also crucial variables influencing long-term economic growth. The literature suggests that economic growth can be achieved by investment in physical capital, improving labour productivity, ensuring efficient credit allocation, enhancing the skills and education level, and promoting international trade. In this regard, a summary of the literature review is presented in table 1.

Table 1

Summary of literature review in the context of economic growth in Pakistan

S#	Author	Year	Sample Period	Dependent Variable	Independent Variables	Method	Research Findings
1	Iqbal and Zahid	1998	1960-1997	Real GDP per capita	Human capital, physical capital, budget deficit, exports, imports, and external debt	OLS	Human capital, physical capital, and trade openness had a statistically significant positive effect on growth, whereas budget deficit and external debt had a negative effect on growth.
2	Abbas and Nasir	2001	1970-1994	GDP	Employment, physical capital, and human capital accumulation are measured by primary school enrolment rates and secondary enrolment rates.	OLS	Primary schooling had a negative effect on growth. However, secondary school enrollment had a positive impact on economic growth in Pakistan. In the case of Sri Lanka, there was no significant improvement by using a human capital proxy.
3	Abbas and Foreman-Peck	2008	1960-2003	Per capita GDP	Human capital is measured by secondary education level and health expenditure.	VECM	The study indicated a critical role for human capital in boosting the economy's capacity to absorb technical progress. Much higher returns, including spillovers, to secondary schooling in Pakistan than in OECD economies is consistent with very substantial under-investment in education in Pakistan. Similarly, extremely large returns to health spending compare very favourably with industrial investment.

S#	Author	Year	Sample Period	Dependent Variable	Independent Variables	Method	Research Findings
4	Shahbaz et al.	2008	1991-2007	GDP per Capita	Credit to the private sector, FDI, foreign remittances, trade openness, and inflation	ARDL	Credit to the private sector, remittances, and FDI had a positive and significant impact on economic growth. However, trade openness had a negative impact.
5	Asghar and Rehman	2012	1974-2009	Log of per capita income	Education index and health index	VECM	The study found a significant positive impact of human capital on economic growth by confirming the direct positive relationship between economic growth and measures of human capital. The existence of a stable long-run relationship between economic growth and both measures of human capital was confirmed through the Johansen Cointegration test.
6	Mujahid et al.	2014	1990-2000	Physical capital	Human capital (primary, secondary, and tertiary enrolment rates)	OLS	Tertiary enrolment had a positive and significant impact on economic growth.
7	Munir and Arshad	2018	1973-2014	GDP per worker	Real physical capital per worker and human capital	ARDL	The results suggested that there is a long-run relationship between factor accumulation and GDP per worker in Pakistan.
8	Ali and Rafique	2019	1972-2016	Log GDP	Exports, trade openness, exchange rate, and terms of trade	ARDL	Exports had a positive and significant impact, while trade openness did not have a significant impact. However, the exchange rate had a negative impact on economic growth.
9	Javid	2019	1972 - 2015	Real GDP per capita	Public versus private investment and infrastructure investment in sub-sectors such as power, roads, and Telecommunication sectors.	VECM, FOLS	Investment in infrastructure at aggregate and at all sector levels was positively significant for economic growth. The public infrastructure coefficient was higher than the agriculture and service sectors. However, private infrastructure had an impact on the agriculture and industrial sectors.

S#	Author	Year	Sample Period	Dependent Variable	Independent Variables	Method	Research Findings
10	Majeed and Atiq	2019	1982 - 2017	Log of real GDP	Bank credit	ARDL	Results confirmed that enterprise credit had a positive and significant impact on Pakistan's economic growth.
11	Irshad et al.	2022	1972-2021	GDP	FDI, trade balance, exchange rate	OLS Granger Causality	FDI and the exchange rate had a positive and significant impact, but the balance of trade had an insignificant impact on economic growth.

Methodology

Economic data with annual frequency from the period of 1972-2021 were obtained from World Development Indicators 2022 and statistical appendix of Economic Survey of Pakistan 2022. Table 2 lists the variables and their units of measurement.

Table 2

Variables and their measurement

Variables	Description	Unit of Measurement	Measurement of variables
LogRGDPt	Real GDP	PKR	Log of real GDP
$LogK_t$	Physical capital	PKR	$K_t = (1-\delta)K_{t-1} + GCF_t$
EF_t	Employed labour force	%	% of the total labour force
$LogENPS_t$	Proxy for human capital	Number	Log of primary school enrolments
$LogBnkCr_t$	Bank credit	PKR	Log of bank credit
$LogX_t$	Exports	PKR	Log of exports
$LogM_t$	Imports	PKR	Log of imports

Results and Data Analysis

Descriptive Statistics

Table 3 gives the descriptive statistics of the variables used in the study. It illustrates the mean, median, standard deviation, skewness and kurtosis values of the variables.

Table 3

Descriptive statistical analysis

Statistics	LogRGDPt	$LogX_t$	$LogM_t$	$LogK_t$	$LogBnkCr_t$	EF_t	$LogENPS_t$
Mean	15.35	8.80	9.31	14.50	13.04	29.72	9.36
Median	15.43	9.02	9.23	14.62	13.20	29.73	9.52
Maximum	16.38	10.13	11.09	17.65	16.32	42.54	10.11
Minimum	14.09	6.46	6.50	10.93	9.43	25.98	8.40
Std. Dev.	0.69	1.08	1.17	2.02	1.97	2.99	0.54
Skewness	-0.23	-0.50	-0.32	-0.14	-0.18	2.73	-0.37
Kurtosis	1.85	2.11	2.52	1.84	1.86	12.75	1.71
Jarque-Bera	3.18	3.77	1.32	3.00	2.98	259.95	4.62
Probability	0.20	0.15	0.52	0.22	0.23	0.00	0.10
Observations	50	50	50	50	50	50	50

Unit Root Test

When analysing time series data, unit root tests play an important role because the results of these tests can have a significant impact on the validity of the analysis as well as the interpretation of the results.

The next step in the data analysis process after the descriptive analysis was to look at the variables' order of integration to make sure that the data series under examination did not break the assumption of the ARDL model. Stationarity and order of integration across all variables were examined using ADF (Augmented Dickey-Fuller). The said unit root test was employed on data first at the level and then at the first difference. Using the Phillips-Perron (PP) unit root test, the stationarity was further examined. The outcomes of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, which were conducted to investigate the presence of stationarity, are presented in Table 4. With the exception of the employed labour force (EF) and LogM (imports), all variables exhibit stationarity in level form I(0).

Table 4

Results of ADF and PP unit root tests

Variables	At Level I(0)		At 1st Difference I(1)		Order of Integration
	ADF	PP	ADF	PP	
LogRGDP	-0.501	-0.501	-5.488***	-5.453***	1(1)
LogK	-1.977	0.072	-5.397***	-5.432***	1(1)
LogENPS	-1.145	-3.098	-6.528***	-7.506***	1(1)
EF	-6.437***	-6.716***	-	-	1(0)
LogX	-1.501	-1.5668	-6.200***	-6.185	1(1)
LogM	-3.532**	-3.5151**	-	-	1(0)
LogBnkCr	-2.620	-2.364***	-4.3799	-4.383***	1(1)

Note: The values with asterisks indicate the significance of the stationarity test. It implies that the unit root null hypothesis is rejected. The levels of significance at 10%, 5%, and 1% are represented by *, **, and ***, respectively.

Table 5

Results of zivot-Andrews unit root tests with structural breaks

Variables	With Intercept			With Trend		
	t	Break Point	Lag	t	Break Point	Lag
LogRGDP	-2.25***	1985	1	-3.321	1992	1
LogK	-2.632	2013	2	-3.699***	2009	2
LogENPS	-3.33***	1988	0	-3.19**	1998	0
EF	-2.98	2014	2	-3.39	1993	2
LogX	-2.62**	2012	0	-3.19***	2012	0
LogM	-5.51***	2005	1	-4.40	2002	1
LogBnkCr	-3.84**	2010	1	-3.07	1985	1

Note: The values with asterisks indicate the significance of the stationarity test. It implies that the null hypothesis, i.e., series, has a unit root with a structural break and is rejected. The levels of significance at 10%, 5%, and 1% are represented by *, **, and ***, respectively.

The purpose of Zivot-Andrews Unit Root Tests with structural breaks is to identify whether a time series variable exhibits a unit root while considering the possibility of structural breaks in the data. A unit root suggests that a variable has a stochastic trend and is non-stationary over time. The Zivot-Andrews test extends traditional unit root tests by allowing for structural breaks, which are points in time where there is a significant change in the mean level of the series. The table 5 presents regression results for various variables, comparing models with and without intercepts and trends. For LogRGDP, the coefficient is -2.25 with a significant break point in 1985, indicating a structural change, and a lag of 1. The possible reason could be the general election of 1985. LogK has a coefficient of -2.632 in the model with an intercept, a break point in 2013, and a lag of 2, while the model with a trend has a coefficient of -3.699 in 2009 and the same lag. In 2013, general elections were held in Pakistan and that could be the reason of break in series. LogENPS shows a significant coefficient of -3.33 in the intercept model with a break point in 1988 and no lag, while the trend model has a -3.19 coefficient in 1998 with no lag. It could be related with Pakistan nationalized private education, aiming for universal free education, yet despite policy initiatives, such as teacher training and curriculum revisions, full implementation faced challenges, and the 1980s policy aimed at compulsory primary education (Roof, 2015). EF has a coefficient of -2.98 in the intercept

model with a break point in 2014 and a lag of 2, while the trend model has a -3.39 coefficient in 1993 with the same lag. In 2014, Pakistan's 'War on Terror' and displacement events prompted significant labor force mobilization, particularly towards industrial hubs like Karachi, amid economic losses and security challenges. LogX exhibits a -2.62 coefficient in the intercept model with a break point in 2012 and no lag, and a -3.19 coefficient in the trend model with no lag. Power outages have hurt the textile industry. From July to March 2012-13, earnings from synthetic textile fabrics and woolen exports dropped by 25.3% and 5.1% respectively compared to the previous year, with quantities also decreasing by 30.0% and 15.8%. These statistics could be associated with structural break in export series. LogM has a significant -5.51 coefficient in the intercept model with a break point in 2005 and a lag of 1, this break is possibly due to the In FY2005, imports surged by 38.1% due to robust economic growth, robust domestic demand, and elevated oil prices, as stated in the Asian Development Report. Whereas the trend model has a -4.40 coefficient in 2002 with the same lag and According to the economic survey, disruptions in shipping, higher freight charges, and reduced international prices led to a nearly 7% decline in Pakistan's imports, improving the trade balance by 34% in the first ten months of the current fiscal year could be the possible reason for structural break in series. Lastly, LogBnkCr has a -3.84 coefficient in the intercept model with a break point in 2010 and a lag of 1, this break may be due to the robust growth, driven by increased seasonal demand for working capital, was observed since January 2010, with over half of private sector credit directed towards the textile sector, primarily influenced by higher input prices, particularly for cotton. The sugar and textile industries were the major contributors to this credit surge, obtaining Rs 105.6 billion and Rs 62 billion, respectively, during Jul-March 2011 (Pakistan Economic Survey, 2010).

ARDL Model Specification

For inferential analysis, the ARDL (Autoregressive Distributed Lag) model is applied by the study, as the data met the assumption of mixed order of integration, and no variable has a second order of integration. Further, this test provides efficient results even for small sample sizes. As the data of this study have a mixed order of integration, the ARDL model can be employed. Model in ARDL form is specified as:

$$\begin{aligned} \boldsymbol{Log\ RGDP_t} = {} & \boldsymbol{\beta_0} + \sum_{i=1}^{n} \boldsymbol{\beta_i \Delta LogRGDP_{t-i}} + \sum_{i=1}^{n} \boldsymbol{\delta_i \Delta LogK_{t-i}} + \sum_{i=1}^{n} \boldsymbol{\gamma_i \Delta EF_{t-i}} + \sum_{i=1}^{n} \boldsymbol{\vartheta_i \Delta LogENPS_{t-i}} + \sum_{i=1}^{n} \boldsymbol{\theta_i \Delta LogBnkCr_{t-i}} \\ & + \sum_{i=1}^{n} \boldsymbol{\rho_i \Delta LogX_{t-i}} + \sum_{i=1}^{n} \boldsymbol{\sigma_i \Delta LogM_{t-i}} + \boldsymbol{\varphi_1 LogRGDP_{t-1}} + \boldsymbol{\varphi_2 LogK_{t-1}} + \boldsymbol{\varphi_3 EF_{t-1}} + \boldsymbol{\varphi_4 LogENPS_{t-1}} \\ & + \boldsymbol{\varphi_5 LogBnkCr_{t-1}} + \boldsymbol{\varphi_6 LogX_{t-1}} + \boldsymbol{\varphi_7 LogM_{t-1}} + \boldsymbol{\varepsilon_t} \end{aligned}$$

The coefficients β_i, δ_i, γ_i, ϑ_i, θ_i, ρ_i, and σ_i represent the short-run effects of the respective lagged differences of Log(RGDP), Log(K), EF, log(ENPS), Log(BnkCr), Log(X), and Log(M) on Log(RGDP) at the current time (t) and the coefficients φ_1 to φ_7 represent the long-run effects of the lagged levels of LogRGDP, LogK, EF, LogENPS, LogBnkCr, LogX, and LogM on LogRGDP at the current time (t).

The short-run effects capture the immediate impact of changes in the explanatory variables on the dependent variable, while the long-run effects capture the equilibrium relationship between the variables after they have adjusted over time.

Bounds Test for Co-Integration Analysis

The unit root test is used to determine whether the variables are stationary before moving on to the bounds test for co-integration. This step's objective is to demonstrate the long-term relationships between the variables being studied. When two or more non-stationary time series show a consistent long-run equilibrium link, co-integration takes place. It implies that there is a stationary linear combination of these variables which is stationary, even though the individual variables have unit roots and appear non-stationary. If the variables have a co-integrating relationship, they may move together over time.

The ARDL bounds test was employed to examine the presence of co-integration. The test proposed by Pesaran et al. (2001) has several advantages in comparison to alternative co-integration methodologies. Even variables with a mixed order of integration can be used, whereas other techniques require an I(0) order of integration. The ARDL bounds test involves creating a regression model that includes lagged

variables at levels and lagged first differences (if necessary), followed by an F-test to determine the significance of the coefficients. The presence of long-run co-integration among the variables, which means that they move together in the long run despite short-term fluctuations, can be observed if the F-test statistic becomes greater over a particular threshold. Table 6 reports the results of the bounds test of co-integration.

Table 6

Bounds test

Test Statistic	Value	Sign in.	I(0)	I(1)
F-statistic	7.3***	10%	1.99	2.94
K	6	5%	2.27	3.28
		2.50%	2.55	3.61
		1%	2.88	3.99

Note: *** indicates significance at 1%.

The critical values for the F-statistic are 2.94, 3.28, 3.61, and 3.99 at significant levels of 10%, 5%, 2.5%, and 1% respectively. The test statistic value of 7.3 is greater than those values. Accordingly, statistical evidence of co-integration is established.

Estimation of Long Run Dynamics

The confirmation of co-integration among the variables is established by applying the technique of the ARDL bounds test. Therefore, the estimation of long-run parameters is conducted. Table 7 presents the estimation results for the long-run dynamics of the variables. The results indicate that there is a statistically significant relationship between physical capital and economic growth, with a positive coefficient. Based on the coefficient value of 0.376382, it can be inferred that a marginal increase of 1% in physical capital will result in a corresponding rise of around 0.376382% in real GDP. The statistical significance of the finding is established by the fact that the p-value is less than 5%.

Primary school enrollment (using LogENPSt as a proxy for human capital) was also found to be statistically significant, and it positively influences economic growth as expected. A 1% increase in human capital will result in a 0.354445% increase in real GDP, according to the LogENPSt coefficient value of 0.354445. Additionally, because the p-value is under 5%, it is statistically significant.

Although imports have negative correlation and exports have a positive correlation with real GDP (LogXt and LogMt, respectively), their effects were deemed to be statistically insignificant. In Pakistan, a significant portion of exports consists of primary sector or low-value-added products, mainly from the textile sector. This might be a reason for the insignificant contribution of exports to economic growth. However, while having a negative association with real GDP, the employed labour force (EFt) and bank credit (LogBNKCRt) were also found to be insignificant. Right now, the government is making it hard for businesses to get loans by keeping monetary policy tight to control rising prices. This means that the small amount of money going to big companies doesn't really help the economy grow in the long run.

Table 7

Estimation of long-run dynamics

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$LogX_t$	0.10308	0.05405	1.90728	0.0652
$LogM_t$	1.03E-01	0.0635	1.62478	0.1137
$LogK_t$	0.376382	0.12829	2.93379	0.006
EF_t	-5.99E-05	0.00258	-0.0232	0.9816
$LogENPS_t$	0.354445	0.12784	2.77267	0.0091
$LogBNKCR_t$	-0.248049	0.17643	-1.4059	0.1691
C	7.941404	0.86817	9.14732	0

Estimation of Short Run Dynamics

Table 8 illustrates the short-run dynamics along with the long-run adjustment.

Table 8

Estimation of short-run dynamics with long-run adjustment

Dependent Variable: D(LOGRGDP)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
$D(LogM_t)$	0.041449	0.013708	3.02384	0.0048
$D(LogM_t\ (-1))$	-0.024134	0.013301	-1.8145	0.0787
$D(LogM_t\ (-2))$	-0.056126	0.013151	-4.2679	0.0002
$D(LogBNKCR_t)$	0.024174	0.024603	0.98257	0.333
$D(LogBNKCR_t\ (-1))$	0.07888	0.028929	2.72667	0.0102
$D(LogBNKCR_t\ (-2))$	0.106721	0.026669	4.00166	0.0003
CointEq(-1)*	-0.300684	0.035765	-8.4072	0

Short-run dynamics can be estimated using the error correction model (ECM). The rate at which variables reach equilibrium can be obtained through Error Correction Term (ECT). The negative sign of the ECT represents short-run convergence. The statistically significant negative sign of the coefficient of error correction term is a necessary condition for confirmation of reaching the equilibrium in case of any disequilibrium.

In Table 8, The Error Correction Term (ECT) coefficient is -0.300684, which is statistically significant at the 1% level. According to this coefficient, the deviation from the long-term equilibrium will be corrected by approximately 30.0684 per cent in the following year.

Robustness Tests

It is important to conduct post-estimation diagnostic tests of normality, serial correlation, heteroscedasticity, and model specification error to ensure the stability, reliability, and robustness of the model. The assessment of heteroscedasticity and autocorrelation is conducted using the Breusch-Pagan-Godfrey and Breusch-Godfrey Serial Correlation LM Tests, respectively. The Jarque-Bera test provides statistical validation for the assumption of normality. The validity of the model's structure and the reliability of its predictions were statistically confirmed through the application of the RESET test, which also provided insignificant F-statistics at a 5% level. Table 9 reports the diagnostic tests.

Table 9

Diagnostic tests

Test	F-statistic (P-values)	Null Hypothesis
Breusch-Godfrey Serial Correlation LM Test:	0.006094 (0.9383)	No serial correlation
Heteroskedasticity Test: Breusch-Pagan-Godfrey	1.649297 (0.121)	No heteroscedasticity
Ramsey RESET Test	2.829493 (0.1023)	The model is correctly specified.
Jarque-Bera	0.008542 (0.995738)	Errors are normally distributed

The Breusch-Godfrey test examines serial correlation among the successive error terms in a regression model. The high p-value (0.9383) indicates that the model does not exhibit serial correlation. Therefore, there is little residual autocorrelation. The Breusch-Pagan-Godfrey test evaluates heteroscedasticity by regressing the variance of the residuals from the original model on the regressors of the original model. A

high p-value of 0.121 indicates that the model is not influenced by the variance of the error term. The Ramsey RESET test evaluates the model specification for omitted variables and functional form misspecification. The test found a p-value greater than 0.05, i.e., 0.1023. Based on these results, the claim that the model is correctly specified cannot be rejected. Hence, the test result confirms statistically that the model is correctly specified. Thus, these post-estimation diagnostic tests confirm that there is no serial correlation, heteroscedasticity, or model misspecification problem in the estimation results of the model.

Stability Tests

The purpose of conducting the stability test is to assess the capacity of the parameters to sustain their stability within the framework of the Error Correction Model (ECM). The analysis of parameter behaviour is conducted by utilization of a stability test, as shown in Figures 1 and 2. It can be inferred that the null hypothesis is rejected when the stability test outcomes indicate that the crucial thresholds have been surpassed at a significance level of 5%. In contrast, the CUSUM and CUSUMSQ graphs depicted in Figures 1 and 2 indicate that there is no significant variation in the parameters. This observation implies that the null hypothesis, which assumes parameter stability, cannot be rejected.

Figure 1

CUSUM Plot

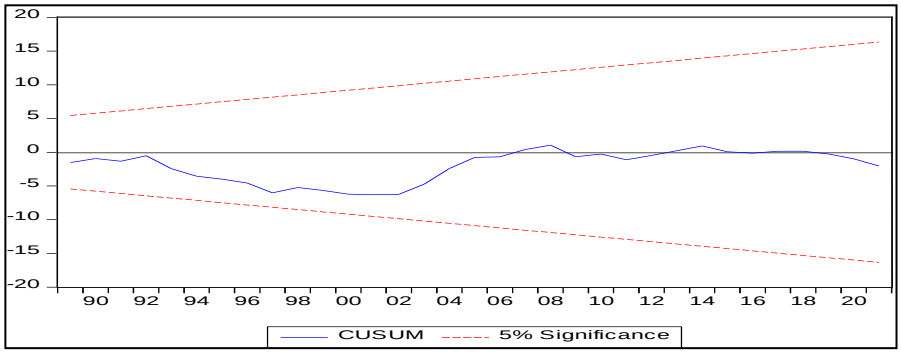
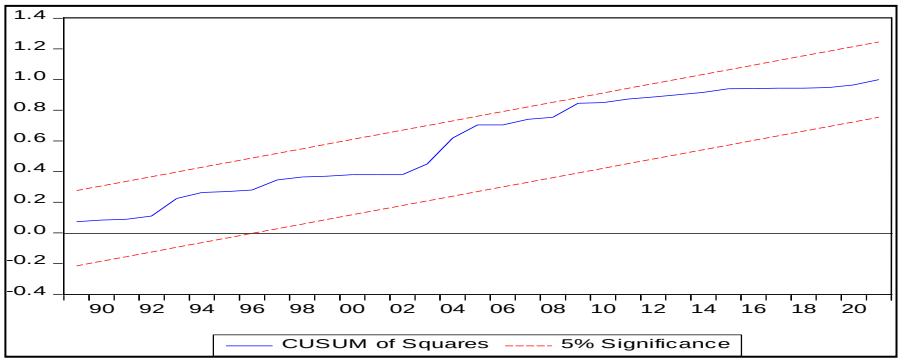


Figure 2

CUSUM of squares plot



Conclusion & Recommendations

The analysis of the ARDL model pertaining to Pakistan's economic growth offers significant insights that can be utilized by policymakers to foster sustainable and equitable development. This analysis takes into account crucial factors that influence economic growth, such as the presence of physical capital, the level of human capital, the degree of trade openness, and the availability of bank credit. The model emphasizes the favourable influence of both physical and human capital on sustained economic growth in the long run. Investments in infrastructure, education, and healthcare have the potential to augment the nation's productive capacity and enhance labour productivity.

Policy recommendations aimed at fostering economic growth in Pakistan encompass several key areas. First and foremost, it is imperative to allocate resources towards infrastructure projects, as they serve as a foundation for sustainable development. Additionally, emphasis should be placed on bolstering the

education sector, which plays a pivotal role in equipping the workforce with the necessary skills and knowledge to drive economic progress. As the study also has identified these factors as significant for economic growth.

Bank credit is of paramount importance in fostering economic growth, given that the ability to obtain credit is vital for enterprises to engage in investment activities and improve their competitiveness through scale economies. However, in this study it could not found statistically significant. Policymakers ought to enhance the efficacy and stability of the banking sector, diminish obstacles to lending, and direct credit towards sectors that generate productivity. Another vital aspect is facilitating access to credit, as this enables businesses, particularly small and medium-sized enterprises to invest, expand, and innovate. By implementing policies that promote easier access to credit, the entrepreneurial landscape can be stimulated, leading to increased economic activity and job creation.

The impact of trade openness on economic growth, as measured by export and import levels, is also observed, albeit to a lesser extent, in the short term. To optimize the advantages of trade, it is imperative for policymakers to prioritize export diversification, trade barrier reduction, and trade facilitation. Furthermore, diversifying the export basket is crucial to reduce reliance on a limited range of goods and expand market opportunities. This can be achieved by encouraging the production and export of a wider array of products, thereby enhancing competitiveness and resilience in the global market.

In conclusion, by prioritizing investments in infrastructure, education, diversifying the export basket and by promoting access to credit for the private sector, Pakistan has the potential to attain a state of sustained and inclusive economic growth.

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