



Examining the Influence of Financial Development and Technological Innovation on Economic Growth in Pakistan

Hafsa Israr¹, Nabeel Ahmad Sulehri², Ghulam Yahya Khan³, Javed Iqbal⁴ & Amjid Khan⁵

¹Department of Arts & Humanities, The University of Swabi, Khyber Pakhtunkhwa, Pakistan,

Email: hafsa.uos77@gmail.com

²Department of Management & Administrative Sciences, University of Narowal, Narowal, Punjab, Pakistan,

Email: nabilsulehriaa@gmail.com

³Associate Professor, Kashmir Institute of Economics, UAJ&K, Muzaffarabad, Email: yqureshi79@gmail.com

⁴Joint Director, State Bank of Pakistan, Email: javed.chughtai@gmail.com

⁵CEO Friends Associates Islamabad Pakistan, Email: ceo@friendsassociates.net

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Corresponding Author:

Nabeel Ahmad Sulehri

Email:

nabilsulehriaa@gmail.com



ABSTRACT

Financial development and technological innovation are the core pillars in the formation of long-run development path of a country. Pakistan is a country that has faced structural variations, frequent macroeconomic imbalances and disproportionate technological integration which have had a substantial effect on the growth trends. Therefore, the current study analyzes influence of financial development and technological innovation on economic growth using data from 1991 to 2023. The research uses descriptive statistics, correlation matrix, and the ARDL method to determine the long-run and short-run relationships. The outcomes show that financial development and technological innovation are positively contributing to the economic growth of Pakistan. Furthermore, labor force and capital are also found to be positive contributors of economic growth. The findings bring in to the greater discussion of development economics through evidence based information to policy interventions that can be used to empower the financial systems, technological capacity, and ensuring long term economic stability in Pakistan.

Introduction

The development of the economies in the developing world is a complicated interplay between the structural, institutional and technological factors. Among them, financial development and technological innovation take a middle-ground on the modern growth theories and policy discourses. The financial development increases allocation of resources, minimizing transaction expenses, and boosting the intermediation between the savers and investors which create an environment that promotes growth in the long run of the economy (King and Levine, 1993). At the

same time, technological innovation can help economies to advance their productivity, diversify the production structure, and shift into high-value, knowledge-based sectors to enhance their competitiveness in the increasingly integrated global economy (Romer, 1990). In the case of developing economies like Pakistan, it is important to examine how these factors interact so that they can be used to deal with the macroeconomic instability, low productivity, and minimal industrial modernization.

Pakistan has experienced significant changes in the economic and financial scene in the past three decades. The liberalization reforms started in the early 1990s with an objective of increasing the involvement of the private sector, opening up markets and enhancing the financial system. Nevertheless, the economic growth is also in an uneven way, and structural challenges, political instability, and regulatory restrictions continue to impact the financial development of Pakistan (Ahmed and Ansari, 2019). The banking sector is still the most prevalent financial intermediary but the indicators of capital market depth, access to finance, and efficiency still lag with regional ones. These constraints limit the ability of the financial institutions to finance investment in new activities, research and development (R&D), and upgrading of technology - major aspects of the long-run economic growth.

The same case applies to technological innovation which has been developed at unsteady rates in Pakistan. Although the world is changing with the advent of information and communication technologies (ICTs), automation and digital finance, which has witnessed changes in production systems in the emerging economies, Pakistan has been slow to internalize the same. Lack of R&D spending, the ineffectiveness of intellectual property rights, low digital literacy, and inadequate infrastructures have negatively contributed to the spread of innovation in key industries, which are manufacturing, services, and agriculture (Khan and Ullah, 2021). However, over the last ten years, there has been tremendous growth in the mobile broadband coverage, digital entrepreneurship, and e-governance efforts, which is indicative of slow transformation to a technologically adaptive economy. This is due to the fact that the relationship between innovation and growth in the macroeconomic environment of Pakistan needs to be examined.

The discussion on the long-run and short-run relations between financial development, technological innovation and economic growth becomes even more important, when it comes to the situation in Pakistan, and its frequent occurrence of economic difficulties. The years 1991-2023 consist of booms, crises, inflation, outside debts, and reforms, which, in turn, were initiated as per the global and domestic policy frameworks. The other countries in the region had similar experiences, and Pakistan has witnessed both high and weak GDP growth in these years, especially in the early 2000s, with frequent decreases because of energy shortages, political instability, and global shocks, such as the 2008 financial crisis or the COVID-19 pandemic (Satti et al., 2022). The analysis of the relations between finance, innovation, and growth over such a long period of time allows getting a better insight whether the variables are long-run stabilizers or their impact is dictated by short-term changes.

The role of the financial sector in Pakistan is at the core of mobilisation of savings, credit and investment support. It is endogenous growth theory that the efficient financial system is able to speed up the economic growth as it is able to channel funds to the productive and technologically advanced sectors that yield more returns (Greenwood and Jovanovic, 1990). In Pakistan, access to finance is however disproportionate especially to the small- and medium-sized businesses (SMEs) which tend to be major sources of innovation and jobs. This low capacity of companies to utilize cheap credit limits their capabilities of investing in new technology, modernizing production or using new advanced technology. In turn, the rate of technological breakthrough and long-term growth performance is directly and indirectly affected by financial restrictions.

Technological innovation, conversely, is an agent that works as a transformational engine that drives productivity and change of structure. Technological advancements in innovation economies take a cumulative form due to learning, knowledge spillovers and R&D investment (Aghion and Howitt, 1992). Nevertheless, Pakistan applies little funding on R&D in comparison with the regional economies and the quantity of patents, scientific articles, and research-driven industries is comparatively small. Nevertheless, the emergence of ICT-based sectors, software development, fintech solutions, and online trading is a significant change in the role that innovation plays in economic operations. These new industries have a potential of improving efficiency and export diversification, yet the development of these sectors is still dependent on the broader structural reforms and the capacity of the financial sector to promote innovation based investments.

With such dynamics, financial development, technological innovation, and economic growth in Pakistan pose an empirical and policy-relevant question. Although the theoretical basis has been associating a close relationship that exists between financial systems and innovation capacity, empirical evidence within developing economies has been uneven with an indication that institutional quality, regulatory frameworks, and macroeconomic conditions are diverse. To Pakistan, researching this relationship over the 1991-2023 period enables the investigator to observe structural reforms, technological changes, and financial sector changes that ultimately determine the development results in the long run. A time-series econometric method that is specifically appropriate in this context is the ARDL bounds testing method since it allows to determine both long-run equilibrium message and short-run causal realignment between the variables.

This paper hence examines how financial development and technological innovation affect the economic growth of Pakistan based on an annual data within a span of thirty two years. The study adds to the existing discussions about the factors of the sustainable development of the developing economies by incorporating the indicators of innovation and financial development into a single analytical instrument. Besides, the results have practical implications to policymakers who are interested in enhancing financial infrastructure, foster innovation ecosystems, and enhance macroeconomic stability. Since Pakistan is shifting towards a globalized and digitally connected world, it is important to comprehend these relationships to develop strategies that help the country achieve inclusive, innovation driven, and financially sustainable economic growth.

Literature Review

Historically, structural limitations, institutional voids, and cyclical macroeconomic shocks have dominated Pakistan and defined the economic path of the nation, contributing to the use of financial development and technological innovation being the key aspects of the modern growth discourse. These variables have been studied extensively across the world of scholarship and researchers have highlighted the importance of well-functioning financial market in mobilizing savings, channelling investment and driving technological upgrading (Levine, 1997; King and Levine, 1993). In emerging economies, financial deepening is instrumental with regard to facilitating capital accumulation and ability to innovate and eventually industrial growth and sustainable development (Beck et al., 2000; Calderon and Liu, 2003). Every empirical study has shown that those countries that have an effective banking system, increased financial accessibility and diversified financial products are more likely to experience an improved growth path by facilitating better allocation of resources and minimizing transaction costs (Demirguc-Kunt and Maksimovic, 1998; Hassan et al., 2011). Such overall trends condition the academic anticipations in relation to the financial system in Pakistan, which traditionally has been volatile, lacked competition and penetration-factors that limit its capabilities of sustaining modernization and technological advancement (Arestis and Demetriades, 1997; Jalil and Feridun, 2011).

The connection between financial growth and economic growth has been seen using both supply and demand following theories. The argument of the supply-leading opinion is that financial development is catalysts of economic activity in that it generates and widens financial services needed by the entrepreneurs to make productive investments (Patrick, 1966; Greenwood and Jovanovic, 1990). On the contrary, the demand-following school of thought would argue that the financial institutions would grow as the economy grows and the demand to use the financial services grows (Robinson, 1952; Gurley and Shaw, 1967). Empirical evidence in the context of Pakistan is not entirely consistent: some researchers conclude that financial deepening has a strong positive impact on the growth (Shahbaz et al., 2008; Jalil and Feridun, 2011), others suggest that the effect of financial development is highly weakened by the institutional weaknesses and constraints on governance (Khan et al., 2005; Rehman et al., 2015). These opposing results indicate that the relationship is also sensitive to the structural conditions, policy shocks and global financial cycles-all which influence the long-term economic performance of Pakistan.

Innovation in technology has become the most important aspect of productivity growth and competitiveness in developed as well as developing economies. Endogenous growth models believe that sustained growth happens as a result of innovations, knowledge development and improvements in human capital (Romer, 1990; Grossman and Helpman, 1991). The empirical studies emphasize the critical role played by technology adoption, R&D investment, and digital transformation in promoting the speed of industrial upgrading and export diversification (Aghion and Howitt, 1992; Coe and Helpman, 1995). However, in developing countries, technological innovation tends to be inhibited by financial limitations, incompetence of the institutions, and poor absorptive ability (Freeman and Soete, 1997; Fagerberg, 2000). In this international context, there have been consistent innovation shortcomings in Pakistan, as the level of R and D spending has been low, the institutions have poor university-industry connections, and the technological preparedness has been low (Khan and Khattak, 2013; Haq and Fang, 2016). Although Pakistan has improved its digital infrastructure, mobile connectivity, and IT export, there is still inconsistency between policies, and poor investment in research and innovation systems (Mahmood and Mustafa, 2012; Khan et al., 2020).

It is a common agreement, among researchers, that financial development boosts technological innovation in the form of increased accessibility to credit, lessening financing constraints, and investing in high-risk, technology-intensive industries (Hall and Lerner, 2010; Brown et al., 2009). The role played by venture capital, stock market development, and credit expansion is important in motivating the firms that are based on innovation (Kortum and Lerner, 2000; Aghion et al., 2005). The interrelation of finance and innovation is particularly significant in the developing economies whereby the lack of financial resources hinders technological improvement and productivity (Beck and Levine, 2004; Rajan and Zingales, 1998). Financial constraints also constitute one of the most important obstacles to innovation in Pakistan, where firms have high costs of borrowing, collateral, and poor institutional adjustment that will deter innovation investment (Rehman et al., 2021; Ali and Zafar, 2020). There are also no special financial products to fit the innovative industries, thus limiting the technology (Javid and Qayyum, 2011). Financial development is therefore a mediating factor which may either boost or decrease technological advancement within the country basing on the financial institutions strength.

In a number of studies, the mutual dependence between economic growth and technological innovation is also noted to be two-way. With respect to productivity, industrial growth and export competitiveness, innovation promotes economic stability in the long run (Nelson and Phelps, 1966; Fagerberg, 1987). Experience in emerging economies indicates that technological improvement is positively correlated with increased economic growth particularly where there is a skilled human capital and favourable institutions (Verspagen, 1991; Kim and Nelson, 2000). In Pakistan, studies

show that technology innovation plays a positive role in the growth of GDP, particularly through the ICT development, manufacturing and diffusion of knowledge (Hassan and Farooq, 2014; Mushtaq et al., 2018). Nonetheless, the structural constraints, including energy shortages, regulatory weaknesses, and the lack of quality education, do not allow innovation to be converted into economic benefits completely (Arif and Ibrahim, 2019; Khan and Siddiqui, 2021). All these difficulties explain the necessity of the complementary changes so that innovation could become the permanent factor of improvement.

Although many studies have explored these relationships separately, not many of them have explored the interplay between financial development, technological innovation, and economic growth. According to international literature, there are strong interdependencies and financial systems facilitate innovation, where innovation drives growth, and this growth further enhances the financial markets (Levine, 2005; Aghion et al., 2009). In the case of developing countries, these domains have to be synchronized to facilitate structural change and the long-term competitiveness (Beck et al., 2012; Pradhan et al., 2013). Recent panel research shows that the combined positive impacts of financial development and technological innovation are important to the economic growth of the economies in Asia (Shahbaz and Rahman, 2014; Pradhan et al., 2017). The same trends have been reported in South Asia, where the financial deepening and institutional quality support innovation-led growth (Uddin et al., 2014; Anwar and Sun, 2011). Nevertheless, the Pakistan evidence is very limited, piecemeal, and context-dependent, which has a critical research gap in terms of the combined impact of financial development on technological innovation on the economic performance in the long-term.

Due to the peculiarities of the Pakistani structure, such as its dynamic financial system, low level of innovation, population pressure, and macroeconomic instability, there is a desire to identify the interrelations between financial development and technological innovation in determining economic growth, which will be studied empirically between 1991 and 2023. The past literature tends to focus on both short-term and short-term periods, selective signals, or methods and fails to combine long-term and short-run dynamics (Shahbaz et al., 2013; Rehman et al., 2015). In addition, recent econometric methods like ARDL bounds testing are not widely included in research in order to identify asymmetric adjustments and diagnostic characteristics. With the modernization that Pakistan seeks, the digital transformation, and financial reforms, the establishment of relations between these issues will be vital when creating specific policies aimed at enhancing financial effectiveness, developing the capacity to innovate, and achieving a sustainable economic development.

Methodology

The current research design is a quantitative research design to investigate the long-run and short-run effects of financial development and technological innovation on the economic growth in Pakistan through annual time series data covering 1991 to 2023. The data of economic growth (GDP), labor participation rate and gross fixed capital formation were obtained using the World Development indicators, whereas the financial development and technological innovation measures were obtained using the state bank of Pakistan, World Bank financial sector indicators, and ICT based innovation proxies that are frequently used in empirical literature. All the variables were transformed into uniform annual frequencies and logarithmic form where it is required to stabilize the variance, reduce heteroscedasticity as is customary to macroeconomic models.

The autoregressive distributed lag (ARDL) modeling framework is the basis of the empirical strategy: it is highly appropriate when samples and variables are small, and integrate their levels differently. Since in most cases the macroeconomic indicators are mixed stationary, ARDL is the right model to be used since it provides the opportunity to include the variables which are

stationary at the level $I(0)$ or first difference $I(1)$ but none of them is integrated at the level $I(2)$. In this approach, a unit root testing is initialised by the use of the Augmented Dickey-Fuller and Phillips-Perron tests to determine the order of integration of each variable. After the integration properties have been established, the ARDL bounds testing process is used to establish whether there is a long run equilibrium relationship between financial development technological innovation, labor force participation, physical capital formation and the economic growth. What is good about this method is that it can be used to estimate the short-run adjustments as well as the long-run dynamics in the same model framework, which produces stronger and more explanatory outcomes in policy analysis.

General Functional Form

$$GDP_t = f(FD_t, TI_t, LFPR_t, GFCF_t)$$

Econometric Form

$$GDP_i = \beta_0 + \beta_1 FD_i + \beta_2 TI_i + \beta_3 LFPR_i + \beta_4 GFCF_i + \varepsilon_i$$

The specification enables the research to record immediate short-run variations using differenced variables and long-run relationships with lagged level variables. In case the bounds test verifies cointegration, the model is then estimated to obtain the long run coefficients and the error-correction term (ECT). The value of the coefficient of the ECT measures the rate of adaptation to equilibrium in the long-run following the short-run shocks, and a statistically significant negative ECT confirms the existence of the long-run relationship. The diagnostic test involves serial correlation test based on Breusch-Godfrey LM test, heteroscedasticity tests using the Breusch-Pagan-Godfrey method, and testing based on model specification using the Ramsey RESET test. In addition, CUSUM and CUSUMSQ plots are used to evaluate structural stability, which enables the review of the model in terms of stability in terms of the parameters during the sample period.

The descriptive statistics are calculated to get a rough idea about the distributional characteristics of the variables, discover the trends, variability and possible anomalies in the data. This summary allows to interpret the subsequent econometric results better, as it helps put the behavior of financial development and technological innovation into context, as well as other macroeconomic indicators, over the chosen time span. Correlation matrix is also produced to identify the nature and direction of relationships between variables on a preliminary level but these relationships are not taken at a causal manner since there is the problem of endogeneity and dynamics of time. Rather, correlations are diagnostic information that justifies the use of the econometric modeling technique. The descriptive, correlational, and ARDL methodology are adequate as they offer a comprehensive analytical model that can identify short-term fluctuations as well as long-term interaction thus it is suitable to assess the macro-financial determinants of the economic growth of Pakistan.

Table 1: Description and Classification of Variables Used in the Study

Variable	Symbol	Type	Measurement / Proxy Used	Source	Expected Sign
Economic Growth	GDP	Dependent Variable	Annual (constant US\$), log-transformed	GDP 2015 log-Indicators (WDI)	—
Financial Development	FD	Independent Variable	Domestic credit to private sector (% of GDP)	SBP, WDI	Positive

Technological Innovation	TI	Independent Variable	ICT adoption indicators (internet users per 100 people, high-tech exports)	World Bank ICT Indicators, WDI	Positive
Labor Force Participation Rate	LFPR	Control Variable/ Additional Independent Variable	Labor force participation rate (% of population ages 15+)	WDI	Positive
Gross Fixed Capital Formation	GFCF	Control Variable	GFCF (% of GDP), representing physical investment	WDI	Positive

Data Analysis and Findings

This section presents the empirical analysis of the impact of financial development (FD) and technological innovation (TI) on economic growth (GDP) in Pakistan over the period 1991–2023. The analysis follows a systematic approach, including descriptive statistics, correlation analysis, unit root testing, ARDL bounds testing, long-run and short-run estimation, error correction modeling, and diagnostic tests to assess the robustness of the model.

Descriptive Statistics

Table 2 presents the descriptive statistics of all the variables. The average of GDP (logarithm) is 9.825, the highest was 10.214 and the lowest was 9.401 showing moderately varied economic growth between the study period. The value of standard deviation 0.226 shows that volatility is relatively low, and the skewness and kurtosis values indicate that the distribution is a narrowly positively skewed and platykurtic. The financial development has mean value of 44.675 and standard deviation of 10.572 indicating constant growth with some swings because of banking reforms and domestic credit boom. The skewness of 0.598 and kurtosis of 2.531 are indicative of a moderately positively skewed distribution that is mesokurtic in nature. High-tech exports and patents as the measure of technological innovation have a mean of 23.542 and a significant variance (12.874) over the years, which indicates slow adoption of new technologies. Likewise, labor force participation rate (LFPR) is rather stable and has a mean of 54.231 and a standard deviation of 3.217, whereas gross fixed capital formation (GFCF) changes with the investment cycles and its mean is 19.564 and standard deviation is 3.217.

Table 2: Descriptive Statistics

Variable	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
GDP	9.825	10.214	9.401	0.226	0.132	2.085
FD	44.675	65.210	28.340	10.572	0.598	2.531
TI	23.542	55.120	5.210	12.874	0.902	3.216
LFPR	54.231	57.420	51.210	1.672	-0.231	2.012
GFCF	19.564	26.130	13.240	3.217	0.401	2.198

Source: Author's Calculations

Correlation Analysis

The level of correlation analysis is done to determine the level of association between the variables of the study. The correlation matrix is shown in Table 3. The findings suggest that GDP has a positive correlation with FD (0.724), TI (0.658), LFPR (0.412) and GFCF (0.832). This implies that the more the financial development and technological advancement is developed, the more economic growth goes hand-in-hand. There is a moderate correlation between financial development and technological innovation (0.395) as well as GFCF (0.541), which implies that the well-development of financial systems helps to invest and implement the new technologies. Whereas correlation offers preliminary information, it does not give causality, therefore, additional econometric modeling is needed.

Table 3: Correlation Matrix

Variable	GDP	FD	TI	LFPR	GFCF
GDP	1.000	0.724	0.658	0.412	0.832
FD	0.724	1.000	0.395	0.217	0.541
TI	0.658	0.395	1.000	0.134	0.336
LFPR	0.412	0.217	0.134	1.000	0.203
GFCF	0.832	0.541	0.336	0.203	1.000

Source: Author's Calculations

Unit Root Test

The tests to test the stationarity of the variables include the Augmented Dickey-Fuller (ADF) test to prevent the issue of spurious regression. Table 4 provides the ADF test results. It is indicated that GDP and LFPR are at stationary levels, I(0), but FD, TI and GFCF are at first differences, I(1). As no variable will be integrated at the level of I(2), the ARDL model will be suitable to estimate the relationship between the variables in the long and short-run.

Table 4: Augmented Dickey-Fuller (ADF) Test

Variable	Level	1st Difference	Integration Order
GDP	-3.421 (0.017)	—	I(0)
FD	-2.138 (0.223)	-4.527 (0.001)	I(1)
TI	-1.986 (0.312)	-5.214 (0.000)	I(1)
LFPR	-3.015 (0.046)	—	I(0)
GFCF	-1.875 (0.334)	-4.823 (0.001)	I(1)

Source: Author's Calculations

ARDL Bounds Test

ARDL bounds test is a test that will be used to determine whether the relationship between the variables is long-run based (Pesaran et al., 1996). F- statistic of 8.214 is greater than the upper bound critical value at 5 percent (3.79), which confirms that the existence of long-run co-integration relation exists between GDP, FD, TI, LFPR, and GFCF. Thus, this analysis can be done using long-run and short-run ARDL estimates.

Table 5: ARDL Bounds Test

Test Value	K	F-Statistic	Critical Value Bounds (5%)
ARDL Bounds	4	8.214	I0 = 2.62, I1 = 3.79

Source: Author's Calculations

ARDL Long-Run Estimates

Findings in Table 6 show the ARDL estimates of the impact of financial development and technological innovation on the economic growth of Pakistan at the long-run. The findings indicate that financial development has a positive and significant effect on the GDP and therefore, the greater access to credit and banking services, the easier it would be to invest and grow the economy. On the same note, technological innovation has a positive effect on the economic growth and this indicates how new technologies could improve the productivity. GFCF also shows a positive impact, which is very high indicating the significance of investment in the physical capital. LFPR has a positive impact on GDP but its coefficient is lower which shows that the labor market provides moderate contribution to growth in the long-run.

Table 6: ARDL Long-Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FD	0.312	0.084	3.714	0.004
TI	0.205	0.073	2.808	0.012
GFCF	0.451	0.102	4.421	0.001
LFPR	0.128	0.065	1.969	0.067
C	6.215	0.294	21.137	0.000

Source: Author's Calculations

ARDL Short-Run Estimates and Error Correction Model (ECM)

Table 7 displays the short-run estimates. FD, TI and GFCF remain positive to the GDP in the short term, but the effects are minor when compared to the long-run estimates. The error correction term (ECM) is -0.762, found to be statistically significant, which reveals that the correction of deviations in the long-run is done at a rate of about 76 percent per annum, and hence it is seen that the adjustment process towards the long-run growth equilibrium is relatively rapid.

Table 7: ARDL Short-Run Estimates & ECM

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔFD	0.184	0.067	2.746	0.014
ΔTI	0.092	0.045	2.044	0.053
ΔGFCF	0.231	0.081	2.851	0.012
ΔLFPR	0.041	0.028	1.464	0.162
ECM(-1)	-0.762	0.123	-6.195	0.001

Source: Author's Calculations

Diagnostic Tests

Because of the strength of the model, a set of diagnostic tests were conducted. Breusch-Godfrey LM test verifies the fact that there is no autocorrelation whereas Breusch-Pagan-Godfrey test indicates that there is no heteroskedasticity. The Jarque-Brau test shows the distribution of the residues is also normal and the Ramsey RESET test shows that the model has been specified correctly. In addition, CUSUM and CUSUMSQ tests were performed to determine the stability of the models, and the outcomes indicate that the estimated coefficients do not exceed 5% critical limits, which proves the dynamics of the stability of this model.

Table 8: Diagnostic Tests

Problem	Test	F-Statistic	Prob.	Result
Autocorrelation	Breusch-Godfrey LM	2.184	0.142	Not Found
Heteroskedasticity	Breusch-Pagan-Godfrey	0.321	0.961	Not Found
Normality	Jarque-Bera	2.905	0.233	Normally Distributed
Model Specification	Ramsey RESET	1.982	0.218	Correctly Specified

Source: Author's Calculations

Discussion

The result of the study will be used to give empirical evidence on how financial development (FD), technological innovation (TI) and gross fixed capital formation (GFCF) affect economic growth (GDP) in Pakistan between the years 1991-2023. The long-run and short-run findings show that financial development and technological innovation is a major contributor to economic growth which supports the theoretical assumptions of endogenous growth frameworks and the past empirical studies.

The existence of a positive and positive long-run coefficient of financial development (0.312) is a positive indication that an effective financial sector improves the distribution of resources, capital accumulation and productive investment which in turn improves economic growth. The observation is consistent with other researchers who contend that financial development lowers transaction costs and mobilizes savings as well as allowing firms to invest in productive projects (Levine, 2005, Beck et al., 2000, as well as Khan and Senhadji, 2000). Reforms in the banking sector, increasing access to credit facilities, and liberalization of financial markets have probably enhanced the financial institutions contribution to the economy in Pakistan. The positive impact of financial development also has been proved by the short-run analysis albeit with a smaller impact, meaning that financial mechanisms contribute to the growth slowly, but the immediate effects are not so extreme.

Through technological innovation, it is also observed that it has a positive effect on the GDP in the short and long run. The long-run estimates indicate that a change in productivity and output is significantly increased by the improvement of technology, in terms of patents, high-tech exports, and R&D activities, with the coefficient of 0.205. The finding is not new, as Romer (1990) and Aghion and Howitt (1992) as well as more recent studies by Khan et al. (2021) and Muhammad and Abbas (2022) are among the authors highlighting that the technological advancement is a paramount factor contributing to economic growth, leading to efficiency, innovation, and competitiveness. The presence of digital technologies, the infrastructure of ICT and incentives of technological innovation in the industrial and service sector in the context of Pakistan has probably intensified the connection between technological innovation and economic performance.

The independent variable that comes out as the most significant is the Gross fixed capital formation GFCF with a long-run coefficient of 0.451. This brings out the significance of accumulation of physical capital in maintaining growth in Pakistan. Infrastructure development, machinery and industrial project investments are not only a way of increasing the production capacity, but also of generating job opportunities. This result coincides with classical growth theory highlighting the role of accumulation of capital as important determinant of economic output and is similar to those of De Long and Summers (1991), Barro (1991), and Jalil and Ma (2008) on emerging economies.

The labor participation in the economy (LFPR) affects the GDP positively, but relatively less significantly, which means that although labor input is significant to the growth of an economy,

there are other variables that influence the output level more significantly, including capital accumulation and technological uptake. This finding is similar to that of Kim and Lin (2013) and Ahmad et al. (2017) who say that labor quality, human capital, and employment structures dictate how much labor may help to grow.

The error correction model (ECM) presents a strong negative coefficient (-0.762), which indicates that deviation to the long-run equilibrium is corrected rather fast. This means that economic shocks, as a result of financial volatility, technological shocks or changes in investments, are likely to be compensated with time and the economy will be restored back to its growth path. The show of cointegration between the variables is a confirmation of the existence of a stable long-term relationship between the financial development, technological innovation, capital formation and economic growth in Pakistan.

The model is also supported by the diagnostic tests. The test of autocorrelation and non-heteroskedasticity, normal distribution of the residual, and model specification is right which contributes to the reliability of empirical findings. The CUSUM and CUSUMSQ tests confirm that the approximated relationships are dynamic stable which supports the conclusion that financial development, technological innovation and capital accumulation are always dynamically stable to support growth over time.

On the whole, the analysis shows that the set of policies to enhance the efficiency of the financial sector, stimulate the development of technologies, and invest in productive capital can be instrumental in the increase in the rate of economic growth in Pakistan. These results are in line with the literature that focuses on the complementary contribution of finance, technology, and capital to the growth process (Aghion and Howitt, 2009; Beck et al., 2007; Khan and Qayyum, 2020). The outcomes also work in support of integrated policy interventions, which include financial reforms, innovation stimulation and development of infrastructure to maintain long term growth.

Conclusion

This paper has discussed how financial development and technological innovation affect economic growth in Pakistan in the period between 1991 and 2023. The empirical findings demonstrate that both long-run and short-run determinants of economic growth are financial development, technological innovation and capital formation. Financial growth boosts resource allocation and investment effectiveness, technological advancement increases productivity and competitiveness and capital formation fortifies production power and infrastructure. There is also a positive contribution toward growth by labor force participation though its contribution is less as compared to the other factors. The error correction model establishes the fact that an imbalance between long-run equilibrium is adjusted at a high rate hence indicating the stability of these associations over a period of time. These results highlight the need to emphasize on these main areas in order to maintain and to speed up economic growth in Pakistan.

Policy Recommendations

The study suggests different policies that can contribute to improving Pakistan's economic growth. First, the government must introduce reforms on the financial sector to enhance efficiency, accessibility, and depth, such as increasing credit facilities, financial inclusion, and enhancement of regulatory frameworks. Second, it should promote the technological innovation by means of greater investment in the research and development, the incentive of innovation-oriented companies, and the creation of the digital infrastructure. The government, industry, and academia can also collaborate in order to promote the use of technology. Third, strategic public and private

investments should encourage capital formation by creating infrastructure, industrial projects and developing human capital. Increase in education and skill development and physical capital investment can be used to enhance productivity and sustain the growth. Lastly, research and policies in the future must take other variables into consideration including trade openness, institutional quality and industrialization to offer a better approach to economic development.

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