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Human Resource, Technology and Economic Development (A Case Study of Pakistan)

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ABSTRACT

This study analyzes the impact of Human Resource Development (HRD) and foreign technology proxied by foreign R&D capital stock, imports of capital goods and FDI on economic growth and development of Pakistan over the period of 1972-2010 by employing co-integration analysis based on Autoregressive Distributed Lag (ARDL) model. Estimates show positive impact of foreign R&D capital stock and imports of capital goods, and negative effect of FDI on economic growth of Pakistan. Absorptive capacity of Pakistan in terms of education shows that present quality of education negatively impacts per capita GDP in the scenario and emergence of a knowledge-based and technological society and new global requirements about human resource characteristics. Quality education and market-driven skills are vital determinants of economic growth for all countries generally and for Pakistan specifically. None of the previous studies has used foreign R&D capital stock measured by domestic R&D capital stock of advanced countries weighted by their import share in the GDP of developing countries for single country case as well as impact of these three channels of foreign technology transmission on the economic growth of the economy simultaneously. Thus this research has filled this gap in literature in the Pakistan context. Pakistan has to develop her human capital in order to survive in the technological global world and achieve faster and sustained economic growth and development.

KEYWORDS*:* Technological Diffusion, Human Resource Development, Foreign R&D Capital Stock and Spillovers, Capital Imports, FDI.

1 INTRODUCTION

Achievement of Sustained output growth has been emphasized by development economists and macroeconomic policy makers as a fundamental objective. That is why much work has been done in the search of determinants of economic and income growth ([8]; [25]; [26]; [33]; and [40]). In the search of determinants of economic growth, recent advances of endogenous growth theory highlighted the importance of human capital and knowledge as an engine for sustained economic growth and development as compared to traditional theories of growth which focused on the factor accumulation for sustained growth. Economic integration acts as a source for using foreign knowledge and technology in the domestic production via foreign trade and capital imports that ultimately promotes total factor productivity. A country can benefit more from foreign research and development (R&D) through imports of more machinery and equipment. Empirical evidence shows that countries trading with World's technological leaders experienced faster growth than those who did not trade with technological leaders. Now-a-days promotion of knowledge (technology) is necessary to catch up the developed countries as well as compete with them in international markets. A well developed and educated workforce has been considered as an important factor for attracting foreign direct investment which in turn integrates the economy into the global world.

Since 1990s, the emphasis on the globalization of trade and finance has been provoked by development paradigm due to accumulation of knowledge. Since 1980s, the share of world trade has increased by 5 times in real terms and from 36 percent to 55 percent of world GDP over the period. A number of low and middle income countries converged to new trading system (IMF, 2007). The global FDI inflow has also increased by 40 percent and has biased towards those economies which have skilled labor force that can adopt foreign technological advances, knowledge and information (UNCTAD, 2008).

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Globalization is a source of promoting income growth, human capital development, technological advances and spillovers in all regions and countries via increased foreign direct investment in the host county. This feature of globalization has been proposed by Kuznets hypothesis which describes that after the transitional phase, industrialization will eventually shrink the inequalities among countries [52].

The beneficial effects of globalization can be utilized by utilizing the foreign technological spillovers. As these technological spillovers are basically local instead of international[1] that is why technologically less developed countries develop close links with technologically more advanced countries in order to explore these spillovers and production facilities. This investment motive of technologically less developed countries has been termed as "technology acquisition" or "technology sourcing" and has been empirically proven[2].FDI inflows enhance economic growth of the host country by promoting manufacturing exports [34]. FDI as a technological diffusion channel is more complex and have data scarcity issue as compared with international trade. That is why FDI has been considered as an inefficient proxy for multinational enterprises, so that technological and knowledge spillovers via FDI has received little attention [77]. Technology transfer from developed countries has multiple channels, one of which is technology oriented machinery and intermediate goods and transport equipment. Multinational Enterprises (MNEs) also transmit international technology through FDI.

For the utilization of foreign technology and managerial skills transmitted by foreign investors, absorption capacity of host country matters a lot. [60] and [13] measured the absorption capacity in terms of human capital. Moreover, a number of studies as discussed above have found the negative effect of FDI on economic growth of the developing countries because of inadequate and insufficient level of human capital along with some other influential factors like lack of basic infrastructure, socio-political issues etc.Pakistan has also failed to capture the positive effect of technological learning by foreign direct investment. Because of these inefficiencies and lack of capabilities, Pakistan has lost 40% inflow of foreign direct investment in 2010. As indicated by UNCTAD (2010), local firms cannot benefit from foreign technology, information and knowledge transmitted by foreign direct investment unless they maintain a minimum threshold level of absorptive capacity (skills and knowledge). Since late 1980s, Pakistan has adopted liberal trade and investment policies by reducing the average tariff rate to 20 percent in 2001-02. Since 1997, Pakistan has given 100 percent conditional foreign ownership in most of the sectors of economy with national treatment provision and duty and tax exemption under FDI followed by WTO obligations. Unfortunately, in spite of all these implications, FDI to GDP ratio of Pakistan has remained less than 1% along-with insignificant effect of FDI on economic growth of Pakistan due to inefficiencies in human capital, infrastructure and some other important factors.

Almost all the economists and policy makers are agreed on the positive effect of foreign technology, knowledge and research and development capital on the productivity enhancement and economic growth of developing countries. But there is much controversy about the most effective channel for foreign technology transmission. Some economists postulate that the country with a high degree of openness in term of exports and imports along-with adequate human capital can benefit more from foreign technology [23].While some other economists argue that an exporter country will be more productive and efficient than non-exporter [14]. As "learning by exporting" hypothesis stems that when exporting country enters in international market, she has to improve the quality and standard of her product in order to compete with global standard as well as to fulfill the requirement of foreign customers. In this way the firms of exporter country will have to improve the quality of product according to the latest knowledge, technical expertise and efficiency level which they have learnt from the international market. Furthermore, by specialization and division of labor, economies of scale will be achieved on one side. And on the other side, per unit cost of production will be reduced by adopting modern method of production. Thus reduction in trade restrictions will increase surplus of consumers as well as of producers of developing countries like Pakistan.

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[1] [6]; [17]; and [48].

[2] [50]; [69][61]; and [68].

Another school of thought postulates that cumulative domestic research and development capital stock and domestic knowledge are more effective channels for capturing the foreign technology spillovers and promoting the domestic productivity ([22]; [35]). Domestic research and development capital stock and R&D efforts of trading partners are very helpful tools for utilizing the international spillovers transmitted by international trade, FDI and international exchange of knowledge and information. A country can benefit from its own existing resources, foreign technical and technological advances on the basis of domestic R&D capital stock. While from foreign R&D capital stock, the country can benefit by learning and exploiting the new technologies, organizational methods and production materials as well as by importing technological knowledge and advances embodied goods and services [23].

In view of this controversy about the different channels of foreign technology transmission, we used in this study, all these three channels to find the most significant channel for foreign technology transmission in the case of Pakistan. In order to measure the absorptive capacity of Pakistan for foreign technology and knowledge, we used the enrollment level of all educational institutes of Pakistan. Whereas, we used imports of machinery, transport equipment and technology imports for the assessment of productivity promotion of Pakistan associated with the use of these capital imports from developed and advanced countries. The per unit increase in GDP associated with foreign competition and other production and organizational spillovers has been assessed by the relationship of foreign direct investment and GDP per capita. In this technological era and knowledge society, research and development capital is essential for the progressive survival of any economy in the global village. Domestic research and development capital stock and domestic knowledge promote the absorption capacity of economy. But unfortunately both of these factors are in scarce supply in Pakistan. In these circumstances, Pakistan can only benefit from technological advances, knowledge, research and information by utilizing the research and development capital stock of its developed import trade partners which have considerable level of cumulative domestic R&D capital stock. We measured the foreign stock of research and development capital stock by bilateral import-share weighted average of domestic R&D capital stock of importing trade partners of Pakistan.

1.2. **Objectives of the Study.** This study serves a number of objectives: (i) To examine the significance of human resource for economic development, foreign R&D capital stock utilization and foreign direct investment of Pakistan. (ii) To find the long-run and short-run impact of technology transmission on per capita income of Pakistan. (iii) To evaluate compatibility of human resource of Pakistan with global technology breakthroughs.(iv)To give suggestions for trade policy, domestic R&D capital stock building and imitation of foreign technology.

1.3.Significance of the Study. All the previous literature has used panel study analysis for analyzing the impact of foreign knowledge peroxied by cumulative domestic R&D capital stock of importing trading partners weighted by their share of imports in the GDP of developing countries. Moreover no study has used the impact of these three channels of foreign technological diffusion and spillovers i.e. FDI, foreign R&D capital stock and imports of capital stock, on the economic growth and development of any economy by using time series as well as panel data analysis. This is the first study which has analyzed the impact of foreign R&D capital stock along-with imports of capital goods and FDI on economic development of a single country of Pakistan simultaneously by using time series data. In this way, our study has filled this gap of literature.

2. **REVIEW OF LITERATURE**

[20]analyzed two different impacts of foreign technological knowledge and spillovers on growth and productivity through competitive effect and technological diffusion effect. His estimates showed that foreign technological knowledge and spillovers enhanced the productive capacity of domestically owned firms through increasing value added per worker in the industry in which the output production is proportionally higher in foreign owned firms. [15]found a significant and positive effect of FDI biased towards higher income developing countries which have relatively increased level of absorption capacity. But they analyzed that absorption capacity of an economy is not the only factor to utilize the FDI. [23]found positive and significant impact of domestic and foreign R&D measured by domestic R&D capital stock of trade partners weighted import shares on the TFP of 21 OECD countries and Israel over the period of 1971-90. They used pooled data for the estimation of innovation-driven growth model. They emphasized that an open economy for foreign trade will reap more significantly and beneficially the impact of foreign R&D capital and international spillovers on domestic growth and productivity. Moreover, elasticity of TFP with respect to R&D capital stock is larger and significant for large countries as compared

to small countries. They found that domestic R&D is most important for TFP of developed G7 countries as compared to foreign R&D.

[32] estimated the extended Cobb Douglas production function to analyze the impact of workforce, capital, investment-to-GDP ratio, domestic R&D investment, foreign R&D capital stock, measured in terms of domestic R&D capital stock of import partners weighted by bilateral import share to GDP ratio, on the GDP of eleven Asian countries categorized by High Performing Asian Countries (HPAC) and Medium Performing Asian Countries (MPAC) for the period 1970-1993. Results showed that coefficients of workforce and capital are positive and significant. But the coefficients of international spillover R&D capital stock, foreign R&D capital stock (international spillover R&D capital stock) and investment-GDP ratio have negative signs. Whereas the coefficient of interaction term of foreign R&D capital stock with school enrollment ratio is negative as well as non-significant. While random effect model showed that interaction term of foreign R&D capital stock with school enrollment ratio as well as with import shares is positive and non-significant. Thus it emphasized on investment in human capital and openness for generation of enhanced absorptive capacity. Furthermore, results showed that HPAC had more absorptive capacity for foreign technological spillovers than MPAC.

[79] employed OLS with white's hetroskedasticity consistent covariance estimation method on Cobb-Douglas production function to analyze the impact of foreign technological transformation of industrialized countries through trade of capital goods, inward and outward FDI, on LDCs' TFP by using data from 1971 to 1990 for 21 OECD countries. They revealed that technology transformation has remarkable positive impact on TFP growth of these countries. They assessed the role of FDI for the transformation of foreign technology and knowledge by using a sample of 13 OECD countries over the period 1983-90. The results indicated that outward FDI transfer imported technology back towards innovating country through multinational enterprises. This study has not taken into account the indigeneity problem of variables that lies in Cobb-Douglas production function. There is also a need to build theoretical justification for econometric issues and methods of study.

[5] explored the presence of Bhagwati hypothesis, FDI significantly affect economic growth under export promotion (EP) regime instead of import promotion (IP) regime, in Pakistan by using time series data and Engle-Granger (*EG*) and Hansen techniques over the period 1970-2001. They have estimated the long run relationship among GDP, FDI, labor force, gross capital formation as a percentage of GDP, education expenditure as a percentage of GDP and total merchandise trade to GDP ratio. Results showed that overalls impact of FDI is positive and significant for Pakistan economy as negative coefficient of FDI is greater than the interaction term of FDI and merchandise trade. So, They have suggested that Pakistan should has to shift its policy regime from IS to EP. And she should give priority to FDI and HRD in its outward looking development strategy.

[43]theoretically analyzed four major channels of foreign knowledge and technology transmission from DCs to LDCs, which are foreign trade in goods, FDI, international mobility of people, trade in knowledge or transmission of techniques and methods of production. They found that total factor productivity (TFP) of LDCs' is strongly enhanced by technical imported goods from industrialized developed countries. That's why they have suggested liberal trade policies for domestic economy as well as certain type of policy recommendations for WTO trade related rules.

[51] investigated the impact of international spillovers through foreign R&D embodied imports and FDI on the growth of 27 transition and 20 western European countries by employing co-integration test and latest technique of panel unit root over the period 1990-2006. Domestic R&D capital stock and human capital have been treated as control variables and as a proxy for absorption capacity of importing country, which have strong impact on the TFP of nominated countries. The study indicated that foreign trade and FDI are significant channels of transferring foreign technology but former has relatively stronger impact on TFP of DCs and LDCs as compared to the latter. In view of these results he concluded that an economy with significant absorptive capacity and domestic R&D capital stock can significantly exploit foreign technology and spillovers.

3. THEORETICAL FRAMEWORK AND DATA SOURCES.

Empirical studies related to the determinants of economic growth explain that economic growth of countries depends upon increased total factor productivity rather than factor accumulation [28]. Technological catch-up of developing to developed countries is strongly based upon foreign technology breakthrough, foreign trade, foreign direct investment and imports of foreign technological knowledge and information embodied capital imports along-with domestic research and development capital stock of developed import partners. But all these channels of foreign technological transmission are dependent upon the developed human capital. [1]indicated that over past 60 years technical breakthrough is skill oriented so it is biased toward high level of skills and education. Level of education and skills are a pre-requisite to absorb, adopt and implement foreign technology and innovations and also for domestic technological and scientific innovations [71]. This view is contrary to the New Classical growth theory and early models of endogenous growth theory. These theories have considered technology as an exogenously and universally available factor. A number of models show the complementary relationship among human capital and technological innovations and imitations. Likewise [60] also presumed that imitation and adoption of foreign technological innovations of developing countries from developed countries are significantly and positively affected by developing countries' level of education. That is why standard cross-country regression has specified and derived a human capital augmented production function [57]. In this Cobb-Douglas production function, per capita income proxied for economic development of the economy in a given period of time depends upon labor force (L), physical capital (K) and human capital (H) as:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} H_t^{\gamma} \quad (1)$$

But contrary to it, [13] defined human capital as a factor that directly impacts productivity rather than specified it as an input factor like L and K. So, now Cobb-Douglas production function will be specified as:

$$Y_t = A_t (H_t) K_t^{\alpha} L_t^{\beta} \quad (2)$$

Productivity level of an economy can be enhanced by a number of channels that depend upon foreign trade [37]. International trade enhances domestic productivity by introducing an ample variety of high tech intermediate and capital goods and equipment along-with improved product design and increased competitiveness. Foreign Direct Investment (FDI) is also a component of globalization. It enables a country to increase value added per unit of input by employing cross-border learning of production and organizational methods. Thus, in this era of scientific and technological innovations, imitation and adoption of foreign technology is a significant determinant for promotion of economic growth. In view of this, [24] and [12] used domestic research and development capital stock of developed importing partners of developing countries that can be utilized by developing countries. And GDP ratio of capital imports of developing countries, imported from the developed import partners which have significant domestic research and development expenditures in their GDP. Import of technology goods is a significant channel of foreign technology transfer and a determinant of productivity as indicated by [23], [47], [24], [77] and [58]. A country can benefit from technological information, breakthrough and knowledge spillover by importing technology goods from them. We have considered this effect of industrialized countries' stock of knowledge and technology through imports of Technology goods divided by total imports of Pakistan (MKG) ([19]; [29]; and [37]).

According to [36] rate of return from investment in R&D is much higher than investment in structures, equipment and machines. Benefits of R&D spillovers are substantial for industrialized countries as well as for their developing trade partners [23]. Developing countries can achieve substantial marginal benefits from domestic research and development capital stock of industrialized developed countries by composing their import to GDP ratio biased towards these industrialized countries. Thus impact of foreign R&D capital stock (T) on Pakistan's economic growth has been measured by weighted average of domestic research and development capital stock of industrialized developed import partners of Pakistan by serving import share of these developed countries in the GDP of Pakistan, as weights. Domestic research and development capital stock is also very significant and important factor for promotion of economic growth and development. However due to non-availability of data on domestic R&D capital stock and insignificant amount of R&D capital stock of Pakistan like other developing countries [23], we dropped this variable from the estimated equation. By inserting these three channels of foreign technological diffusion, knowledge and R&D capital stock, we reach at testable equation of Pakistan based upon literature and theoretical background of the study.

$$\ln(Y)_t = \beta_0 + \beta_1 \ln(K)_t + \beta_2 \ln(L)_t + \beta_3 (MKG)_t + \beta_4 (FDI)_t + \beta_5 (T)_t + \beta_6 \ln(H)_t + \mu_t \quad (3)$$

Where Y is GDP per capita and is used as a proxy for economic development of Pakistan. MKG is technology goods import intensity defined as imports of technology goods divided by total imports. FDI is foreign direct investment to GDP ratio of Pakistan. K and L are gross fixed capital formation and number of employed workers, which act as the core determinants of production. Total education including enrollment of all kinds of educational and occupational institutions of Pakistan are taken as a proxy for human capital. All variables have been taken in natural log except for ratio variables that are MKG, FDI and T. $\mu_t$is a random error term.

3.1. Data Sources. Data of gross fixed capital formation (Rs. Millions) and GDP per capita (Rs. Millions), imports of technology goods and total education were taken from Pakistan Economic Survey (various issues). The data for employed labor force was taken from International Labor Organization. The variable of foreign research and development capital stock was calculated from the domestic gross expenditure on research and development (GERD) data from the OECD's Main Science and Technology Indicators. This data was in nominal terms, so we deflated it by using R&D price index that is as follows:
R&DPI = 0.5 WPI + 0.5 CPI
Where WPI and CPI are the wholesale price index and consumer price index, respectively. Research and Development capital stock (S) was calculated by using following perpetual inventory method on the basis of domestic R&D expenditures.

$$S_t = (1 - \delta)S_{t-1} + R_{t-1}$$

Where δ is the depreciation rate and is taken as 5 percent. Benchmark for research and development capital stock (S) has been calculated by Griliches (1988) procedure that is as:

$$S_0 = {R_0}/{(g + \delta)}$$

Where g is the annual logarithmic growth rate of R&D expenditures on average over the period for which published data of R&D was available, R_0 is the first year's available R&D data and S_0 is the benchmark for the first year research and development capital stock.

We used data on domestic R&D expenditures from the paper of [23] over the period 1971-80 and further we generated domestic R&D capital stock of countries by using perpetual inventory method on the basis of gross domestic R&D expenditures.

The year of 1971 was very critical period for Pakistan due to the separation of East Pakistan so we used the period for estimation from 1972 to 2010. The data for visual analysis via tables and graphs has been taken from HEC, Annual report of State Bank, WDI and Pakistan Economic Survey (Various issues).

4. ECONOMETRIC SPECIFICATION.

Co-integration analysis tests the existence of long run relationship through linear combination of non-stationary variables. Existence of co-integration among any set of variables shows that in the long run variables will come to their equilibrium position even in short run if they show fluctuations against the equilibrium position ([4]; [30]). Co-integration technique developed by [31], [44] and [45] is an inconsistent and unreliable technique for small sample size and its pre-requisite is the same integration level for all variables. This condition is seldom fulfilled in most of the studies ([39]; [49]; [56]; [67]).

In order to get rid of the drawbacks of co-integration technique described above, Pesaran and Pesaran [64], Pesaran and Smith [66] and Pesaran et al. [65] developed a technique based upon general-to-specific modeling technique called ARDL Model. This model is suitable for short run as well as for long run and after the recognition of lags for ARDL model the co-integration can be showed by simple OLS [59]. ARDL bounds testing approach to co-integration can be estimated efficiently and reliably for small sample size [41] as well as it creates data generating process under the general-to-specific framework by taking satisfactory number of lags [53]. It also takes into account the problem of endogeneity of descriptive variables. A dynamic ECM obtained by ARDL, after simple linear transformation, integrates short run dynamics and speed of adjustment to long run from short run disturbance along with long run information [9]. The decision of co-integration under bounds testing approach is based upon F statistic which is sensitive to first differenced variables' lag numbers [7]. So after imposing restrictions on coefficients with null hypothesis, F statistic can be carried out. Null hypothesis under ARDL model indicates that there is no long run relationship among variables and vice versa for alternative hypothesis. If F statistic is greater than the upper bound, it will lead to rejection of null hypothesis and if it is less than the lower bound we cannot reject the null hypothesis. Finally, if F statistic lies between the two bounds, the decision of co-integration will be inconclusive.

4.1.Unit Root Analysis. Stationarity test for data series is a prerequisite for any econometric model in order to avoid estimation of spurious regression and unreliable results that emerge due to non-stationary of data. As [63] reported that it is prerequisite condition for bounds testing that data series must be integrated of order I(0) or I(1). Otherwise in case of integration at I (2), the computed F statistic value will become invalid Pesaran et al., [65].

Dickey and Fuller [27] developed Augmented Dickey Fuller test to check the stationary of data and it uses higher order lags to control the higher order serial correlation as ADF can be used with correlated error term. Null Hypothesis under ADF test is about the non-stationary of series against the alternative hypothesis that assumes the series to be stationary i.e.

$H_0 = \delta_2 = 0$

$H_1 = \delta_2 = 1$

The following regression equation has been estimated under ADF test:

$\Delta Z_t = \delta_0 + \delta_1 t + \delta_2 Z_{t-1} + \sum_{k=1}^{n} \varphi_k \Delta Z_{t-k} + v_t$ ……………………………………….. (4)

In order to make error term, v_t, serially uncorrelated, we have to include n number of lagged changes in Z_t by assuming homoskedastic or white noise error term.

Equation 5.5 and 5.6 are also related to ADF test in which data series are characterized by I (1) process with a drift and without a drift as:

$\Delta Z_t = \delta_0 + \delta_2 Z_{t-1} + \sum_{k=1}^{n} \varphi_k \Delta Z_{t-k} + v_t$ …………………………………………………………………..…(5)

And

$\Delta Z_t = \delta_2 Z_{t-1} + \sum_{k=1}^{n} \varphi_k Z_{t-k} + v_t$ ………..………………………………………………………………..……(6)

The decision about presence and absence of unit root depends upon t statistic.

τstatistic $= \frac{\hat{\delta}_2}{SE(\hat{\delta}_2)}$...(7)

If the value of calculated τ statistic is greater than critical tabulated values developed by MacKinnon (1990) then we will be able to reject the null hypothesis related to unit root of the data series and do not reject alternative hypothesis based upon stationary status of data and vice versa.

Furthermore, Ng and Perron [62] proposed that first estimate ADF test by setting upper bound with n_{max}, if absolute value of t statistic is greater than 1.6 then use same n_{max} lag length and apply unit root test. Otherwise in case of less than 1.6 value of t statistic, reduce lag length by one and repeat the same process in order to avoid practical problem of lag length selection under ADF test.

4.1.1. Phillips-Perron Test (PP). Phillips-Perron test is a modified generalized form of ADF test developed by Phillips and Perron [67] that incorporates an automatic correction to auto-correlated error term. PP test has same test hypothesis and regression equations like ADF i.e. with drift and time trend and without drift and time trend. Its t statistic is also same as that of ADF test so it is comparable with MacKinon[55] tabulated values.

5. STABILITY TEST

Brown, Durbin, and Evans [18] proposed and Pesaran et al. (2001) suggested CUSUM test for structural stability of parameters and CUSUM square test to check the constancy of parameters, in short run and long run, based upon recursive residuals which have following characteristics with constant parameters assumption:

$RR_t \sim N[0, \frac{\delta^2}{n-1}]$ .... (8)

Null hypothesis of this test states the consistency of parameters and RR_t^2 are distributed $X^2(1)$ variables. The anticipated value of numerator and denominator is (t-i) and (T-i), respectively.

So

$E(S_t)$= t-i/T-i ....(9)

t=i+1,i+2,i+3,…,T

The significance of divergence of both tests can be evaluated by drawing two parallel lines around the mean value under 5% critical bounds that passes through the following points:

$(T_t, d\sqrt{T-i})$ and $(T_t, \pm 3d\sqrt{T-i})$

Where d parameters depend upon selected significance level (α) for the test and normally it takes value of 5%.

If the graphs of CUSUM and CUSUMSQ stay within the bounds then null hypothesis about stability, constancy and proper specification of parameters can't be rejected.

6. ARDL BOUNDS TESTING PROCEDURE.

Bounds testing approach developed by Pesaran et al. (2001), Pesaran and Pesaran and Pesaran [64] and Pesaran et al. [65] to test long run relationship are a prior step before testing ARDL model. For above mentioned purpose, we estimated following equation for all variables that include short run as well as long run estimates of long run co-integration among variables.

$$\Delta \ln(Y_t) = \alpha + \sum_{i=1}^{m} \alpha_{1i} \Delta \ln(Y)_{t-i} + \sum_{i=0}^{m} \alpha_{2i} \Delta(MKG)_{t-i} + \sum_{i=0}^{m} \alpha_{3i} \Delta \ln(EDU)_{t-i}$$

$$+ \sum_{i=0}^{m} \alpha_{4i} \Delta \ln(L)_{t-i} + \sum_{i=0}^{m} \alpha_{5i} \Delta \ln(T)_{t-i} + \sum_{i=0}^{m} \alpha_{6i} \Delta \ln(K)_{t-i} + \sum_{i=0}^{m} \alpha_{7i} \Delta(FDI)_{t-i}$$

$$+\delta_1 \ln(Y)_{t-1} + \delta_2 (MKG)_{t-1} + \delta_3 \ln(T)_{t-1} + \delta_4 \ln(L)_{t-1} + \delta_5 \ln(K)_{t-1} + \delta_6 (FDI)_{t-1} + \delta_7 (EDU)_{t-1} + v_t \quad \Delta \quad \ldots\ldots (10)$$

Where αs are denoting short run coefficients and δs are showing long run multipliers while m is the optimal lag length of ARDL model in above equation. The null and alternative hypotheses under ARDL model are as follows:

H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$

$H_{1;}$ $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq \delta_7 \neq 0$

These hypotheses will be tested by using Wald Test for which F statistic will be computed from equation 5.10. Moreover, this calculated F statistic will be compared with critical values, tabulated by Pesaran et al. [65] table. If this computed F statistic is greater than upper bound then null hypothesis indicating no co-integration will be rejected in favour of the alternative hypothesis. If the computed F statistic is smaller than lower bound then null hypothesis indicating no co-integration will not be rejected. And finally if the value of F statistic lies within the critical bounds then the test of co-integration will be nominated as inconclusive.

6.1. Empirical Findings and Results Discussion. Stationarity test for variables is a pre-requisite for estimation of any econometric model. So, before applying bounds testing approach we have to check stationarity status of variables so that our results should not be spurious and unreliable by misleading value of F statistic. For this purpose we applied Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test to check out the stationarity status of variables. The results of both of these tests are presented below:

Table 1
Augmented Dickey Fuller Test

variables	Level		1st difference	
	With intercept	With trend and intercept	With intercept	With trend and intercept
(MKG)	-3.579063*	-3.521069***		
ln(TEC)	2.038467	-1.021337	-6.084707*	-7.291713*
ln(L)	.462999	-1.270544	-5.823433*	-5.832488*
ln(EDU)	-522257	-1.829499	-6.439245*	-6.516761*
ln(K)	-1.830423	-2.691438	-4.180878*	-4.366245*
FDI	-3.504487*	-3.441427**		
Ln(Y)	-0.351135	-1.670772	-4.984107*	-4.906820*

, **, * denotes significance level at 1%, 5% and 10%, respectively.*

ADF results show that imports of technology goods variable and Foreign Direct Investment variable are stationary at level while technology measuring variable, capital, Labor, total education variable peroxide for human resource and GDP per capita are integrated of order one because null hypothesis of non-stationary has not been rejected at level for these variables based upon t statistic.

Results of Phillip-Perron test are showing same results about stationarity status of variables as shown by ADF test. Phillip-Perron test shows that imports of technology goods and foreign direct investment variables are stationary at level i.e. integrated of order I (0). Whereas technology measuring variable, Labor, capital, Total education and GDP per capita variables are integrated of order I (1).

Table 2
Phillips-Peron (PP) Test

variables	Test statistic at Level		Test statistic at 1st difference	
	With intercept	With trend and intercept	With intercept	With trend and intercept
(MKG)	-3.579063*	-3.521069**	-	-
Ln (TEC)	3.590832	-0.715437	-6.086029*	9.132905*
Ln (L)	.482398	-1.362049	-5.819972*	5.828490*
Ln (EDU)	.638988	-1.824032	-6.439394*	6.542707*
Ln (K)	-1.830423	-1.636441	-4.219393*	4.366245*
FDI	-3.514599*	-3.450153**	-	-
Ln(Y)	-0.617911	-1.769678	-5.034605*	4.961226*

, **, * denote significance level at 1%, 5% and 10%, respectively.*

6.2. Results of ARDL Bounds Testing. Table 3 contains value of computed F-statistic from equation 5.10. The optimal lag length is 2 which has been selected according to the David Hendry's general-to-specific approach about lag selection. The F-statistic has a value of 5.22 which is greater than upper bound tabulated value of F-statistic at both 10% and 5% significance levels. Thus we reject the null hypothesis of no co-integration and accept the alternative hypotheses that dependent and independent variables of the model are highly co-integrated over long run.

Table 3
Wald's F-Statistic for Co-Integration

Calculated F- statistic	At 10% level of significance		At 5% level of significance	
	Lower bound I(0)	Upper bound I(1)	Lower bound I(0)	Upper bound I(1)
5.22	2.03	3.13	2.32	3.50

After the confirmation of long-run co-integration among dependent and independent variables of our model, we proceed towards long-run estimates of ARDL model based upon equation 7.14. Estimates of long-run ARDL model are tabulated in Table 4 below:

$$\ln(Y_t) = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i}\ln(Y)_{t-i} + \sum_{i=0}^{m} \alpha_{2i}(MKG)_{t-i} + \sum_{i=0}^{m} \alpha_{3i}\ln(EDU)_{t-i} + \sum_{i=0}^{m} \alpha_{4i}\ln(L)_{t-i} + \sum_{i=0}^{m} \alpha_{5i}\ln(T)_{t-i} + \sum_{i=0}^{m} \alpha_{6i}\ln(K)_{t-i} + \sum_{i=0}^{m} \alpha_{7i}(FDI)_{t-i} + u_t ----------(14)$$

Table 4
Long-run Coefficients
ARDL (1, 0, 1, 1, 0, 0, 1) Selected Based on Schwarz Bayesian Criterion

Dependent variable is ln(Y); 40 observations from 1972 to 2009				
Regressor	**Coefficient**	**Standard error**	**T- Ratio**	**Probability**
Constant	2.742	.241	11.392*	[.000]
(MKG)	.003	.001	2.262*	[.033]
ln(T)	.0185	.011	1.756**	[.092]
ln(L)	.692	.184	3.751*	[.053]
ln(EDU)	-.083	.039	-2.149*	[.042]
ln(K)	.1853	.084	2.217*	[.037]
FDI	-.002	.169	-.014	[.989]

** and ** denote 5% and 10% levels of significance, respectively.*

Table 4 shows long-run relationship between GDP per capita and imports of capital goods intensity, foreign technology spillovers, labor, capital, education and foreign direct investment.

Results show that all variables positively impact GDP per capita in long run except FDI and education because education is not enriched in quality that is a prerequisite for foreign technological adoption and absorptive capacity.Further, results indicate that imports of capital goods intensity (MKG) has positive and significant effect on per capita income as 10% increase in imports of capital goods (capital, machinery, parts of machinery and transport equipment) leads to .03% increase in per capita income. Import of capital goods intensity is a way to increase domestic as well as international competition. It can increase value addition process in domestic firms and enhance skills of labor force of Pakistan. On the other hand, it will increase incentives of foreign investors to invest in a capital oriented production processing country like Pakistan who can achieve this title by increasing imports of capital goods instead of finished luxurious items. It is also a significant source of transferring technological knowledge from industrialized innovating countries to developing ones [70]. Our results are superior to those of Akbar et al. [2], as they have estimated no significant relationship between imports and economic growth for the Pakistan economy while our research stems that imports of capital goods are not only positively affecting economic growth but are also a significant factor to enhance it.

Stock of foreign technology spillovers (T) which Pakistan has accessed, as measured by domestic R&D capital stock of her industrialized developed countries weighted by Pakistan's imports-to-GDP ratio with these importing partners, has also significant and positive impact on per capita income as 10% increase in it will lead to 0.2% increase in per capita income that will further enhance economic growth and development. Foreign technological spillover is a source to achieve foreign knowledge spillovers and technological innovations that can be imitated by developing countries like Pakistan. Furthermore, it modifies the domestic production function positively. Such technological transfer leads to enhance total productivity of economy and boost economic development aside from capital accumulation alone and is a source to explain the Solow Residual of growth ([23]; [28]; [46]; [73]; and [24]).

Traditional factors of production, capital and Labor both are positive and significant as 1% increase in capital and labor is a source to increase GDP per capita by .18% and .69%, respectively. These results supportSolow [75], Swan [76], and Romer ([71] and [72]).

Human capital variable has been used as a proxy for absorptive capacity for foreign knowledge, technology spillover and imitating capability. It was assumed to be positive and significant but it has appeared negative showing negative impact on per capita income in association with foreign technology, knowledge spillover and imports of capital goods. A 1% increase in recent low quality level of education will lead to 0.8% decline in per capita income of Pakistan. In other words, recent education quality of Pakistan in terms of absorptive capacity for foreign technological knowledge spillover will lead to decline in economic growth. Because such education cannot generate such skills and technological knowledge oriented labor force that is required and consistent for the adoption of foreign knowledge spillovers and imitation capability. Our findings support the findings of [10] who described that only more educated and trained workers can have advantage to adopt and implement the imported foreign technology. Likewise [74] has estimated negative and insignificant impact of Human development index (HDI) on economic growth of low income countries in a cross sectional study by using fixed effects model. Furthermore, our findings are also consistent with the findings of [58] who estimated that low education and skill quality of developing countries' labor force are not consistent with technologically specialized imported machinery. This low quality education of Pakistan is responsible for relatively less positive effect of technology transferring channels on per capita GDP.

Foreign direct investment is showing insignificant as well as negative impact on per capita income of Pakistan. This negative relation of FDI with economic growth can be due to well-known data issues as well as by using FDI as a poor proxy for MNEs as being unable to measure the technology related activities of MNEs [42]. Our results are consistent with the findings of [3], [21] and [54]. The insignificant and negative impact of FDI on economic growth of developing countries like Pakistan is due to lack of highly qualified and skilled labor force that is a pre-requisite and essential requirement in order to gain from capital intensive and foreign knowledge oriented FDI ([11]; [15]; and[16]). FDI is negatively affecting per capita GDP of Pakistan due to inconsistent infrastructural facilities, bad law and order conditions, energy crisis, low absorptive capacity in terms of unskilled and uneducated labor force and focus on import substitution regimes.

Finally, for the short-run dynamic parameters, ECM has been estimated using the following equation.

$$\Delta \ln(Y_t) = \alpha + \sum_{i=1}^{m} \alpha_{1i} \Delta \ln(Y)_{t-i} + \sum_{i=0}^{m} \alpha_{2i} \Delta (MKG)_{t-i} + \sum_{i=0}^{m} \alpha_{3i} \Delta \ln(EDU)_{t-i} + \sum_{i=0}^{m} \alpha_{4i} \Delta \ln(L)_{t-i}$$
$$+ \sum_{i=0}^{m} \alpha_{5i} \Delta \ln(T)_{t-i} + \sum_{i=0}^{m} \alpha_{6i} \Delta \ln(K)_{t-i} + \sum_{i=0}^{m} \alpha_{7i} \Delta (FDI)_{t-i} + \emptyset (ecm)_{t-i} + v_t \quad ----(7.15)$$

Where speed of short-run adjustment towards long-run equilibrium is indicated by 'ϕ' and estimated by equation 7.15. Results of ECM are presented in Table 5.

$$ecm_t = \ln(Y)_t - \delta_0 - \sum_{i=1}^{m} \delta_{1i} \ln(Y)_{t-i} - \sum_{i=0}^{m} \delta_{2i} (MKG)_{t-i} - \sum_{i=0}^{m} \delta_{3i} \ln(T)_{t-i} - \sum_{i=0}^{m} \delta_{4i} ln(L)_{t-i} - \sum_{i=0}^{m} \delta_{5i} \ln(K)_{t-i} - \sum_{i=0}^{m} \delta_{6i} (FDI)_{t-i} \quad (16)$$

The results of ECM confirm the short-run adjustment of prescribed model towards long-run equilibrium. As ECM coefficient shows that model will adjust towards long-run equilibrium with the speed of 39% per year from short-run disturbance.

Table 5

ErrorCorrection Representation for the Selected ARDL Model

ARDL (1, 0, 1, 1, 0, 0, 1) selected based on Schwarz Bayesian Criterion Dependent variable is dln (Y); 38 observations used for estimation from 1972 to 2009.

Regressor	Coefficient	Standard Error	T-Ratio[prob]
C	1.0663	.16702	6.3841[000]
D(MKG)	.0012474	.4481E-3	2.7840[.010]
dln(T)	.0071875	.0035907	2.0017[.056]
dln(L)	-.13052	.12230	-1.0672[.296]
dln(EDU)	-.0031814	.017608	-.18068[.858]
dln(K)	.072047	.038691	1.8621[.074]
dFDI	.011692	.059918	.19514[.847]
ecm(-1)	-.38891	.070054	-5.5516[.000]
R- Squared = 0.76258	**Adj R-squared = .63870**		
F- stat. F(9 , 26) =8.2081 , prob(F-stat) = [.000]			
Mean of Dependant Variable = .0097855			
S.D of dependant variable = .0082060			
DW – statistic = 2.3869			

R^2 explains 76% variation of dependent variable due to independent variables and the remaining is due to error term. Goodness of fit of the model and functional form are indicated by Adjusted R^2 and F statistic which are .63 and 9.2, respectively and both are significant.

7. DIAGNOSTIC TEST

Sensitivity analysis has been employed to test and evaluate the homogeneity, normality and proper specification of model.

- The specification errors of model i.e. omitted variable error, incorrect functional form, evaluation of correlation and specified data form in terms of logs, power, reciprocal or any other form are analyzed by regression specification error test (RESET) proposed by Ramsey. Null hypothesis under Ramsey RESET test hypothesis is that the model is correctly specified and vice versa for alternative hypothesis.
- Hetroskedasticity is checked by White test which is based on the regression of squared residuals on squared fitted values.
- Normality of data is checked by skewness and kurtosis of residuals.
- Serial Correlation is assessed by Lagrangian Multiplier (LM) Test.

Table 6

Diagnostic Tests

Problem	Test	X^2-statistic	F – statistic
Serial Correlation	Lagrange Multiplier	X^2=1.8208[.177]	F= 1.1720 [.291]
Normality	Skewness and Kurtosis of Residuals	X^2 =4.2996 [.117]	-----
Functional Form	Ramsey's RESET	X^2 =.4479E-3 [.983]	F= .2737E-3 [.987]
Hetroskedasticity	White	-	1.1497 [0.366]

7.1. Variance Decomposition Test. In order to investigate relative exogenous intensity of variables among each other, Variance Decomposition Test has been applied that is summarized in Table 5.4.7. It analyzes forecast error of one variable at the base of other variables. Furthermore, it shows relative strength of variable in creating fluctuations in other variables.

According to estimates of Table 7, per capita GDP (Y) is less exogenous than other variables as it explains 42 percent fluctuations by itself after 7 years. On the other hand, T, MKG, L, K, FDI and EDU explain forecast variance and fluctuations about 3.45, 9.76, 23.85, 3.82, 3.49 and 12.80 percent, respectively, after seven years.

Table 7
Variance Decompositions Test

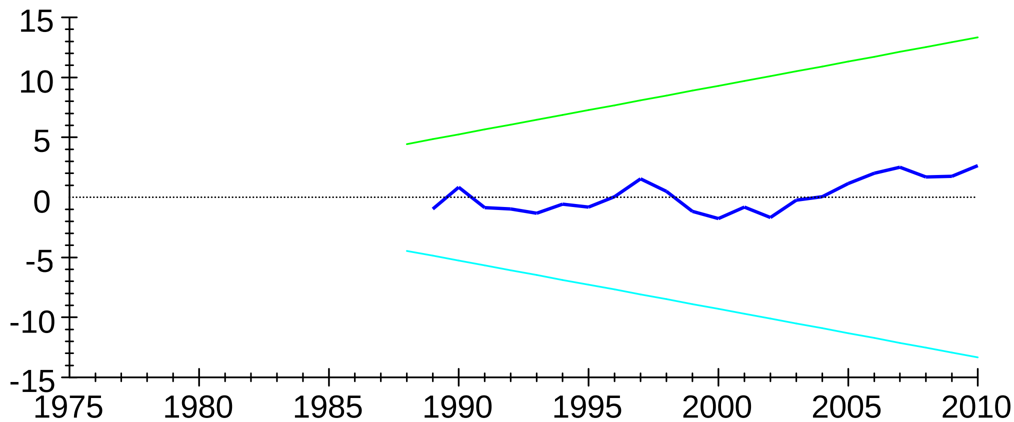
VDC of Y	Period	S.E.	Y	T	MKG	L	K	FDI	EDU
Y	1	.007300	100.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	5	0.0187	51.91	3.25	7.17	17.48	3.77	3.28	13.109
	7	0.0209	42.79	3.45	9.76	23.85	3.82	3.49	12.80
T	1	0.1473	5.2921	94.707	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.1780	8.4142	85.708	2.2126	0.0071	1.0239	2.5055	0.1283
	3	0.2203	15.205	66.985	5.7896	3.6072	5.7033	2.6197	0.0891
MKG	1	3.2695	45.511	6.9150	47.573	0.0000	0.0000	0.0000	0.0000
	2	4.1053	46.802	7.1005	34.961	0.8812	7.3543	0.5276	2.3720
	3	4.4076	47.969	6.3505	30.374	1.1562	9.7339	2.2032	2.2122
L	1	0.0081	3.6413	4.4821	14.056	77.820	0.0000	0.0000	0.0000
	2	0.0095	5.5760	3.2839	18.913	69.887	0.8286	1.0915	0.4186
	3	0.0111	6.0254	2.4542	20.211	64.484	2.6100	0.9287	3.2858
K	1	0.0302	49.774	0.3299	6.8512	0.1402	42.903	0.0000	0.0000
	2	0.0466	56.823	1.6292	9.6750	1.1470	30.089	0.2199	0.4165
	3	0.0560	53.490	4.2601	10.438	2.3583	24.189	4.1377	1.1247
FDI	1	0.0154	1.7415	7.5064	0.0066	0.0069	5.1805	85.557	0.0000
	2	0.0167	1.9521	6.7359	1.1037	0.2230	14.425	75.189	0.3707
	3	0.0192	4.1772	5.5701	7.7998	0.1729	23.104	58.363	0.8114
EDU	1	0.0570	3.6378	1.9379	9.6342	0.8409	2.1324	1.8782	79.938
	2	0.0702	2.4151	2.6854	8.2491	6.2782	1.4170	2.3707	76.584
	3	0.0781	2.0801	5.1473	6.9665	6.6670	1.1690	1.9175	76.052

Cholesky Ordering: Y T MKG L K FDI EDU

7.2. Test of Model Stability. Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUM square) have been used to check the stability of parameters. It has proved the stability of our model as the fitted residualsdo not get out of 5% critical bounds.

These figures show that short-run speed of adjustment towards long-run is stable at 5% significance level and no fluctuations are outside the critical bounds.

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

FIGURE 1

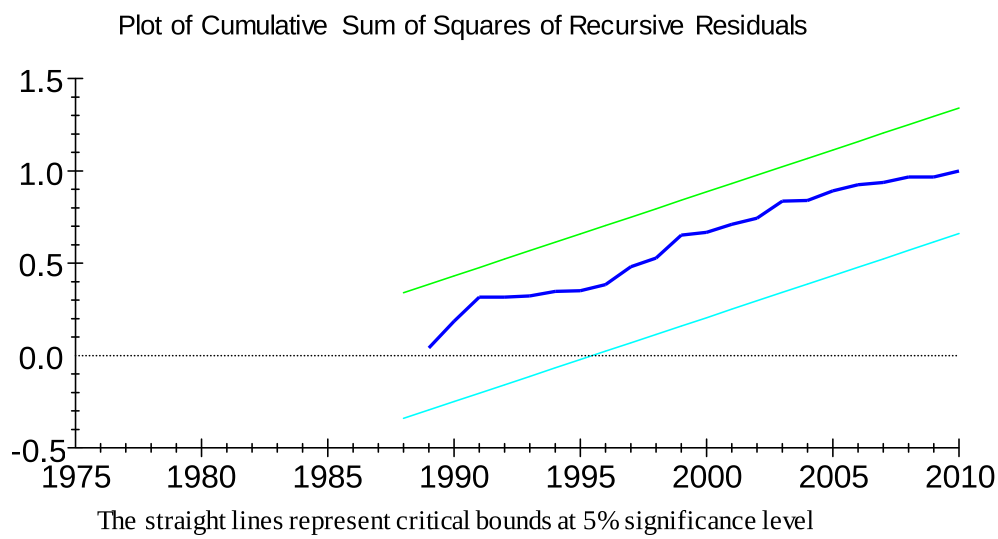


Figure 2

8. CONCLUSION AND POLICY RECOMMENDATION

The results show that imports of capital goods and foreign R&D capital stock have positive effect on per capita income of Pakistan in terms of foreign technological transmission and knowledge spillovers in Pakistan. FDI shows negative effect on economic growth. This finding is consistent with the findings of several single-country studies that technology spillover impact of MNEs in terms of FDI is positive and significant for developed countries like Australia and Canada but insignificant for developing countries like Morocco and Venezuela.

Absorptive capacity of Pakistan appears with negative sign indicating poor quality of educational system of Pakistan which is incapable to utilize and imitate the foreign technological transmission. Pakistan has skill mismatch with new global required skills, low literacy rate and inadequate human capital. With the passage of time technological breakthroughs are increasing so if quality of education of Pakistan remains on the same standards then its education will negatively impact its economic growth.

Unfortunately, Pakistan has very low investment in research and development and she has only three industrialized developed countries in the list of her top ten trade partners which has significant domestic research and development capital stock among other Asian countries which have insignificant research and development capital stock.

On the basis of all theoretical and empirical discussion and estimation of this study, we can postulate that imports of capital goods and foreign research and development capital stock are significant factors for the transmission of foreign technological spillover, knowledge, managerial skills and ultimately for economic growth, prosperity and development of Pakistan. FDI has insignificant and negative impact on per capita income of Pakistan. Pakistan must build domestic research and development capital stock and well developed and managed human capital for the promotion of her absorptive capacity so that she can utilize these channels of foreign technological transmission and can beneficially utilize FDI.

8.1. Policy Recommendations. In order to survive and promote economic growth in this knowledge based technological society, Pakistan should avail new emerging opportunities in Asia and Middle Eastern countries, but she should formulate her import policy biased towards the imports of capital and technological goods and towards those countries which have significant level of domestic R&D capital stock. So that there emerge new employment opportunities (value addition processes) that will ultimately curtail the crucial issue of unemployment.Energy Crisis, poor Law and Order situation, terrorism and under-developed financial system are significant hurdles in the way of promotion of domestic and foreign investment in Pakistan. Government must solve energy crisis on priority basis by importing electricity from Asian countries at low cost and by building new dams and increasing the generation capacity of already existing power houses. By removing line losses, streamlining payment to energy producers and strong management and law and order situation, this problem can be overcome at some extent.Pakistan must focus on quality education for creation, development and management of long-term competitive human resource capital. Focus of educational policies should be on quality oriented education and demand-driven skills that can match with needs and requirements of domestic and global markets.Economic policies, social policies, labor market policies and human development policies need parallel attention for the promotion of adoptive and absorptive capacity, sustainable economic growth and accelerated faster economic development.

FDI has emerged an insignificant factor for economic development of Pakistan because we have not enough resources for productive and beneficial utilization of FDI. Unfortunately, Pakistan has also failed to attract substantial level of FDI due to above mentioned in-efficiencies including poor infrastructure and poor human resource. Creation of human resource development is essential not only for MNEs but also for domestic firms in order to stimulate their managerial and production expertise. By providing tax and financial incentives, liberalizing policies for foreign investors, proper infrastructure, security and skilled and educated labor force, Pakistan can utilize the technological spillovers generated by FDI.

REFERENCES

1. Acemoglu, D. J., Simon and Robinson, James A. (2000). "The Colonial Origins of Compar-ative Development: An Empirical Investigation.". [Working Paper No. 7771].
2. Akbar, M., Naqvi, Z. F., & Din, M. (2000). Export Diversification and the Structural Dynamics in the Growth Process: The Case of Pakistan [with Comments]. *The Pakistan Development Review*, 573-589.
3. Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2004). FDI and economic growth: the role of local financial markets. *Journal of international Economics, 64*(1), 89-112.
4. Asteriou, D., & Hall, S. G. (2007). *Applied econometrics: a modern approach using EViews and microfit*: Palgrave Macmillan.
5. Atique, Z., Ahmad, M. H., Azhar, U., & Khan, A. H. (2004). The Impact of FDI on Economic Growth under Foreign Trade Regimes: A Case Study of Pakistan [with Comments]. *The Pakistan Development Review*, 707-718.
6. Audretsch, D. B., & Feldman, M. P. (1996). R&D spillovers and the geography of innovation and production. *The American Economic Review, 86*(3), 630-640.
7. Bahmani-Oskooee, M., & Brooks, T. J. (1999). Bilateral J-curve between US and her trading partners. *Review of World Economics, 135*(1), 156-165.
8. Bajracharya, P. (2002). *Total factor productivity in Nepal.* Paper presented at the APO Workshop on TFP Growth and Its Determinants, Kuala Lumpur.
9. Banerjee, A., Dolado. J, Galbraith, J. W., & and Hendry, D. F. (1993). *Cointegration, Error Correction,and the econometrica analysis of non- stationary data*. Oxford: Oxford University Press.
10. Bartel, A. P., & Lichtenberg, F. R. (1987). The comparative advantage of educated workers in implementing new technology: some empirical evidence. [NBER,Working paper,1718]. *1*, 1-11.
11. Bashir, A. (1999). Foreign direct investment and economic growth in some MENA countries: theory and evidence. *Department of Economics, Grambling State University*.
12. Bayoumi, T., Coe, D. T., & Helpman, E. (1999). R&D spillovers and global growth. *Journal of international Economics, 47*(2), 399-428.
13. Benhabib, J., & Spiegel, M. M. (1994). The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary economics, 34*(2), 143-173.
14. Bernard, A. B., & Bradford Jensen, J. (1999). Exceptional exporter performance: cause, effect, or both? *Journal of international Economics, 47*(1), 1-25.
15. Blomstrom, M., Lipsey, R. E., & Zejan, M. (1994). What explains the growth of developing countries? *Convergence of productivity: Cross-national studies and historical evidence*, 243-259.
16. Borensztein, E., De Gregorio, J., & Lee, J. W. (1998). How does foreign direct investment affect economic growth? *Journal of international Economics, 45*(1), 115-135.
17. Branstetter, L. G. (2001). Are knowledge spillovers international or intranational in scope?: Microeconometric evidence from the US and Japan. *Journal of international Economics, 53*(1), 53-79.
18. Brown, R. L., Durbin, J., & Evans, a. J. M. (1975). Techniques for Testing the Constancy of Re-gression Relationship Over Time. *Journal of Royal Statistical Society B, 37*, 149-192.
19. Caselli, F., & Wilson, D. J. (2004). Importing technology. *Journal of monetary economics, 51*(1), 1-32.
20. Caves, R. E. (1974). Multinational firms, competition, and productivity in host-country markets. *Economica*, 176-193.
21. Chakraborty, C., & Basu, P. (2002). Foreign direct investment and growth in India: a cointegration approach. *Applied Economics, 34*(9), 1061-1073.

22. Coe, D., & Moghadam, R. (1993). Capital and Trade as Engines of Growth in France: An Application of Johansens Cointegration Methodology.
23. Coe, D. T., & Helpman, E. (1995). International r&d spillovers. *European Economic Review, 39*(5), 859-887.
24. Coe, D. T., Helpman, E., & Hoffmaister, A. W. (2008). International R&D spillovers and institutions: National Bureau of Economic Research.
25. Cororaton, C. (2002). Total factor productivity in the Philippines. *Total Factor Productivity Growth: Survey Report*.
26. Denison, E. F., & Denison, E. F. (1962). *The sources of economic growth in the United States and the alternatives before us* (Vol. 13): Committee for Economic Development New York.
27. Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association, 74*(366a), 427-431.
28. Easterly, W., & Levine, R. (2000). It's not factor accumulation: stylized facts and growth models. [Working paper,164].
29. Eaton, J., & Kortum, S. (2001). Trade in capital goods. *European Economic Review, 45*(7), 1195-1235.
30. Enders, W. (2004). *Applied econometric time series*: John Wiley & Sons.
31. Engel, R. F., & Granger, C. W. J. (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica, 55*, 251-254.
32. Evenson, R. E., & Singh, L. (1997). *Economic growth, international technological spillovers and public policy: Theory and empirical evidence from Asia* (Vol. 777): Economic Growth Center, Yale University.
33. Fu, T. (2002). *Survey on determining factors of TFP growth: Taiwan, Republic of China.* Paper presented at the APO Workshop on TFP Growth and Its Determinants, Kuala Lumpur.
34. Ghose, A. K. (2004). Capital inflows and investment in developing countries. [Employment Strategy Paper, No. 2004/11].
35. Griliches, Z. (1988). Productivity puzzles and R & D: another nonexplanation. *The Journal of Economic Perspectives, 2*(4), 9-21.
36. Griliches, Z. (1992). The search for R&D spillovers. *The Scandinavian Journal of Economics, 94*, 29-47.
37. Grossman, G. M., & Helpman, a. Y. E. (1991). Innovation and Growth in the Global Economy: Cambridge, MIT Press.
38. Grossman, G. M., & Helpman, E. (1993). *Innovation and growth in the global economy*: MIT press.
39. Hakkio, C. S., & Rush, M. (1991). Cointegration: how short is the long run? *Journal of International Money and Finance, 10*(4), 571-581.
40. Han, M. J. (2003). Testing The Predictive Ability Of Measures Of Total Factor Productivity Growth. [A Ph.D. dissertation, University of Missouri-Columbia].
41. Haug, A. A. (2002). Temporal Aggregation and the Power of Cointegration Tests: a Monte Carlo Study*. *Oxford Bulletin of Economics and statistics, 64*(4), 399-412.
42. Hejazi, W., & Safarian, A. E. (1999). Trade, foreign direct investment, and R&D spillovers. *Journal of International Business Studies*, 491-511.
43. Hoekman, B. M., Maskus, K. E., & Saggi, K. (2005). Transfer of technology to developing countries: Unilateral and multilateral policy options. *World development, 33*(10), 1587-1602.
44. Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of economic dynamics and control, 12*(2), 231-254.
45. Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and statistics, 52*(2), 169-210.
46. Keller, W. (1998). Are international R&D spillovers trade-related?: Analyzing spillovers among randomly matched trade partners. *European Economic Review, 42*(8), 1469-1481.
47. Keller, W. (2001a). The geography and channels of diffusion at the world's technology frontier *NBER Working Paper 8150* Cambridge: National Bureau of Economic Research.
48. Keller, W. (2001b). International technology diffusion. NBER Working Paper,8573, Cambridge.: National Bureau of Economic Research.
49. Kim, T. K., Leybourne. S, & Newbold, P. (2004). Behavior of Dickey-Fuller Unit-Root tests under trend misspecification. *Journal of Time Series Analysis, 25*, 755-764.
50. Kogut, B., & Chang, S. J. (1991). Technological capabilities and Japanese foreign direct investment in the United States. *The Review of Economics and Statistics*, 401-413.
51. Krammer, M. S. (2008). International R&D spillovers in transition countries: the impact of trade and foreign direct investment: Kiel advanced studies working papers.

52. Kuznets, S. (1955). Economic growth and income inequality. *The American Economic Review, 45*(1), 1-28.
53. Laurenceson, J., & Chai, C. (2003). *Financial reform and economic development in China*: Edward Elgar Publishing.
54. Lyroudi, K., Papanastasiou, J., & Vamvakidis, A. (2004). Foreign direct investment and economic growth in transition economies. *South Eastern Journal of Economics, 1*, 97-110.
55. MacKinnon, J. G. (1990). *Critical values for cointegration tests*: Department of Economics, University of California.
56. Mah, J. J. (2000). An empirical examination of disaggregated import demand of Korea: the case of information technology products. *Journal of Asian Studies, 11*, 233-244.
57. 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.
58. Mayer, J. (2001). *Technology diffusion, human capital and economic growth in developing countries.* Paper presented at the United Nation Conference on trade and development.
59. Narayan, P. (2004). *Reformulating critical values for the bounds F-statistics approach to cointegration: an application to the tourism demand model for Fiji*: Monash University.
60. Nelson, R. R., & Phelps, E. S. (1966). Investment in humans, technological diffusion, and economic growth. *The American Economic Review*, 69-75.
61. Neven, D., & Siotis, G. (1996). Technology sourcing and FDI in the EC: An empirical evaluation. *International Journal of Industrial Organization, 14*(5), 543-560.
62. Ng, S., & Perron, P. (1995). Unit root tests in ARMA models with data-dependent methods for the selection of the truncation lag. *Journal of the American Statistical Association, 90*(429), 268-281.
63. Ouattara, B. (2004). Foreign aid and fiscal policy in Senegal. *University of Manchester, Manchester, UK*.
64. Pesaran, M. H., & Pesaran, B. (1997). *Working with Microfit 4.0: Interactive econometric analysis*: Oxford University Press.
65. 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.
66. Pesaran, M. H., & Smith, R. P. (1998). Structural analysis of cointegrating VARs. *Journal of Economic Surveys, 12*(5), 471-505.
67. Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika, 75*(2), 335-346.
68. Potterie, B. P., & Lichtenberg, F. (2001). Does foreign direct investment transfer technology across borders? *Review of Economics and Statistics, 83*(3), 490-497.
69. Pugel, T. A., Kragas, E. S., & Kimura, Y. (1996). Further evidence on Japanese direct investment in US manufacturing. *The Review of Economics and Statistics*, 208-213.
70. Rivera-Batiz, L. A., & Romer, P. M. (1991). Economic integration and endogenous growth. *Quarterly Journal of Economics*, *425*, 531-555.
71. Romer, P. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5), S71-S102.
72. Romer, P. M. (1986). Increasing returns and long-run growth. *The Journal of Political Economy*, 1002-1037.
73. Rosenberg, N. (1983). *Inside the black box: technology and economics*: Cambridge University Press.
74. Sharma, B., & Gani, A. (2004). The effects of foreign direct investment on human development. *Global Economy Journal, Article 9., 4*(2).
75. Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics, 70*(1), 65-94.
76. Swan, T. W. (1956). Economic growth and capital accumulation. *Economic record, 32*(2), 334-361.
77. Xu, B., & Wang, J. (2000). Trade, FDI, and international technology diffusion. *Journal of Economic Integration, 15*(4), 585-601.