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The Impact of Investment in Human Capital on Industrial Development: An Empirical Analysis of Pakistan

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ABSTRACT

Over the last half-century, reduction in poverty and reasonable economic growth have been the fruit of continued industrial development, mostly in Asia. Improved telecommunication, liberalized markets, and better infrastructure cannot accelerate economic growth unless an appropriate level of investment in human capital is not available. The study mainly targets to investigate impact of investment in human capital on industrial development in Pakistan from 1980 to 2023. The study incorporates government expenditures on education (EXE), government expenditures on health (EXH), and growth in enrollment rate in vocational institutes (EVG) as indicators of investment in human capital. The study has applied Augmented Dickey-Fuller to check stationarity of variables followed by estimation of Autoregressive Distributive Lag (ARDL) model to find co-integration. It is resulted from estimation that expenditure in health and enrollment in vocational training confirm leaves positive impact on industrial development in case of Pakistan. The empirical outcomes are consistent with existing evidence found on the same subject for other economies. In Pakistan, there is a need for policy formulation to achieve the right direction of educational development for industrial development.

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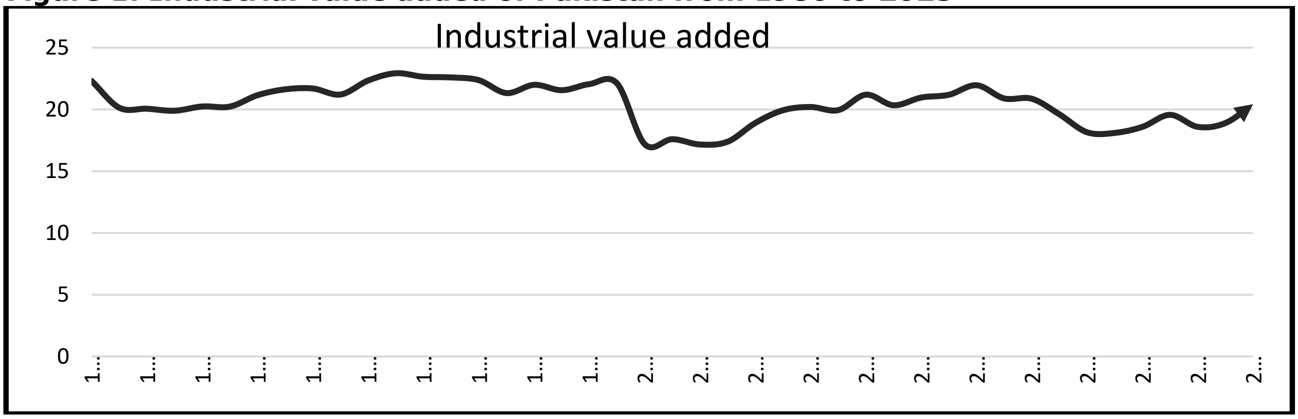
1. Introduction

It has been observed that the industrial sector carries the utmost importance for the development of economic activities in an economy. According to the World Bank (2022), the industrial sector contributed 27.51 percent of the total GDP of the world. Historically, it has been proved that the countries with strong industrial sectors have shown more economic growth and achieved rapid developmental goals in a short period of time (DESA, 2007). The development of industries in emerging economies like China, Korea, Taiwan, and Indonesia has accelerated growth and reduced poverty in recent decades (Kniivilä, 2007). The industrial transformation from developed countries to agrarian economies is making structural changes in the macroeconomy (Syrquin, 2010). At the same time, industrial development requires the adoption of modern technologies, investment in human capital, and innovative progressive approaches to achieve desirable economic development through industry. Therefore, it is imperative to study and explore the important aspects directly related to the industrial sector (UNIDO, 2013). Theoretically, it is not a new notion to invest in human capital to have successful economic growth, it comes from the time of Adam Smith (1776), and classical economists explain the importance of investment in human capital for the sake of economic growth. To let an economy on the path of growth a justified amount of investment in human capital is vital. The economies are successfully built themselves as economic Asian tiger are the ones who has invested in human capital. Investment in human capital is the main root cause of development of Asian economies (Jaiyeoba, 2015). Poor health conditions lead to less labor force participation and limit economic growth and too many economic problems born because of poor health conditions like the nations downward trend in living standards, employment, and poverty (Strauss, 1986). The human capital index gives different rankings to economies depending on the investment they make in human capita and checks whether the country is developing its human capital or deploying it. According to the HC index, Pakistan is ranked 114 out of 124 countries which are lowest in Asia (World Bank, 2023).

The literature confirms the relationship exists between investment in human capital and industrial growth. Previously, Adejumo, Olomola, and Adejumo (2013); Collin and Weil (2020); Hamid and Pichler (2009); Imran, Bano, Azeem, Mehmood, and Ali (2012), have investigated the correlation between investment in human capital and industrial productivity. Some other studies have investigated relation of human capital and economic growth, unemployment, and poverty in developed and developing economies. All these studies have focused on the major industrial issues and the problems of investment in human capital. However, it is hard to find any comprehensive study that examined the question impact of investment in human capital on industrial development in a time series analysis in the case of Pakistan. Thus, the present study holds a significant contribution to the literature on the importance of human capital for industrial development in the context of Pakistan. Therefore, the current study has filled the gap in the literature. The study also provides valuable policy implications enforced with statistical findings to boost industrial production by investing in human capital. Pakistan is recognized as 2nd largest country in South Asia and 6th most populous country with an estimated 230 million population in the year 2022 in the world. The condition of the industrial sector is not satisfactory in Pakistan. Before independence, 921 total industries existed in the sub-continent, from which Pakistan got only 34 industries out of 921 which was just 3.69 % of total industrial share. The labor productivity is constantly declining as it was 4.2 percent annually in 1980s and by 1990s this shunned to 1.8 percent further having a decline to 1.3 percent in 2015. However in neighboring countries the trend of labor productivity is enhancing. Decline in investment is the first major reason of decline in productivity, followed by poor situation of education particular in giving new skills and technology adaptation to workforce. Pakistan ether has illiterate workforce or the workforce has less than 10 years of education due to which it becomes a Hercules task to be on the path of industrial growth. The industrial value added of Pakistan is presenting unevenly declining trend with no future goals defined:

Figure 1: Industrial value added of Pakistan from 1980 to 2023



Source: World Bank 2024

The above figure shows the trend of industry value added in Pakistan. According to World Bank data, Pakistan's industry value added went downward and in the year 2014-2015, it decreases because of weak external demand, energy shortage, low investment, and security situation in some industries a big issue of Pakistan's industry downward trend is the absence of coherent industrial policy. According to the World Bank data set, the decade vise industrial growth of Pakistan has also had declining trend. The industrial sector relied on low-tech resources and did not take comparative advantage of local or export products. Human capital refers to education, skills, health, talent, and physical capacity that is essential to use technology and land to yield production of miscellaneous goods and services that is ultimately consumed by humans (Keeley, 2007). The investment in human capital means that an economy spends on its education, skills, health, and training to enhance future earnings and productivity (Schultz, 1961). The government of Pakistan is currently spending 1.9 % of its GDP on the education sector (Economic Survey of Pakistan, 2022). The remaining part of the study includes a literature review in section 2. Methodology in sections 3 and section 4 presents the empirical evidence on the subject to justify the hypothesis. Section 5 i.e. the last section comprehends the conclusion of the study.

2. Literature Review

The concept of investment in human capital is not new because most of the literature elaborates on human capital investment from 1960 onward, but in 1776, Adam Smith's “Wealth of Nations” clearly explains the importance of investment in human capital. He elaborates in this book that people should know that capital stock is not only in the form of physical capital like machines, factories, and other tools, but the most important part of capital stock is human beings. Investing in human beings increases their productivity, which will ultimately enhance economic development. In the twentieth century, Walsh (1935) explained that investment in education was a more profitable and important tool for gaining economic growth. As a result, the skills acquired via advanced education are more productive than the other investment. Then, with time, human capital theory was developed by Schultz (1961), who postulated that investment in education is more precious than investment in physical capital. Advanced education and a healthy workforce enhance productivity and earnings. On the other hand, Nelson and Phelps (1966) introduced the term innovation for the sake of growth in output through the adoption of technology. Consequently, human capital is not a single type of input that can be embodied in production function; however, capital and labor both ultimately enhance skills and efficiencies, which is one sign of high productivity. Romer (1989) explained that job training is beneficial in elevating human capital, and this contributes to enhancing growth by producing productive labor and promoting technical skills. Lucas Jr (1988) presents in his model that “human capital is the engine of growth.” Investment in human capital increases the marginal product of labor and productivity levels.

Empirically, many economists used education attainment and health expenditures as proxies of human capital and skill development (Barro & Lee, 1993; Teixeira, 1998). Numerous researchers Mincer (1996) explained that investing in schooling and job training increases workers' productivity. Mankiw, Romer, and Weil (1992) examined the role of human capital on economic growth using cross-country analysis. The results showed that human capital has a positive effect on an economy's growth rate. Many studies also address the theoretical relationship. For example, Benhabib and Spiegel (1994) differentiate the countries according to technological and human capital development. For this purpose, they used a growth accounting framework among all countries. The result showed that human capital enhances economic growth by producing new technologies and a skilled labor force, along with the productivity of the labor force. Some empirical studies have also determined the impact of investment in human capital and economic development. Kazmi, Ali, and Ali (2017) stated that the increase in expenditures for vocational training and skills development enhances the human capital of the country, which is a very important determinant of economic development. Similarly, Gyimah-Brempong and Wilson (2004) investigated that economies which spend more on human capital building result in providing high income per capita to individuals or in other words higher income is associated with higher human capital. The study concluded that less developed countries boost their per capita income by investing in health in the short run but, in the long run, enhance their overall income and economic growth. Burger (2014) rendered research for South Asian industries and found the relation between the effect of worker education and productivity. Naturally, this is resulted that more attainment of education is highly correlated with elevated individual earnings.

Moreover, Olayemi (2012) explores the role of physical capital in increasing industrial productivity. Nigeria has abundant human capital, which contributes to productivity; however, enhancement of this capital is ensured by integrating it with physical capital. Teixeira (1998) estimated that human capital is important to facilitate a country's getting the benefits of its innovation-native efforts. The literature in Pakistan is scarce on the direct question; however, some researchers have conducted studies on other aspects of the subject. Dutta (2006) empirically analyzes that for the short-term behavior of industrial growth in Pakistan, an error correction model was applied, and the error correction term was found to be negatively signed and statistically significant. Mustafa, Abbas, Saeed, and Anwar (2005) suggested that for a developing country like Pakistan, education, health facilities, and skill development are priorities for human development, but we should move one step forward to cope with the development that is only possible through strong and planned strategies and a way forward for development. Furthermore, Ali, Chaudhry, and Farooq (2012) estimated that education enrollment, GFCF, and the index of poverty coefficient also have a positive and significant impact on the economic growth of Pakistan. Akram et al. (2008) suggested that health indicators should be included in the growth equation because they are a very important determinant of human capital that would help increase the productivity and earnings of the workforce. Schultz (1961) recommends that developing countries have a low status of investment in human capital because they need more resources. Poor health slows down the growth and workers' productivity. Role of technology in enhancing human productivity has been proven by Solow growth model as well. Empirical applications of Solow growth model has enhanced the fact that human capital can be increased with technical skills (Ericsson, 2014). Abbas and Nasir (2001) examined the role of human capital in the economy as critical because it helps the economy absorb foreign assistance, and it is possible only through sound investment in skills and knowledge. Further, Nilsson (2010) argued that government expenditure on education and skill development enhances human capabilities and increases productivity growth in the long run. Khilji, Kakar, and Subhan (2012) rendered a study for Pakistan and found positive impact of vocational training on growth. Imran et al. (2012) recommended that there should be an increase in social spending to boost productivity and economic development. Umer and Alam (2013) investigated positive impact of FDI on GDP for both short and long run.

Bano, Yang, and Alam (2022) explored the gap among industries and highly skilled personnel. The skilled workforce is required in various industries of country however the presence of more unskilled and semiskilled individuals in labor market is leading to formulation of non-formal institutions and sectors. This gap between industries and skills can be bridged with technical vocational education and training. The 60 percent of young people in Pakistan who are belonging from informal sector due to unskilled attributes if trained can lead to tremendous manpower for economy. Lack of human capital is the major structural issue present with Pakistani economy and lack of investment in this sector is effecting on productivity, all the above literature has discussed the factors which impact on productivity of humans in Pakistan. Since last 30 years the investment is grown only by 5 percent, this is due to miscellaneous factors including inflation and other structural issues however survival of industries can be secured in the difficult times by investing more on boosting human capital. The linkage between human capital and industry is debated under literature and this is also explored that capacity of humans can be enhanced by education, health and other factors. Industrial growth is a matter of concern now days because industrial growth will lead to economic growth. Training and development of individual's increases their engagement with organization leading to increase in productivity (Hussain, Khan, & Khan, 2020). Cohee et al. (2021) explored the ways health interventions can be injected to prevent prevailing health conditions among people to enhance productivity. The studies also investigate the nature of industries in Pakistan such as industrialization is a process which helps the economy moves from agricultural production to mass scale technological goods and services. This includes huge shifting from rural to urban labor and impacts on standard of living as well. the productivity is expanded exponentially.

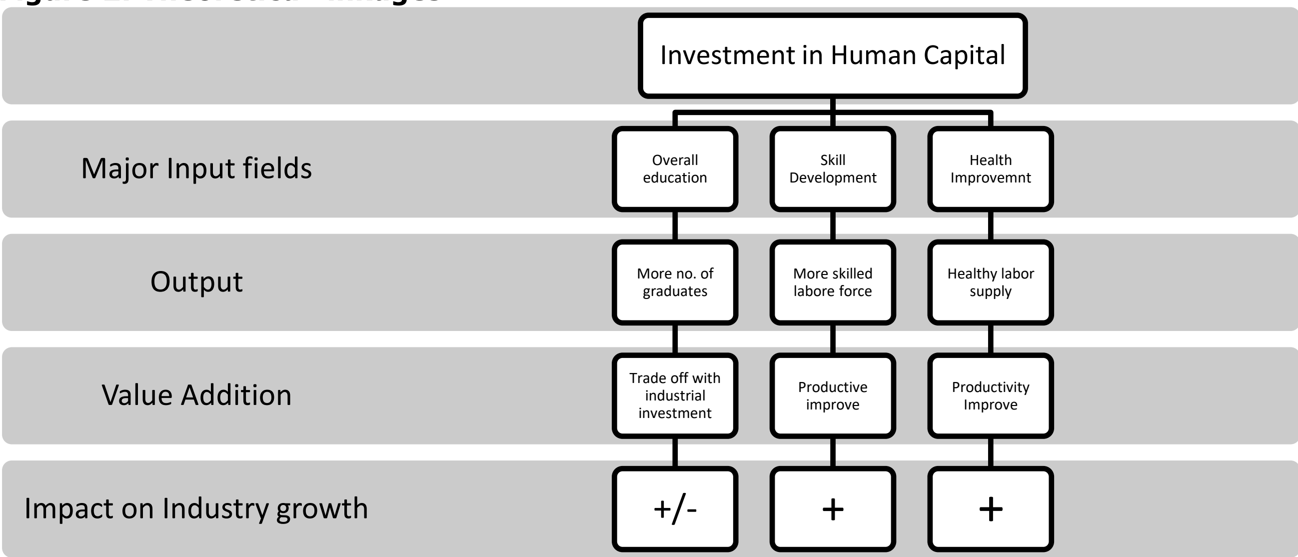
2.1. Literature gap and contribution of study

The linkage between industrial growth and economic development is inordinately studied. Miscellaneous literature studies have explored the obstacles in the education and health sector, and many other studies have found a significant relationship between industry and economic growth in the context of Pakistan. However, there exists a literature gap as the impact of human capital on industrial growth is yet to be studied. Moreover, better human capital leads to better industrial growth. Labor specialization is a lacking dimension in Pakistan, and this study contributes to explaining the role of education and health in labor productivity, leading to industrial growth and economic growth.

3. Data, Theoretical Framework, and Methodology

The most frequently used model in the literature is Solow growth model which is developed by Robert Solow and received Nobel Prize for it. Indeed, Solow's model is specified for developed economies but it is also frequently used for developing countries to investigate hypothesis related to growth and development. It yields that different economies having similarities in saving depreciations, labor force and economic growth will converge to same level of development (Todaro & Smith, 2009). The Solow's model is the extension of Harrod-Domar model for calculating productivity and growth, and Solow included the flexibility in substitution between labor and capital and assumes to diminishing returns to scale. Technological progress should be considered different form the rise in capital intensity. As per neoclassical thoughts capital is assumed with diminishing returns. In this model, technological progress is measured by the Solow Residual or total factor productivity. Literature has also suggested some theoretical linkages between the investment in human capital and industrial development differently for different economies according to their development stages. Government expenditures on education may initial because the trade between industrial investment and cause negative relationship between overall education expenditures and industrial development in small economies. On the same time this may not be significant in industrial to increase the expenditures on unspecified education rather than investing in specific skills (Adejumo, Olomola, & Adejumo, 2013).

Figure 2: Theoretical linkages



Source: Adejumo et al. (2013) & Authors own Work

3.1. Model Specification

A Neoclassical-Solow growth production function is considered standard method of growth. Considering the production function of this form;

$$Y_t = f(AK_tL_t) \tag{1}$$

Where,
Y = aggregate production in industry
A = Level of technology
K = Physical stock of capital
L = Quantity of Labor
T = Time Dimension

Earlier works include the human capital as input factor and assumed that the economy will grow with the increase in labor, human and physical capital (Mankiw et al. 1992; Romer & Odusola, 1992).

$$Y_t = A_t K^{\alpha1} L^{\alpha2} H^{\alpha3} \tag{2}$$

Where H is Investment in human capital, α1 + α2 + α3 = 1. Solow model has an assumption of constant returns to scale or in other words this means that doubling the inputs capital and labor will double the amount of output. So the proportion of inputs is equal to the proportion of outputs. The empirical model estimated in this study is inspired from Solow economic growth theory in which the human capital along with capital and labor adds into production activity. "A" stands for the coefficient of technology. Econometric model for selection of appropriate proxies and indicators the study follows (Khilji, Kakar, & Subhan, 2012; Umer & Alam, 2013).The basic functional form of the model will be:

$$INDV = f(EXE, EXH, EVG, TOT) \tag{3}$$

The final equation can further be elaborated as,

$$INDV_t = \beta_1 + \beta_2 EXE_t + \beta_3 EXH_t + \beta_4 EVG_t + \beta_5 TOT_t + \varepsilon \tag{4}$$

Industry value added is well-defined as it is the net production of the sector from specific industry which sums up all the output and deduct all the raw material/inputs (World Bank, 2022). According to the literature, there is a positive relationship between investment in human capital and industrial productivity (Olayemi, 2012). Total expenditures that government spends on education through that is referred to the local, regional and central government. These expenditures are expressed in percentage of GDP (WDI). The relationship between investment in the education sector and output growth is positive. Some other studies have determined a negative relationship between overall expenditures on education and industrial development with special reference to developing economies (Basu & Bhattarai, 2012). However, some empirical studies have determined that overall expenditures on education may not have any significant implications on industrial development as the total expenditures on education may not specifically fulfill the demand for skilled labor in industrial sector (Adejumo, Olomola, & Adejumo, 2013). According to World Development Indicators the total health expenditure is the summation of all types of health expenses no matter public or private. The health services that are included in health expenditure are wide ranging and multiple such as family planning, emergency healthcare services and nutrition related activities however the health expenditure does not include availability of clean and hygienic water and other sanitation activities. Romer (1989) elaborated in study the insignificant negative relationship of health and growth whereas significantly positive relationships occurs between growth and health indicators. But in contrast the negative relationship between industrial productivity and investment in health.

Skills development is also an important indicator of human capital. By the Skills development the economies can meet the demands of changing and developed economies in the context of globalization. Skills development is proxied by the on job training and enrollment rate in technical institutes and professional colleges. The is positive relationship between skill development and value added (Kemal, 1981; Wagner, 2005). This research has used time series data of 33 years i.e. 1980 to 2023. The source of data collection is World Development Indicator as the data is secondary and time series which is easily available on the World Bank website. Moreover economic surveys of Pakistan are also consulted for data purposes. To test the stationarity the study applies Augmented Dickey-Fuller (ADF) test of unit root. Table 1 below presents the stationarity results that which variable is stationary at which level so that correct technique can be applied in later stage.

Table 1: Results of unit root test for stationarity

Augmented Dickey-Fuller test results					
At level			**At difference**		
Variables	**With intercept**	**Intercept and trend**	**With intercept**	**Intercept and trend**	**Decision**
INDV	-2.57[0] (0.1080)	-2.74[0] (0.2260)	-6.46[1] (0.0000)***	-6.48[1] (0.0000)***	I(1)
EXE	-3.51[1] (0.0133)**	-3.46[1] (0.0604)*	---------	----------	I(0)
EXH	-1.52[0] (0.5103)	-3.88[0] (0.0243)**	-4.38[1] (0.0013)***	-4.32[1] (0.0088)***	I(0)
EVG	-4.15[0] (0.0027)***	-4.09[0] (0.0148)**	----------	-----------	I(0)
TOT	2.12[0] (0.2368)	-2.26[0] (0.4412)	-7.10[0] (0.0000)***	-7.19[0] (0.0000)***	I(1)

*, **, *** shows the level of significance at 10%, 5% and 1% respectively

Among five variables two variables are integrated at level I whereas remaining three are integrated at level 0. The dependent variable is also integrated at level 0. The explained variable is I(1) and explanatory variables are the combination of I(0) and I(1), this condition will lead to application of ARDL as applying ordinary least square will result in spurious results and results in interpretation of wrong causal relationship which is actually not existing.

Autoregressive Distributive Lag (ARDL) model is the appropriate technique when variables are having mixed integration.

3.2. ARDL approach for co-integration

The first and foremost step of ARDL process is to select the optimal lag. The commonly and popularly used optimal lag selection criterions are AIC, SC and HQ. The command of unrestricted VAR is run to select optimal lags, the results of AIC, SC and HQ mentioned below in table 2.

Table 2: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-319.7230	NA	448.4968	20.2951	20.52421	20.37110
1	-253.3191	107.906*	34.4844*	17.7074	19.0815*	18.1629*
2	-227.8777	33.39190	37.9533	17.6798	20.19909	18.51491
3	-199.8920	27.98570	44.5638	17.4932*	21.15759	18.70787

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Endogenous variables: INDV EXE EXH EVG TOT

The AIC has selected the three lags as optimal lags thus this ARDL model will use three lags and later the cointegration among variables will be checked. Both short run and long run results can be estimated using ARDL test and bon tests further elaborates the existence of cointegration among variables. The equation has been divided into short run and long run parts that is why the variables are lagged (l) times and 1 time separately. The error correction mechanism is also showed in the equation below, the ARDL equation gives long run, short run as well as ECM results:

$$DINDV_t = ƛ_1 + ƛ_{2l}\sum_{l=1}^{3} DINDV_{t-l} + ƛ_{3i}\sum_{i=0}^{3} DEXE_{t-l} + ƛ_{4i}\sum_{i=0}^{3} DEXH_{t-l} + ƛ_{5i}\sum_{i=0}^{3} DEVG_{t-l} + ƛ_{6i}\sum_{l=0}^{3} DTOT_{t-1} + ƛ_7 INDV_{t-1} + ƛ_8 EXE_{t-1} + ƛ_9 EXH_{t-1} + ƛ_{10} EVG_{t-1} + ƛ_{11} TOT_{t-1} + \varepsilon_t$$

In ARDL equation we estimate short run and long run coefficients thus two different results are acquired for short and long run. Moreover in this study, Wald test is also applied to analyze the cointegration. Cointegration test is essential to know the long run relationship of variables, if Wald test result is not significant it means there exists no long run relationship among variables. To explain the cointegration among variables the below mentioned equations are used; in case there exists cointegration $\boldsymbol{H_0}$ will be rejected and $\boldsymbol{H_1}$ will be accepted.

$$\boldsymbol{H_0}\colon ƛ_7 = ƛ_8 = ƛ_9 = ƛ_{10} = ƛ_{11} = 0$$

[if all lambdas (ƛ , coefficients) are equal to zero it means the variables have no long run cointegration]

$$\boldsymbol{H_1}\colon ƛ_7 \neq ƛ_8 \neq ƛ_9 \neq ƛ_{10} \neq ƛ_{11} \neq 0$$

(if the coefficients are non-zero then it shows cointegration)

4. Results and Discussion

The results of F statistic of Wald test gives significant value of 7.56 significant at 0.0016, this value is significant at 1% level of significance thus the study accepts alternative hypothesis of cointegration and rejects $\mathrm{H_0}$. Thus in light of the Wald test the cointegration among variables can be confirmed. The F-statistics of Wald test is compared with the F-critical from (Pesaran, Shin, & Smith, 2001). The results of the long run estimates indicates that expenditures on health (EXH) is positively and significantly contributing in INDV and enrolment rate in technical institutes (EVG) is also significant and positive determinant of industrial growth. The results from long run equation are summarized in below table:

Table 3: Long run results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.7171	3.4019	2.5624	0.0178
Industrial growth INDV(-1)	0.5521***	0.1480	3.7290	0.0012
Industrial growth INDV(-2)	-0.3290*	0.1788	-1.8394	0.0794
Industrial growth INDV(-3)	0.4104**	0.1518	2.7030	0.0130
Expenditure on Education (EXE)	-1.7958**	0.7467	-2.4048	0.0250
Expenditure on Health (EXH)	2.0854*	1.1245	1.8544	0.0771
Enrolment rates in Vocational institutes (EVG)	0.0308**	0.0112	2.7384	0.0120
Terms of Trade (TOT)	0.0314**	0.0142	2.2065	0.0381
Diagnostics				
R-squared	0.7595	F-statistic		9.9256
Adjusted R-squared	0.6829	Prob(F-statistic)		0.00000

*, **, *** shows the level of significance at 10%, 5% and 1% respectively. Dependent Variable: Industrial growth INDV

The long run results show significant and positive impact of all three independent variables on the dependent variable. Table 3 indicates that expenditure on health impacts industrial development positively with probability 0.0771 which indicates the 10% level of significance. It indicates on average one percentage point increase in health expenditure by government will lead to 2.09 percentage point increase in industrial growth. The indicator for skill development i.e. enrollment rate in vocational training institutions is also significant and positively contributing in industrial growth. On average one percentage point increase in EVG will lead to 0.0308 percentage point increase in industrial growth. Other measure used in the study is TOT which is significant and positive relation with INDV. EXE is significant and negative, which is justified in the literature. Basu and Bhattarai (2012) explored a puzzling pattern of lower growth with more public spending. The private sector has no incentive in schooling due to excessive government intervention.

Moreover, when the government intervenes in the education sector and makes public spending, the private sector responds, lowering the school returns and growth activities. If the government share is more significant in the education sector, then positive returns are seen in countries; however, in economies where the government share in the education sector is small, the negative relationship between government spending on education and growth is observed. The private schools lower the efforts in response to high government spending, leading to a puzzling relationship between education and development. Thus the negative and significant relationship between education and industrial growth is somehow cleared from the literature. R square shows the goodness of fit as it is 0.75 which means that 75 percent (p value 0.0000) of variation in industrial growth is due to expenditure in health, expenditure in education, enrolment rates in vocational training and terms of trade. In order to understand the phenomenon of convergence/divergence error correction mechanism is used, after confirming configuration from Wald test the ECM term is generated and unit root test is applied on it to analyze its stationarity. The first lag is selected to run the ECM equation. Short run results are given below in table 4.

Table 4: Short run ECM results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0270	0.1797	0.1505	0.8818
DINDV(-1)	0.6620***	0.2070	3.1973	0.0045
DINDV(-2)	-0.2686*	0.1339	-2.0055	0.0586
DINDV(-3)	0.5573***	0.1633	3.4112	0.0028
DEXE	-1.0882	0.7409	-1.4686	0.1575
DEXH	0.8580	1.9797	0.4334	0.6693
DEVG	0.0349***	0.0085	4.1056	0.0005
DTOT	0.0286	0.0218	1.3099	0.2051
ECM2(-1)	-0.1407***	0.2883	-3.9559	0.0008
Diagnostics				
R-squared	0.7033	F-statistic		5.9283
Adjusted R-squared	0.5847	Prob(F-statistic)		0.0005

*, **, *** represents the level of significance at 10%, 5% and 1% respectively. Dependent Variable: DINDV

The results of short run ECM models shows that ECM(-1) is significant at 1% level with probability value of 0.0008, this negative and significant coefficient of ECM confirms the convergence process that in long run the cointegration exists and in short run there is convergence in the relationship. The indicator in the regression like DEVG is significant and positive. R square is significant at 70 percent (F test is 0.0005). The tests are applied on short run error correction model to analyze residuals variance, normality, serial correlation and model specification the, model have been shown in table 5.

Table 5: Diagnostic tests for ECM Model Two

Breusch--Godfrey Serial Correlation LM Test			
F-statistic	0.12	Prob.-	0.8860
Obs*R--squared	0.39	Prob. -Chi-Square	0.8239
Heteroskedasticity Test: Breusch--Pagan-Godfrey			
F-statistic	2.15	Prob.-	0.1778
Obs*R--squared	13.34	Prob. -Chi-Square	0.1976
(Jarque-Bera Test of Normality)			
Jarque--Bera	0.79	Prob.	0.6714
Ramsey RESET Test			
t--statistic	2.98	Prob.-	0.3875
F--statistic	8.90	Prob.-	0.3875

The Jarque Bera test is done on the model in order to confirm the normality of residuals. Because the value of JB test for this model is insignificant thus it implies normality of residuals as the estimated JB test has value of F-statistic 0.79 and probability is 0.6714. The study also rejects the presence of serial correlation as Bruesch Godfrey test to check serial correlation has been applied, it estimated F value 0.12 with probability 0.8860. Moreover in order to check the variance of error terms the heteroskedasticity test is applied, according to the tests applied on equation the heteroskedasticity is not present and thus variation of error term is normal with F-statistics 2.15 and probability 0.1778. Last but not the least is the model misspecification test, Ramsey RESET shows F-statistic is 2.98 (p=0.3875) to confirm that model is correctly specified. From the above mentioned tests it can clearly be indicated that model is free of serial correlational, it has no issue of heteroscedasticity, residuals are normally distribution there is no misspecification problem in the model. Figure 5 presents the parameter stability of the model. Stability of the model is checked by CUSUM and CUSUM square. In order to check the constancy of variables of error correction model (short run) the CUSUM and CUSUM square tests are rendered.

Figure 5: CUSUM and CUSUM squared test for stability of ECM model

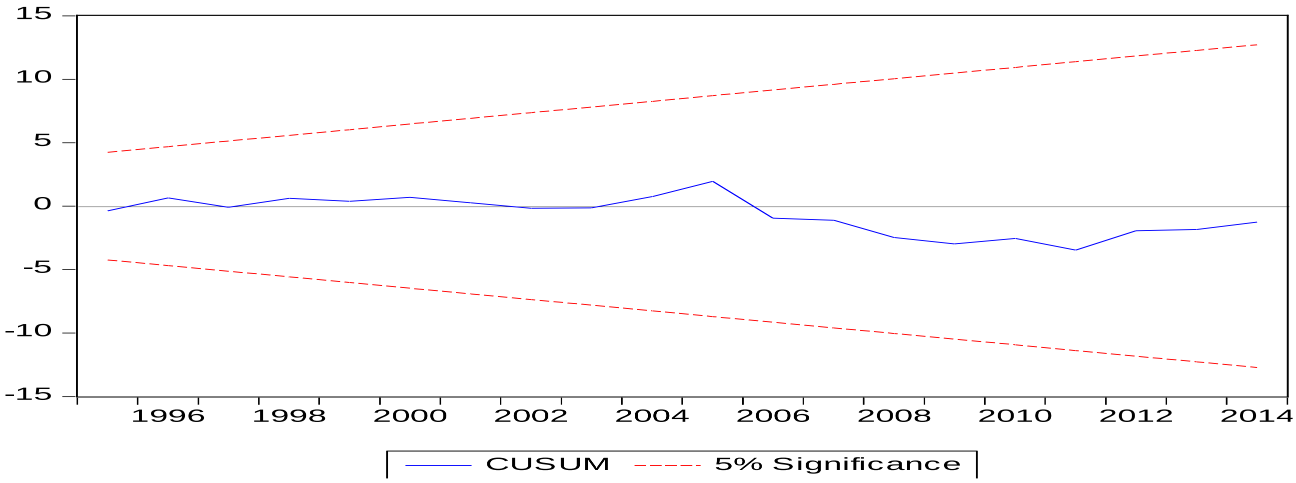
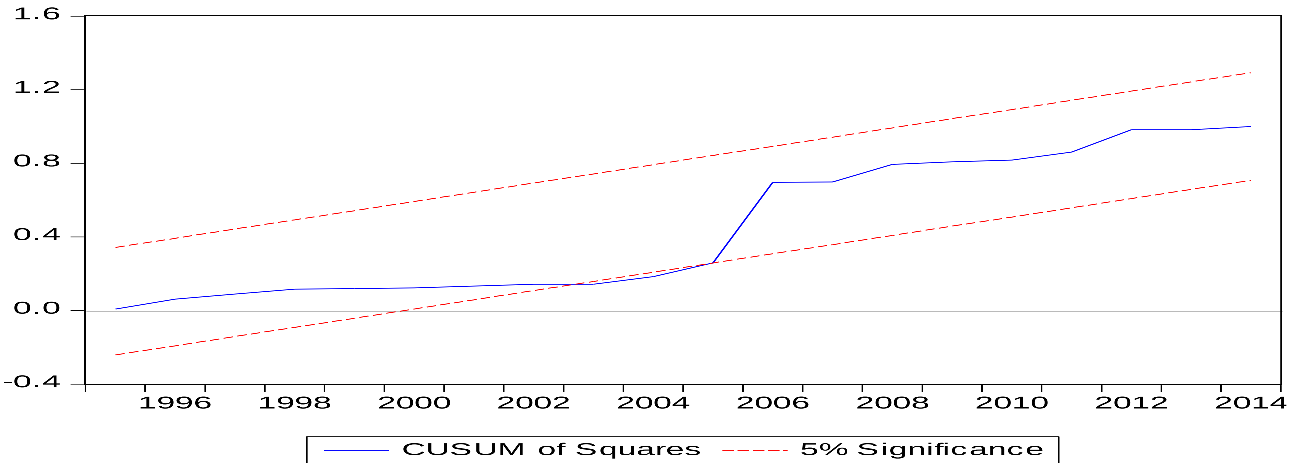


Figure 5 analyzes systematic and sudden changes in the regression coefficient and this shows that parameters have constancy, the above figure shows all disrupt changes in mean in result of small shifts. However the deviations lies between the ranges. Previously studies conducted on the subject; impact of investment in human capital on industrial development and impact of skill development on industrial sectors have been observed for different countries experiencing different stages of development Adejumo, Olomola, and Adejumo (2013) determined the same relationship between investment in human capital and industrial development. The negative sign of EXE is discussed by Basu and Bhattarai (2012) in which the author argued that the less develop countries of countries in the process of development may have a negative relationship between expenditures on education and industrial growth. However, overall results of the study are according to expectations.

Figure 6



5. Conclusion

The study follows some recent empirical literature to develop appropriate model and study used industrial value added growth to capture industrial development and expenditures on education and expenditures on health (EXH) are used as proxies for investment in human development. To capture skill development the study incorporated growth in enrollment rate in technical institutes (EVG). Control variable is terms of trade (TOT). The study rendered tests on time series data from 1980 to 2023 for Pakistan and by applying unit root test the study applied ARDL approach of co-integrations with standard diagnostics. Solow model basics is explained earlier to explain the notion that there exists a connection between population and technology. The low income economies have more margin of rapid growth by incorporating technology and giving skills to individuals in comparison to developed economies. Pakistani economy can achieve catch up rates by mingling technical skills with population. Empirical studies on Solow growth model has been done, different models through different times have been established to show the difference that why poor countries are growing faster in comparison to richer economies. Technology plays an integral role along with population in growth. In OECD economies the convergence was achieved due to population and technological growth rates and capital depreciation. This is devised by multiple studies to invest in enhancing human capital so economic growth can be accelerated in low income economies. The population control is also another solution to the slow growth problem (Ericsson, 2014).

The results of the study concludes that investment is an integral determinants of human capital and it significantly determines industrial development in Pakistan. The nature of industries in Pakistan is agro based, there is a dire need to bring in right technical talent and skills among individuals to foster manufacturing industry. Expenditure on health sector and enrollment rate in vocational training both are positively and significantly impacting on industrial development in the long run. Moreover results suggest that terms of trade (TOT) is a significant and positive determinant of INDV. The earlier literature also confirms the results of this study and all standard diagnostics confirms the validity of the results. The findings of this research adheres with the earlier researches rendered on the subject in different similar economies. So the study concluded that industrial development in Pakistan can be fostered by making investments in human capital, moreover the traditional factors are also important determinants of industrial development. With special reference to Pakistan there is need of strong policy formulation for achieving right directions of educational development and need to have specific skill in labor force and the investment in human capital should be correctly specified in particular fields that may be helpful to achieve high growth in industrial sector in future. The study provides reasonable base for future research, in future the author way forward to conduct more research on the same hypothesis by including more sample from regional countries particularly in South Asia. The further research can also be expended into multiple sectors of the economy to test the impact of investment in human capital and skill development.

5.1. Policy recommendations

- Industrial growth determinants are integral to study for the sake of economic growth. Education and health plays integral role in formation of human capital thus government must prioritize its expenses in the above mentioned sectors.
- Unskilled and semi-skilled workers are not contributing in formal production process thus role of education, free of cost/minimal cost vocational training can enhance enrollments.
- Health spending positively impacts industrial growth; thus, induce universal access to essential health services, national vision must cover equal health benefits/services for all.
- Vocational training institutes give skills to people and bridge industrial and academic gaps; more connections are needed to be built between industries and academia particularly vocational training institutes.

5.2. Limitations of the study

- This study investigated the negative impact of education on industrial growth; however, the types of education, quality of education, and years of schooling are all such drivers of education that are not added to the domain of study, only macro level variables of education proxy are selected (Valero, 2021).
- The terms of trade are added as a control variable, and the presented model explains 75 percent of the variance (R-square) in industrial growth due to independent variables.
- Miscellaneous other variables can be added as mediating variables that may impact human capital and industrial growth positively or negatively.

References

Abbas, Q., & Nasir, Z. M. (2001). Endogenous growth and human capital: A comparative study of Pakistan and Sri Lanka [with comments]. *The Pakistan Development Review*, 987-1007.

Adejumo, A. V., Olomola, P. A., & Adejumo, O. O. (2013). The role of human capital in industrial development: The Nigerian case (1980-2010). *Modern Economy, 2013*. doi:https://doi.org/10.4236/me.2013.410069

Ali, S., Chaudhry, I. S., & Farooq, F. (2012). Human capital formation and economic growth in Pakistan. *Pakistan Journal of Social Sciences, 32*(1), 229-240.

Bano, N., Yang, S., & Alam, E. (2022). Emerging challenges in technical vocational education and training of Pakistan in the context of CPEC. *Economies, 10*(7), 153. doi:https://doi.org/10.3390/economies10070153

Barro, R. J., & Lee, J.-W. (1993). International comparisons of educational attainment. *Journal of Monetary economics, 32*(3), 363-394. doi:https://doi.org/10.1016/0304-3932(93)90023-9

Basu, P., & Bhattarai, K. (2012). Government Bias in Education, Schooling Attainment, and Long-Run Growth. *Southern Economic Journal, 79*(1), 127-143. doi:https://doi.org/10.4284/0038-4038-79.1.127

Burger, J. M. (2014). Situational features in Milgram's experiment that kept his participants shocking. *Journal of Social Issues, 70*(3), 489-500. doi:https://doi.org/10.1111/josi.12073

Cohee, L. M., Halliday, K. E., Gelli, A., Mwenyango, I., Lavadenz, F., Burbano, C., . . . Bundy, D. A. (2021). The role of health in education and human capital: why an integrated approach to school health could make a difference in the futures of schoolchildren in low-income countries. *The American journal of tropical medicine and hygiene, 104*(2), 424. doi:https://doi.org/10.4269/ajtmh.20-0779

Collin, M., & Weil, D. N. (2020). The effect of increasing human capital investment on economic growth and poverty: A simulation exercise. *Journal of Human Capital, 14*(1), 43-83.

DESA. (2007). *Report of the Department of Economic and Social Affairs of the United Nations, New York*. Retrieved from

Ericsson, K. A. (2014). Why expert performance is special and cannot be extrapolated from studies of performance in the general population: A response to criticisms. *Intelligence, 45*, 81-103. doi:https://doi.org/10.1016/j.intell.2013.12.001

Gyimah-Brempong, K., & Wilson, M. (2004). Health human capital and economic growth in Sub-Saharan African and OECD countries. *The quarterly review of economics and finance, 44*(2), 296-320. doi:https://doi.org/10.1016/j.qref.2003.07.002
Hamid, A., & Pichler, J. H. (2009). Human capital spillovers, productivity and growth in the manufacturing sector of Pakistan. *The Pakistan Development Review*, 125-140.
Hussain, A., Khan, M. A., & Khan, M. H. (2020). The influence of training and development on organizational commitment of academicians in Pakistan. *Review of Economics and Development Studies, 6*(1), 43-55. doi:https://doi.org/10.47067/reads.v6i1.183
Imran, M., Bano, S., Azeem, M., Mehmood, Y., & Ali, A. (2012). Relationship between human capital and economic growth: use of co-integration approach. *Journal of Agriculture and social sciences, 8*(4), 135-138.
Jaiyeoba, S. V. (2015). Human capital investment and economic growth in Nigeria. *African Research Review, 9*(1), 30-46. doi:https://doi.org/10.4314/afrrev.v9i1.4
Kazmi, S., Ali, K., & Ali, G. (2017). *Impact of human capital on economic growth: Evidence from Pakistan*. Retrieved from
Keeley, B. (2007). Human Capital: How What You Know Can Shape Your Life. *Danvers, MA, Ed*.
Kemal, A. R. (1981). Substitution elasticities in the large-scale manufacturing industries of Pakistan. *The Pakistan Development Review*, 1-36.
Khilji, B. A., Kakar, Z. K., & Subhan, S. (2012). Impact of vocational training and skill development on economic growth in Pakistan. *World Applied Sciences Journal, 17*(10), 1298-1302.
Kniivilä, M. (2007). Industrial development and economic growth: Implications for poverty reduction and income inequality. *Industrial development for the 21st century: Sustainable development perspectives, 1*(3), 295-333.
Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of Monetary economics, 22*(1), 3-42. doi:https://doi.org/10.1016/0304-3932(88)90168-7
Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics, 107*(2), 407-437. doi:https://doi.org/10.2307/2118477
Mincer, J. (1996). Economic development, growth of human capital, and the dynamics of the wage structure. *Journal of Economic Growth, 1*, 29-48. doi: https://doi.org/10.1007/BF00163341
Mustafa, U., Abbas, K., Saeed, A., & Anwar, T. (2005). Enhancing Vocational Training for Economic Growth in Pakistan [with Comments]. *The Pakistan Development Review*, 567-584.
Nelson, R. R., & Phelps, E. S. (1966). Investment in humans, technological diffusion, and economic growth. *The American economic review, 56*(1/2), 69-75.
Nilsson, A. (2010). Vocational education and training–an engine for economic growth and a vehicle for social inclusion? *International Journal of Training and Development, 14*(4), 251-272. doi:https://doi.org/10.1111/j.1468-2419.2010.00357.x
Olayemi, S.-O. (2012). Human capital investment and industrial productivity in Nigeria. *International Journal of Humanities and Social Science, 2*(16), 298-307.
Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics, 16*(3), 289-326. doi:https://doi.org/10.1002/jae.616
Romer, P. M. (1989). Human capital and growth: Theory and evidence. In: National Bureau of Economic Research Cambridge, Mass., USA.
Schultz, T. W. (1961). Investment in human capital. *The American economic review*, 1-17.
Strauss, J. (1986). Does better nutrition raise farm productivity? *Journal of political economy, 94*(2), 297-320.
Syrquin, M. (2010). Kuznets and Pasinetti on the study of structural transformation: Never the Twain shall meet? *Structural Change and Economic Dynamics, 21*(4), 248-257. doi:https://doi.org/10.1016/j.strueco.2010.08.002
Teixeira, A. (1998). Human capital stock: an estimation of a time series for Portugal. *Estudos de Economia, 18*(4), 423-442.
Todaro, M. P., & Smith, S. C. (2009). *Economic development*: Pearson education.
Umer, F., & Alam, S. (2013). Effect of Openness to Trade and FDI on Industrial Sector Growth: A Case Study for Pakistan. *Romanian Economic Journal, 16*(48).
UNIDO, T. (2013). Sustaining employment growth: the role of manufacturing and structural change. United Nations Industrial Development Organization Report. In: Geneva: United Nations.

Valero, A. (2021). Education and economic growth. In *The Routledge Handbook of the Economics of Education* (pp. 555-582): Routledge.
Wagner, A. (2005). Robustness, evolvability, and neutrality. *FEBS letters, 579*(8), 1772-1778. doi:https://doi.org/10.1016/j.febslet.2005.01.063
Walsh, J. R. (1935). Capital concept applied to man. *The Quarterly Journal of Economics, 49*(2), 255-285. doi:https://doi.org/10.2307/1884067
World Bank, w. (2022). *World development indicators*. Retrieved from https://databank.worldbank.org/source/world-development-indicators
World Bank, w. (2023). *Pakistan Human Capital Review: Building Capabilities Throughout Life*. Retrieved from https://www.worldbank.org/en/region/sar/publication/pakistan-human-capital-review-building-capabilities-throughout-life#:~:text=Pakistan's%20Human%20Capital%20Index%20(HCI,average%20HCI%20value%20of%200.40.