

Impact of Trade Openness and Human Capital on Economic Growth: A Time Series Analysis for Pakistan

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Abstract

The objective of this study is to investigate the impact of trade openness and human capital on economic growth in Pakistan, utilizing time series data from 1982 to 2025. Initially, the unit root test was conducted, indicating that all variables are I(1). Then Johanson's co-integration method was applied for estimation. The empirical results reveal that human capital is found to be positive and statistically significant at a 1% level. The coefficient on trade openness is also positive and statistically significant at 5% level. The error correction model (ECM) illustrates a negative and significant error correction term, indicating 25% convergence per period. The conclusion drawn from this study is that both trade openness and human capital play a pivotal role in the economic growth of the country. The interaction between trade openness and human capital helps in creating a research-intensive specialization culture and accelerates economic growth in Pakistan.

Keywords: Trade openness, Human Capital, Economic development, Johanson's Co-integration

1. Introduction

Trade openness and human capital are two pivotal factors that play a vital role in a country's economic development (Barro & Sala-i-Martin, 1990). These factors are not only limited to the definition of trade but also encompass the transfer of ideas, technologies, and knowledge, which play a crucial role in the development of a country (Krugman, 1995). In the present globalized economic revolution, where countries are becoming increasingly open, trade liberalization plays a crucial role in a country's economic fate (Rodrik, 1999). This is particularly true for developing countries such as Pakistan, where becoming a part of the global trade system and using human capital is the only way to unlock sustainable growth (World Bank, 2006). In Pakistan, these two factors are of utmost significance in light of the geographical position, size, and requirement for economic development of the economy (Asian Development Bank, 2021).

Due to trade liberalization, countries can take advantage of specializing in the production of goods and services. The production process becomes more efficient, and the countries get a comparative advantage, which is beneficial for trade. This specialization and trade lead to the production of quality goods at reasonably lower costs. Therefore, the production process is more efficient and diverse, which provides better and cheaper options to a consumer. The trade barriers are removed, and the economies get access to the huge global markets. The competitive atmosphere encourages companies to work on innovations in search of new ways

of production and better services. The recent developments in the field of medicine and digital technology have occurred because of the open markets and improved trade opportunities.

The endogenous growth theory presented by Paul Romer (1986) offers a strong explanation for the crucial role of human capital in economic growth. Human capital is the skilled and trained workforce, which is very advantageous to an economy. Romer states that improved human capital leads to technological progress and innovation that can ensure a fair growth rate of the economy. The workforce with improved skills and knowledge can ensure increasing returns to scale in the long run. Human capital is referred to as the technical know-how and knowledge of the country's workforce, which acts as an engine of economic growth. The development of human capital is essential for the full exploitation of trade openness. Human capital can significantly enhance the productivity of the economy, making it more competitive in the international market. Education and training institutions play a crucial role in the development of human capital, as they provide the skills and knowledge that the workforce requires.

Human capital plays a significant role in economic development along with openness. Building a competent and trained workforce, focusing on research and development, and encouraging a culture of specialization is a highly significant task. Human capital is inescapably linked with economic development due to the productivity gains that arise from investments in education and skills. Investment in the education and training of the workforce is an investment in human capital, just as investment in equipment. Many studies have underlined the significance of education and health of the workforce in economic development; Mankiw et al., 1992; Benhabib et al. 1996; Barro, 1991; Bhargava et al., 2001). The association between trade openness and human capital is a complex and complementary one (Barro & Sala-i-Martin, 1997). Trade openness can result in economic development due to the gains in human capital that arise from the acquisition of new knowledge and technology (Krugman, 1985; Romer, 1990). In Pakistan, this complementary relationship offers opportunities that result in innovation and economic development. The study aims to investigate the role of trade openness and human capital in economic growth in Pakistan by using Johansen Co-integration Test during 1982-2025.

2. Literature Review

An empirical study conducted by Alesina et al. (2000) exhibited that trade openness and human capital have a positive and significant effect on economic growth. Salinas and Aksoy (2006) analyzed the data of 39 countries during 1970-2004 and found that trade openness has a significant positive effect on GDP growth, and the growth rate increased by 1.2 times after trade openness. Kim et al. (2011) analyzed the effect of trade openness on economic growth using the panel data comprising 61 countries during 1960-2000. The empirical findings show that trade openness is advantageous for developed countries but can be detrimental to low-income countries. Huang and Chang (2014) analyzed the data of 46 countries to examine the relationship between financial market development, trade openness, and economic growth. The findings show that although the development of the stock market and trade openness have a positive effect on economic growth, the relationship becomes negative in the case of an underdeveloped stock market.

Zarra-Nezhad et al. (2014) conducted an empirical analysis using data from 94 economies and 103 variables. It was found that trade indicators increase GDP growth regardless of the development levels. Iyke (2017) examined the role of trade openness in economic growth in Central and Eastern European economies. Using panel data from 17 countries for the period 1994-2014, he found that trade openness is a vital determinant of economic growth in the region. Ogundari and Awokuse (2018) collected data on 35 African countries to examine the influence of human capital on economic growth. The generalized method of moments (GMM) estimation technique has been used to find that human capital promotes economic growth.

Fatima et al. (2020) examined the association between trade liberalization and human capital to stimulate economic growth in Asian nations. It has been found that trade liberalization affects GDP growth positively. However, this positive effect is diminished if the country has low human capital accumulation. Luqman and

Soytas (2023) advocate that trade liberalization and human capital have asymmetric effects on economic growth in Pakistan. Specifically, trade liberalization hurts GDP growth in the long-run, while human capital has a minimal positive effect on GDP growth in both the short and long-run.

Sajid et al. (2021) investigated the role of trade openness, human capital, and institutions in influencing economic growth in 47 OIC member nations during 1991-2021. The authors used dynamic common correlated effects and found a positive relationship between the variables. The authors recommended that OIC economies should continue to focus on trade openness and human capital. Gharsallah and Trabelsi (2024) examine the nonlinear effects of trade openness on GDP growth over a sample of advanced and developing economies for the period 1980–2020. Using a Dynamic Panel Threshold Model, it is revealed that trade openness has a positive effect on GDP growth. Moreover, trade openness can improve economic performance if the human capital is high; otherwise, this impact is negative.

Poudel et al. (2024) use cointegration and dynamic OLS (DOLS) to find that both human capital and trade openness positively and significantly contribute to economic growth in the long-run. Usman et al. (2024) suggest a positive and significant role of industrialization, human capital, and trade liberalization on economic growth in the selected Asian countries.

Panel results show positive contributions of trade openness and human capital to GDP per capita in Asia. Geetha et al. (2025) investigate the effect of trade openness, human Capital, investment, and infrastructure development on economic growth using time series secondary data. The findings reflect that trade openness, human capital, and investment significantly contribute to GDP growth, while infrastructure development shows no significant impact.

3. Empirical Model and Data:

The empirical specification of the model used in this study mainly comes from a production function with output as a function of physical capital, labor, and human capital. For an open economy, we incorporate the trade openness variable to add the external sector. According to Robert Solow, capital and labor force are the major factors of production and the key driving forces for the growth of an economy. Gross fixed capital formation is added in the regression to represent physical capital. Population is used as a proxy for labor availability and market size. The GDP growth can be expressed as a function of changes in the human capital stock (Mankiw, 1992). The new growth theories suggest that trade policy and human capital formation affect long-run growth through their impact on technological change (Grossman and Helpman, 1992).

The econometric specifications used in this study are mainly based on Harrison (1996) for analyzing the influence of trade openness on economic growth by taking GDP per capita as a dependent variable. The econometric model may be expressed as given below.

Where,

EG = Economic growth, which is measured as GDP per capita in constant US dollars in 2015.

GFC = Gross Fixed Capital Formation as a % of GDP

LFP = Labor Force Participation rate

Open = Trade Openness (exports + imports as a % of GDP).

HC= Education expenditures as a share of GNP as a measure of human capital.

u_{it} = Error term

The log form of all the variables is used to get precision in calculation and ease of interpretation. The annual data on the Pakistan economy is collected for the period 1982-2025. The data on all variables is obtained from the World Development Indicators (WDI) available on the World Bank website.

3.1 Augmented Dickey-Fuller (ADF) Unit Root Test

The Augmented Dickey-Fuller (ADF) test is used to test whether a series is stationary or not. The *ADF* test has some advantages over the old Dickey-Fuller (DF) test. Firstly, DF assumes that the error term u_t was uncorrelated, but in the case of ADF u_t is correlated. The ADF test is advantageous because it controls for the serial correlation using lags. The ADF test is more powerful and can handle more complex models as compared to the simple DF test. The test should be used with caution because it has a relatively higher tendency to commit a Type I error. The ADF test with intercept and trend can be represented by the following equation for the Y variable, as given below,

ADF Unit Root Test Equation with intercept and trend can be written as given below,

Where:

- = time series or variable to be tested
- = first difference operator
- = intercept
- = time trend
- = lagged level of the series
- = coefficient
- = optimal lag length (to remove serial correlation)
- = white-noise error term

The ADF test follows a null hypothesis of a unit root, while the alternative hypothesis states no unit root. If the computed t value in absolute terms is greater than the critical τ value, we reject H_0 and the series is stationary.

The ADF test gives the order of integration of a series. If the series is stationary (without taking differences), it is stationary at the level. So it is integrated of order zero and called I (0). If the series becomes stationary after taking the 1st difference, then it is integrated of order 1 and called I (1). If the series becomes stationary after taking the 2nd difference, then it is integrated of order 2 and called I (2).

3.2 Johansen Co-integration Test

The Johansen co-integration approach is advantageous due to its utility in a multivariate framework. The Johansen co-integration technique is utilized to check the existence of a number of co-integrating relations between the variables. If all the variables are I(1) or integrated of order one, Johansen co-integration technique is a suitable method to find the number of co-integrating relations between the dependent and independent variables. The general equation of Johansen's co-integration technique is presented below (Johansen, 1991, 1995):

$$\mathbf{Z}_t = \boldsymbol{\mu} + \mathbf{A}_1\mathbf{Z}_{t-1} + \mathbf{A}_2\mathbf{Z}_{t-2} + \dots + \mathbf{A}_k\mathbf{Z}_{t-k} + \mathbf{B}\mathbf{x}_t + \boldsymbol{\varepsilon}_t$$

Where,

In the equation given above, \mathbf{Z}_t is the vector for the I(1) independent and dependent variable, and \mathbf{X}_t is a vector of non-random control variables along with the error correction term. If all the variables selected in this study are I (1), then the Johansen co-integration test is feasible.

3.3 Error Correction Model (ECM):

After establishing cointegration among the variables, the short-run dynamics can be modeled using an Error Correction Model. The general ECM specification is expressed as:

Where, EG is dependent (i.e., EG), X is a vector of independent variables (i.e., GFC , LFP , $OPEN$, and HC). α is the term representing error correction β is the speed of convergence. Δ is the 1st difference operator and the white-noise error term, respectively.

4.

5. Empirical Results

Table1: ADF Unit Root Test

Variable	ADF t-Stat. at 5% level of Significance		Decision
	Level	Ist. Diff.	I (1)
EG	0.9842	-4.8402*	I(1)
GFC	-1.6345	-3.8719**	I(1)
LFP	-0.5647	-6.1231*	I(1)
HC	0.6017	-5.9155*	I(1)
OPEN	-1.9758	-3.781*	I(1)

Note: ADF t-stat values are reported at the level and first difference, including the intercept. $I(1)$ symbols * and ** show the stationarity of a series at 1% and 5% level of significance, respectively.

Table 2: Johanson Co-integration Test

Hypnotized#. of CE(s)	Trace Statistic	0.05 Critical value
None	69.99*	63.82
At most 1	37.525	47.86
At most 1	21.657	29.80
At most 1	9.79	15.49
At most 1	1.1468	3.84

Normalized Equation				
Log(EG) =	0.3650 GFC* +	4.932	LFP* +0.0353 OPEN** +	8.67
SE..	(0.0276)	(0.619)	(0.0131)	(0.0445)

Note: The parentheses contain standard errors. The notation * and ** show significance at 1% and 5% levels, respectively.

Table 3. Error Correction Model Results

Note: standard errors are given in parentheses. All variables are in log form. The notation * and ** show significance at 1% and 5% levels, respectively.

Dependent variable: EG	
ΔEG_{t-1}	0.1474* (0.055)
ΔEG_{t-2}	0.1042* (0.0603)
$\Delta OPEN_{t-1}$	0.0153* (0.0031)
$\Delta OPEN_{t-2}$	0.0156* (0.0314)
C	-4.870* (1.351)
GFC	0.1108* (0.028)
LFP	0.567** (0.254)
HC	0.067* (0.020)
EC_{t-1}	-0.2505* (0.0606)

6. Interpretations and findings

The results of ADF unit root test are presented in Table 1. The ADF test statistics indicate that all variables are non-stationary at the level. It means that the series is non-stationary, having a unit root. However, by applying the first difference, the series becomes stationary. Therefore, the series are said to be integrated of order one or simply I (1).

Table 2 shows the results of Johanson co-integration approach for the estimation of long-run relationships. We use the log form of a series for a better understanding of data. The value of the trace statistic is 69.9, which is greater than the critical value of 63.8. So, there is one co-integrating series detected because the trace statistic is greater than the 5 percent critical value in only one case. The normalized co-integrating equation was then written. We find that all the series are statistically significant with positive coefficients. Our core variable, trade openness, is statistically significant at the 5 percent level, while human capital is statistically significant at the 1 percent level of significance. The normalized equation shows that a one percent increase in trade openness leads to an increase in economic growth by .04 percent or vice versa. Similarly, a one percent increase in education expenditures or human capital formation leads to a rise in economic growth by 8.67 percent or vice versa. Trade openness and human capital affect economic growth positively and significantly in Pakistan. The openness of trade plays a vital role in boosting economic growth through technological diffusion, innovations, and competition. Similarly, human capital also promotes growth by enhancing the use of technology and work efficiency. The collaboration between trade openness and human capital facilitates a research-intensive specialization and enhances economic growth in Pakistan.

The short-run coefficients do not significantly affect the dependent variable. The long-run coefficient of gross capital formation and labor force participation proved to be strongly significant. The gross fixed capital formation coefficient is 0.11, which reveals that a 1% increase in the physical capital leads to an increase in economic growth of 0.16% or vice versa. The coefficient of LFP is also positive with a magnitude of 0.56, which is statistically significant at 5 % level. These results are in line with Hrrison (1996), Yankia (2003), and other major studies. The physical capital has a vital role in economic growth because the investments are mainly based on the availability of finances. The various production functions take capital as a key factor in producing output.

Comprehensively speaking, ECM shows the short-run dynamics towards the long-run equilibrium.

When the variables are co-integrated, there is an equilibrium relationship between the two. Of course, in the short-run, there may be a situation of divergence from the equilibrium path. We can use the error term to tie the short-run behavior of Y to its long-run value. The Granger representation theorem states that if two variables, Y and X, are cointegrated, then the relationship between the two can be expressed as an ECM. We found the negative and significant error correction term, which is -0.25, showing 25 percent convergence or adjustment is taking place per period.

The positive role of human capital and trade has been confirmed by Solmaz (2010), Yankia (2003), Harrison (1996), Atiq-ur-Rehman (2021), and many others. The trade openness, along with better human capital, plays a vital role in boosting economic growth through increasing exports and promoting a research-intensive specialization culture, especially in low-income countries. By opening up the borders for trade and developing better human capital, Pakistan may be able to grow faster through trade, innovations, and a culture. For South Asia, the coefficient on trade openness is significant but low, which indicates that the impact of trade openness is beneficial but still minuscule in the case of Pakistan, because the focus of the economy is diverted towards imports rather than exports. This is due to the structural gridlocks, like fragile macroeconomic governance, poor institutional quality, inferior human capital, and hesitancy to enter the regional and global trading blocs. Due to policy inconsistency and regional rifts, the benefits of trade openness are limited in Pakistan.

7. Conclusions and Policy Recommendations

The study focuses on examining the effect of trade openness and human capital on economic growth in Pakistan by using time-series data for the period 1982 to 2025. After applying the ADF unit root test, all the variables are found to be I (1). Then Johanson co-integration method is applied for the estimation of long-run relationships. We find that all the variables are statistically significant with positive coefficients in the normalized equation. Trade openness is statistically significant at the 5 percent level, while human capital is statistically significant at the 1 percent level of significance. The error correction model is also applied to gauge the short-run dynamic adjustment towards the long-run. We found the negative and significant error correction term showing 25 percent convergence towards the equilibrium per period. It is concluded that trade openness and human capital affect GDP growth positively and significantly in Pakistan.

Moreover, the export promotion policies can bring a new era of innovations and competition. The human capital also promotes growth due to better technical know-how and advancements in production. Trade openness and human capital formation both create a research-intensive specialization culture, especially in developing economies like Pakistan, which helps promote and speed up economic growth. The openness of trade has the potential to play a vital role in boosting economic growth through technological diffusion, innovation, and competition. Similarly, human capital also promotes growth by enhancing the use of technology and work efficiency. The interrelationship between trade openness and human capital facilitates a research-intensive specialization culture and stimulates economic growth in Pakistan.

However, despite these challenges, Pakistan has many opportunities available to it to capitalize on trade openness and human capital for economic growth (Hussain, 2018). Pakistan's geographic location, size, and economic diversification offer a great starting point for economic growth. By concentrating on improving the skills of the human capital, improving infrastructure, and developing institutions, Pakistan can make the most of trade openness and achieve economic growth. The connection between trade openness, human capital, and economic growth has important implications for Pakistan's policies. To make the most of trade openness, Pakistan must make efforts to develop its human capital and create an environment that promotes innovation and competitiveness. This requires a collective approach by policymakers, educators, and the business community to ensure that the country's human capital has the skills and knowledge to thrive in a globalized world. Education and vocational training are important for improving human capital in Pakistan (OECD, 2019). Increasing access to education, particularly in rural areas, and improving the quality of education at all levels are critical steps. Additionally, promoting lifelong learning and skills development will help workers adapt to changing economic conditions and remain competitive globally (UNCTAD, 2021). Pakistan's trade policies should complement these efforts by focusing not only on market access but also on facilitating knowledge and technology transfers, thereby aligning trade strategies with human capital development to build a more dynamic and resilient economy.

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