Discussion Papers
in
Development Economics and Innovation Studies

Knowledge Spillovers across Developing Economies: Empirical Evidence

by

Manjinder Kaur
Lakhwinder Singh

Discussion Paper No. 15
November 2016

Centre for Development Economics and Innovation Studies (CDEIS)
PUNJABI UNIVERSITY

Knowledge Spillovers across Developing Economies: Empirical Evidence

Manjinder Kaur*
Lakhwinder Singh**

Abstract

Globalization has dramatically transformed the world economy during the last quarter of 20th century and more vigorously in the first decade and a half in the 21st century. The most important characteristics of this phase of globalization are the rise of cross border flows of trade, investment, finance and technological knowledge. The rising investment in technological knowledge drives increasingly the long term growth process of the developing economies. It is increasingly realized that the level of trade and FDI across borders effects the knowledge generation and dissemination across countries. In this study an attempt is made to examine the relationship between economic growth measured through total factor productivity and knowledge economy variables such as domestic and foreign R&D stock covering the period of 2001-2012 across 19 developing countries. The regression analysis used in this study is based on panel data analysis using random and fixed effects model. The results of the study reveals that domestic knowledge stock, human capital, gross fixed capital formation and the interaction terms of foreign R&D spillovers with trade, human capital, FDI and openness turned out to be positive. An important policy implication that results from this analysis is that the higher is the human capital and international trade results in higher level of productivity growth via knowledge spillovers.

Keywords: Domestic R&D Spillovers, Foreign Spillovers, Trade, Technological Capabilities.

* Research Scholar (UGC-SRF), Department of Economics, Punjabi University, Patiala, Email: manukaur30@yahoo.in
** Professor, Department of Economics, Punjabi University, Patiala, Email: lakhwindergill@pbi.ac.in

I. **Introduction**

The current phase of economic development and growth is driven by knowledge economy. The fast pace of increasing integration of the developing economies with industrially advanced countries has facilitated the flows of trade, knowledge and the both foreign direct investment and finance. The advent of globalization over the past few decades has fostered the mutual interdependence among nations as they tend to develop more interrelations among them to cater their needs of consumer goods and intermediate products to target the market of their trading partners. However, these interrelations among the different nations are not confined to just import and export of different types of goods and services, rather than that have also engrossed the other very significant undertakings like technology transfer, manufacturing methods, modes of organization, marketing and product design which are going to effect the level of their wellbeing and also establish a linkage among their growth rates (Bayoumi et.al, 1999). Thus, it has become crucial topic in both theoretical and empirical literature relating to economic growth and trade aimed at to determine the potential role of technological externalities in spurring the level of economic growth and shaping the pattern of trade across the economies (Grossman and Helpman, 1990).

According to endogenous growth models, the innovative capacities residing in different firms and industries not only contribute towards the generation of new products but also tend to augment the cumulative stock of knowledge leading to emergence of more and new differentiated products without making a persistent investment in various kinds of research resources. In other words, the benefits of any innovative activity undertaken by a firm or industry do not remain confined to that industry only rather than that they spillover to other firms and industries by augmenting their level of knowledge further, thus providing the basis of new innovations. Grossman and Helpman have also cited these spillovers as engine of economic growth (Coe and Helpman, 1995).

Furthermore, as most of the new technology and innovations activities are concentrated in the handful of rich industrialized countries, the developing countries have been largely noticed to depend on these advanced economies for technological spillovers (Keller, 2004, Saggi, 2002 and Eaton and Kortum, 1999). Although, the significance of these international R&D spillovers or knowledge spillovers has been recognized a long time earlier, but research related to theoretical and empirical estimation of these spillovers got a boost in the 1990s with the emergence of new growth models by Romer (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992), Coe and Helpman (1995) and Coe et. al. (1997). Contrary to neo-classical growth theories treating the technological progress as exogenous, the new endogenous growth models have recognized the commercially oriented innovative efforts by profit seeking firms as a major engine of technological progress and productivity growth (Coe et. al. 2009).

Hence, realizing the potential of these R&D spillovers in economic growth theory, a number of empirical studies have been conducted emphasizing the international trade driven by profit seeking firms as resilient factor for the spread of technology, resulting into the development and productivity growth (Romer, 1990; Grossman and Helpman, 1991 and Aghion and Howitt, 1992). Thus, the R&D investment augmented by the development of new R&D inputs tends to reduce the future costs associated with this investment, subsequently leading to R&D spillovers. Further, through these R&D spillovers in the form of better quality of domestic and R&D products, the host countries can improve their quality of products at a faster rate as it will be based on higher quality of initial products aroused as a result of spillovers (Coe, et. al., 2009).

The first empirical study carried out in context of these spillovers was by Coe and Helpman (1995) which involved the assessment of benefits to a host country in accordance with the technological capabilities or knowledge of their trade partners and their own degree of openness. The findings of this study reveal that the knowledge spillovers and returns to domestic R&D estimated through coefficient of foreign and domestic R&D variables have statistically significant impact on cross-country productivity (Coe and Helpman,1995). In addition to that, more open economies are likely to be more benefitted by these spillovers (Ruge-Leiva, 2015). Later on, a large number of studies have focused on trade and FDI as a major carrier of R&D spillovers. Thus, in this sphere, a study conducted by Evenson and Singh (1997) and Singh (2001) gauging the impact of domestic and international R&D capital stock with import GDP ratio and human capital has confirmed the positive role of country’s own R&D stock as well the R&D stock of its trading patterns in enhancing its productivity. Furthermore, enhancement of domestic capabilities through public policy can prove to be very helpful in absorbing the R&D externalities and can generate higher productivity growth in developing countries.

Similarly, another study conducted by Amann and Viramani (2014) confirm the presence of long-run relationship between total factor productivity and two main channels of R&D spillovers i.e. outward foreign direct investment and inward forward investment. Further, assessing the role of R&D intensity and five knowledge diffusions channels in augmenting the productivity of manufacturing firms in Turkey over the period of 2003-07 reveals that 1 per cent increase in in-house R&D leads to 0.3 per cent increase in labor productivity across the firms. In addition to that regarding the five knowledge diffusion channels, it has been found out that R&D spillovers tend to have negative impact on productivity of firms having low technological capabilities as compared to firms having high technological capabilities. Thus, it highlights the prominence of country's own technological capability and absorptive capacity in the form of human capital in getting the advantage of foreign knowledge spillovers. On the other hand, impact of foreign ownership share and technology licensing tends to have positive contribution in augmenting firms' productivity but impact of international trade has remained insignificant. (Ulku and Pamukcu, 2015).

There is growing evidence of catch-up and increasing level of economic development in some of the developing countries while others lagging behind. The question of why some countries forging ahead and others lagging behind is a matter of great policy concern. Therefore, this study aims at to examine the economic growth pattern of the 19 developing countries and their interaction with the industrially developed countries who are also predominantly modern technological knowledge producers. The emphasis of this study is to provide empirical evidence from the 19 developing countries who sufficiently invest in technological knowledge generation themselves. Furthermore, it strives to capture the impact of domestic and foreign R&D spillovers while using interaction variables such as interaction of human capital, trade, openness and FDI with foreign knowledge spillovers. The empirical evidence from the most recent decade fills the gap in economic literature and strives to validate the endogenous theories of economic growth. The rest of the paper is organized in four sections. The second section provides theoretical and empirical review of literature. The third section describes the data base and also develops econometric model. The empirical evidence and analysis is presented in section four. Summary and conclusions are presented in the last section.

II. Theoretical and Empirical Review of Literature

From Neoclassical to endogenous growth models, there has been a drastic shift in the literature on the sources of economic growth. As in case of former, economic growth has been assumed to be spurred by capital accumulation while considering the technological progress as an exogenous process, whereas in the case of latter i.e., endogenous growth models, the underlying force behind the technological progress and economic growth is assumed to be commercially oriented innovative efforts responding to the various economic incentives (Romer,1990 and Grossman and Helpman, 1991). But, it has been widely noticed that a considerable share of these innovative activities are concentrated in only a handful of rich countries while the developing countries are lagging far behind in this arena. Thus, the pattern of worldwide technical change is largely getting determined by international technology diffusion (Keller, 2004) which results in the growing integration and inter-dependence among developed and developing economies.

To study the impact of this phenomenon on economic growth and productivity, a number of the studies have been conducted so far by taking the different channels for the transmission of these spillovers especially arising from innovative and technological activities undertaken in developed or advanced economies. Thus, in this section we have very briefly included the glimpses of literature relating to these knowledge or technological spillovers and their consequent impact on productivity and growth across various economies. As, there exist a number of different channels for the diffusion of these knowledge or technological spillovers, we have classified the different studies on the basis of the channels they have included in their studies.

Foreign R&D capital stock

A pioneering empirical study in this context was conducted by Coe and Helpman (1995) to assess the impact of domestic as well as foreign R&D capital stock on country's productivity level by using the dataset of 21 OECD economies plus Israel from 1971-90 and found out the positive and significant impact of domestic as well as foreign R&D spillovers on total factor productivity. This study initiated a debate and was extended by other researchers by including the other significant channels of spillovers rather than relying only upon foreign trade as a source of diffusion of technology.

Trade

Trade has been regarded as an engine of economic growth (Joseph, 2013). Bringing into prominence the significance of international growth linkages while determining the factors behind long-run economic growth Singh (2001) have enlarged the scope of Coe and Helpman (1995) study by including the import of capital goods from the leader country and also its interaction with foreign R&D capital stock as another significant channels for the diffusion of international R&D spillovers on productivity level by taking the case of 11 Asian economies over the period of 1970-93.The findings from this study have supported the positive role of international R&D spillovers for productivity growth across this sample. However, import alone has not represented any significant spillovers effect but its interaction with foreign R&D stock have casted the positive role in augmenting the level of TFP. In the similar vein, Engelbrecht (1996) have also provided the empirical support for the existence of large R&D spillovers and the significance of trade as a conduit for their propagation. Further, Coe et al. (1997) in his subsequent study, while establishing the positive role of domestic and international R&D stocks in enhancing productivity has also recognized the trade as a major transformation mechanism. Realizing the beneficial impact of trade in boosting the productivity of an economy, the study also confirmed this notion by adding the empirical evidence of developing economies other than Newly industrialized economies (NIEs) in which amplifying the imports of manufactures by 5% points of GDP resulted into enhancement of output by 6.5 percent in the long run. Following this study, Kao, et.al. (1999) have also cited that impact of foreign spillover on TFP is determined by the extent of trade of economies with other economies. Thus, openness of the economies is also a major determinant for augmenting foreign R&D spillovers. Singh (2004) in his another study while assessing the impact of foreign R&D spillovers, by taking the data of 28 industries of Korea over the time period of 1970-2000 has also brought into prominence potential role of trade in augmenting the impact of foreign spillovers as compared to the technology matrix. Thus, innovation and trade are two important carriers of technological spillovers for developing economies to catch-up with developed ones (Madden, 2008). A recent study conducted in this context by Ang and Madsen (2013) while assessing the impact of the stocks of knowledge and international knowledge spillover across six Asian miracle economies on their TFP by taking the imports, exports, inward FDI, flow of patents between countries, geographical prosperity and the general channel as the transmission mechanisms have found the import channel and general channel as the most significant channel of knowledge spillovers for Asian miracle economies.

Foreign Direct Investment (FDI)

Although, trade has been considered as the most significant channel for the diffusion of technology spillovers across the countries, but after 1991 reforms, there has been a large rise in the inflow of FDI in developing economies (Gill and Singh, 2012), thus it has become an another potential channel for technology transfer. Therefore, a number of studies have been conducted to ascertain the role of FDI as a channel of technology spillovers across economies. Comparing the two different trade regimes i.e, inward and outward oriented in case of Uruguay, where under the former approach, the foreign firms were required to bring with them new technology and also have to focus on the development of local market but in the case of latter, these foreign firms have started exploiting the human capital and skills of the host country, they are no longer engaged in such operations based on new production technologies that can be easily imitated or adopted by local forms. Thus, there exist no evidence of productivity spillovers from the operations of these more outward-oriented MNCs to locally owned.(Kokko, et.al. 2001). Similarly, while examining the efficiency of three channels of R&D spillovers in case of 21 OECD economies plus Israel from 1981-1991, bilateral trade and information technology have remained as the most significant channels for international R&D spillovers, but the impact of FDI has been found to be very mild (Zhu and Jeon, 2007). Reviewing the possible sources of FDI induced spillovers and then evaluating its empirical evidence on productivity, wages and exports spillovers in developing, developed and transitional economies have revealed that there exists no clear evidence that domestic firms always and unambiguously gain from the presence of MNEs. (Gorg and Greenaway,2003).

Geographic effects on international technology diffusion

Assessing the impact of geographic and spatial factors of international technology diffusion, Bransletter (1999) while estimating the relative impact of international and international knowledge spillovers on innovation and productivity by using data at the firm level from US and Japan from 1985-1989 and 1983-89 have found out the strong evidence of intra-national knowledge spillovers as compared to international spillovers. The underlying reason behind it is that weak knowledge flows and strong rivalry results into negative foreign R&D spillovers. Similarly, Bottazzi and Peri (2002) in their paper have made an attempt to identify and estimate of research externalities in spurring the innovations across space by using data of 86 European countries over the time period of 1977-95.The results of their study revealed that although R&D expenditure incurred by a region tend to generate the externalities for other regions but it is bounded by the distance of 300 KM, afterwards which the impact of these externalities begins to decline. The underlying cause behind this short range of spillovers for other regions is that such spillovers are the outcome of diffusion of non-codified knowledge between people having frequent interactions, thus, they mostly interact within border as compared to across countries leading to weak externalities.

Likewise, a wide range of differences in the institutions, policies and regulations can be traced across the international borders; contrary to it regions within borders are more integrated and engaged in more trade and risk sharing factors. Thus, a study conducted by Naveed and Ahmad (2014) has explored the border effects of knowledge spillovers by taking the case of various regions of EU and dividing them into internal and external border region reveals that although regional productivity is determined to a large extent by external regional knowledge and technological spillovers, but the strong border effects overpower the effects of technology and knowledge transfer. Hence, the impact of spillovers across the international borders are statically insignificant due to the presence of language and cultural barriers, borders and as well as impediments of various rules and regulations

Human capabilities as an absorptive determinant of Foreign R&D spillovers

Extending the study of Coe and Helpman (1995) further, Engelbrecht (1996) has included human capital as another variable explaining TFP in addition to domestic and international capital stock. The inclusion of this new variable has resulted into shrinking share of international R&D spillovers by about 30 per cent while having little impact on other coefficients. Thus, human capital is found to have significant impact on TFP, as an input variable as well as a catch up variable. Engelbrecht (2002) in his another study has compared the two major approaches given by Lucas and Nelson-Phelps towards including the human capital in the growth regressions in context of developing country models with international knowledge spillovers. This study has brought into prominence the role of human capital in absorption of embodied R&D spillovers as well as disembodied spillovers by confirming the superiority of Nelson-Phelps approach over Lucas approach which considers human capital only as a factor of production. In another study conducted by Singh (2001) underlying the significance of international growth linkages while determining the factors behind long-run economic growth has observed that these spillovers do not benefit all the economies on equal basis because human capital and learning abilities play a very important role in absorbing these spillovers. Thus, the important policy implication of the study is that to fully realize the potential of foreign spillovers, a country should emphasize on improving its human capabilities and develop basic technological capabilities.

R&D Co-operation and Foreign ownership share

Further taking into account R&D cooperation and localization of FDI as the other two significant transmission channels of technological externalities in addition to own R&D, and

R&D efforts of its trading partners, Sadraoui (2011) has tried to explore the relationship between total factor productivity and these technological or knowledge externalities for six Mediterranean countries for the period of 1970 to 2008. The results of the study reveal that impact of R&D cooperation in expanding the growth of an economy is determined by a country's internal expenditure on R&D. Although R&D Cooperation in the situation of excessive competition tend to increase social welfare by augmenting the consumer as well as producer surplus, but very few spillovers effects of R&D cooperation has been noticed for his study. Thus, however in some developing economies there exists a positive relationship between R&D cooperation and economic growth but this finding cannot be generalized to all economies. Belitz, Molders and Berlin (2013) have included two another significant sources of international knowledge spillovers i.e., imports of high-tech goods and internationalization of business R&D by covering both developing and industrial countries. While analyzing the impact of these two variables, we have used the foreign owned patents as a proxy for R&D activities of multinationals. The results of the study confirm the significance of import spillovers for all countries included, and the existence of additional spillovers for developing countries through the import of high-technology goods, but in case of second variable, only developed countries seemed to benefit with the diffusion of knowledge that originates through cross-border cooperation in R&D by multinationals. In a recent study by Ulku and Pamukcu (2015), while assessing the impact of R&D intensity and five knowledge diffusion channels in augmenting the productivity of manufacturing firms in Turkey over the period of 2003-07 has found that 1 per cent increase in the in house R&D leads to 0.3 per cent increase in labor productivity across the firms having average technology capabilities Further, analyzing the impact of five major knowledge diffusion channels on augmenting the productivity level reveal that impact of foreign ownership share and technology licensing on firms' productivity remain consistently positive and significant, however, the impact of technology licensing become significant only after reaching a threshold level of technological capability.

Based on the review of the earlier literature on knowledge and technological spillovers arousing through different channels and ascertaining their impact on augmenting the level of TFP and growth across different economies, most of the studies revealed that trade and human capital have remained the most significant conduits for the transmission of these spillovers. While the studies based on other diffusion channels i.e, FDI and R&D Co-operation have not revealed any apparent evidence regarding the impact of these channels in augmenting the level of TFP and growth across economies. Thus in the present study, we have tried to enlarge the scope of earlier studies by integrating all the prominent channels of knowledge spillovers i.e, trade, human capital, FDI and openness to trade and as well as their interaction with foreign knowledge spillovers as the transmission mechanisms for R&D spillovers across 19 selected developing economies over the period of 2001-2012.

III. Database and Methodology

From the above reviewed literature, role of technological progress for sustaining the long run economic growth is amply clear. However, various endogenous growth models developed by Grossman and Helpman (1991), Aghion and Howitt (1992) and Coe and Helpman (1995) and Coe et. al. (1999) has regarded the commercially-oriented innovative efforts as the prominent agent of technological progress and productivity growth. Thus, it leads to the sizeable investment in technological capability for ensuring effective use of technological knowledge and generating sizeable spillover benefits. These spillovers effects are likely to accumulate majorly by the economies having comparatively higher investment in

R&D and those who are more integrated through international flows of trade. Thus, when an economy has an access to the inputs available in its trading partners, its productivity is no longer determined only by its own R&D but rather it also depends on R&D activities of its trading partners. The present study is based on the empirical evidence of trade-related international R&D spillovers mentioned by Coe and Helpman (1995). Like Luintel and Khan (2004), this study is also based on the assumption that elasticity of R&D to TFP is not identical across all the countries. Thus, the economies investing more in R&D are likely to get more benefits of external R&D stock.

This paper builds on the methodologies suggested by Coe and Helpman (1995) and Singh (2001). Therefore, methodology of our study overlaps noticeably with the above mentioned studies. In the present study, we have taken the data for 19 developing economies for the period of 2001-2012 and the selection of number of countries and this time period is governed by the availability of data. The main sources of data are World Development Indicators (WDI) of the World Bank, UIS Statistics on Science and Technology, IMF Direction of Trade Statistics and the conference Board total economy database, 2016.

Unlike the most of cross country studies examining the output growth as an outcome of accumulation of labor and capital in addition to some other economic and political determinants, the present study focused on the growth of TFP which is the component of output growth that is not attributable to the accumulation of inputs. The present study is based on the data published by The Conference Board where the growth of Total Factor Productivity is estimated as a Tornqvist Index.

Specification and Estimation

The production function of an economy is assumed to be linearly homogenous function of employed inputs. Furthermore, the quality and quantity of these inputs improves through R&D investment made by a particular economy. Thus, there exist a strong linkage between TFP and the domestic R&D capital stock of an economy.

In addition to domestic R&D capital stock, international trade in intermediate goods also enables a country to have access to all the inputs available in the rest of world. Thus, the country's TFP also becomes dependent on R&D stock of its trading partners bringing into prominence the significance of foreign R&D stock. Another potential determinant of TFP is human capital.

Thus, in the framework of our study, we consider a log-linear Cobb-Douglas production function transformed as follows:

$$\log(TFP)_{it}=\alpha_{it} + +\beta_1 \log RD_{it}+\beta_2 \log SRD_{it}+\beta_3 GFCF_{it}+\beta_4 IMP_{it}+\beta_5 HC_{it}+e_{it} \text{-------------(1)}$$

Where
α_{it} is the intercept term
TFP $_{is}$ the total factor productivity
RD_{it} is the domestic R&D stock
SRD_{it} is international R&D stock
IMP is the import share of GDP
HC_{it} is human capital taken as a proxy for labor force participation rate
$GFCF_{it}$ is gross fixed capital formation

e_{it} is the random disturbance term

As TFP depends on the available conglomeration of intermediate inputs which further depends on past R&D investment both at the domestic and international level. Thus, to estimate domestic R&D stock based on the R&D expenditure incurred by the economies, we have employed Perpetual Inventory method as follows

$RD_{it}=(1-\delta)R_{t-1}+R\&Dexp_t$

Where
RD_{it} is the R&D capital stock in period t
δ is the rate of depreciation which is assumed to be 5% in present study
$R\&Dexp_t$ is the real R&D expenditure derived by deflating the nominal expenditure by R&D price index

Thus, R&DPI = 0.5 WPI+0.5 CPI
Here, WPI stands for wholesale price index
CPI is cost of living index of urban workers

Attaching weights of 0.5 to both of these indexes is guided by the assumption that half of the total R&D expenditure is incurred on the salary of scientists and engineers employed in this sector while the other half is used for utilizing the intermediaries' and equipment in R&D sector. Based on Singh (2001) study, the benchmark for the year 2001 is calculated as follows

$R_{2001=}(R\&Dexp_{2001})/(g+\delta)$

Where g represents trend growth rate of real R&D expenditure over the period of 2001-2012.Thus, following the above equation, the R&D stock for each of 19 developing economies have been constructed.

After constructing the R&D capital stock for each of the 19 developing economies, foreign R&D capital stocks denoted by SRD has been constructed, where SRD is the sum of the bilateral import shares weighted average of RD (Domestic R&D capital stock) of each country's trading partners.

Although, the foreign R&D capital stock SRD has been weighted by import shares, these weights are the fractions that add up to one and therefore do not properly reflect the level of imports. Whenever two countries have the same composition of imports and face the same composition of R&D capital stock among the trading partners, the country that imports more relative to its GDP may benefit more from foreign R&D. Therefore, a modified specification of equation (1) that accounts for the interaction between the foreign R&D capital stock and level of international trade may be preferable. Furthermore, the enhancement of technological capacity through educated human capital can lead to a better usage of their own R&D and can absorb the spillovers arising from foreign R&D resulting into higher productivity growth leading to the inclusion of another interaction term i.e., human capital and foreign R&D capital in following equation. Thus, our subsequent equation has been defined as follow:

$$\log(TFP)_{it}= \alpha_{it} +\beta_1 logRD_{it}+\beta_2 logSRD_{it}+\beta_3 GFCF_{it}+\beta_4 IMP_{it}+\beta_5 HC_{it}+\beta_6 logSRD_{it}*IMP_{it} +\beta_7 logSRD_{it}*HC_{it}+e_{it} \text{-----} (2)$$

We extend the equation (2) further, by including FDI and openness to trade as additional sources of international knowledge spillovers in equations (3) and (4)

$$\log(TFP)_{it}= \alpha_{it} +\beta_1 logRD_{it}+\beta_2 logSRD_{it}+\beta_3 GFCF_{it}+\beta_4 IMP_{it}+\beta_5 HC_{it}+\beta_6 logSRD_{it}*IMP_{it} + \beta_7 logSRD_t*HC_{it}+ \beta_8 FDI_{it} + \beta_9 Openness_{it}+ e_{it} \text{-----} (3)$$

where FDI is the Foreign Direct Investment, net inflows (% of GDP) and Openness stands for the openness to trade captured by the data on Trade (% of GDP)

$$\log(TFP)_{it}= \alpha_{it} + \beta_1 logRD_{it}+\beta_2 logSRD_{it}+\beta_3 GFCF_{it}+\beta_4 IMP_{it}+\beta_5 HC_{it}+\beta_6 logSRD_{it}*IMP_{it} + \beta_7 logSRD_{it}*HC_{it}+ \beta_8 FDI_{it} + \beta_9 Openness_{it}+ \beta_{10} logSRD_{it}*FDI_{it}+ \beta_{11} logSRD_{it}*Openness_{it}+e_{it} \text{-----} (4)$$

IV. Empirical Evidence and Analysis

The data employed in the present study is a panel of 19 selected developing economies covering the time period of 2001-2012.Table 2 reports summary statistics on the data employed in the present study. All variables are expressed as logarithms and are given as percentages except TFP for which Tornquist expression of TFP growth has been employed.

In table 1, the columns (1), (2), (3), (4) and (5) show the mean and standard deviation values of TFP, R&D Stock, Foreign Knowledge Spillovers (SRD), Human Capital and Import Shares. The column (1) displays average and standard deviation of TFP across the selected economies over the period of 2001-2012 and it reveals that average value of TFP has remained highest for Belarus followed by Azerbaijan, Bulgaria and Egypt whereas it has been least in case of Madagascar and Armenia. The column (2) reveals that average of R&D stock, which is found to be highest in case of Brazil, followed by India and Mexico whereas it has remained lowest for Kyrgyz_Republic. Taking the case of Foreign Knowledge Spillovers in column (3) highest value has been found out for Mexico followed by Panama, Brazil and China whereas it has remained lowest for Bulgaria. Looking at the another important variable i.e, Human capital in column (4) which is captured through labor force participation rate in the present study reveal that China is having highest average of human capital followed by India and it has been lowest in case of Armenia. Lastly, in case of import share in column (5), Malaysia has the highest average of import share over this period of time followed by Panama and Belarus whereas Brazil has recorded the lowest import share over this period of time. Thus, these descriptive statistics reflect that the countries having the higher level of human capital and import share are also having the higher level of foreign knowledge spillovers, whereas TFP and domestic R&D stock do not seem to be have an unambiguous relationship with foreign knowledge spillovers.

To carry out further analysis, we have tried to estimate the productivity effects of a country's own R&D capital stock and, international spillover R&D stock as well as human capital and gross fixed capital formation on the individual country's productivity growth, by using a panel data set for a sample of 19 developing economies constructed over the period 2001-2012. The panel data techniques i.e, fixed effect model and random effects model has been applied on this data by using the statistical software known as STATA 13. As, there is always a trade-off between efficiency and consistency in the random and fixed effects models, the results of Hausman test help us to accept the results of fixed or random effect model on the plea that whether the magnitude of bias from random effect model exceeds the gain in efficiency. Thus, results of Hausman test in the present study clearly reject the estimates of random effects model in the favor of fixed effects model. The results of Fixed effects model are shown in Table. 2 corresponding to the four models included in the present study.

Table 1: Mean values of Key variables included in Equation (1)

Countries	TFP	R&D Stock	RDW	Human Capital	Import Share
India	1.54 (0.73)	10.99 (1.40)	17.17 (1.22)	19.95 (0.04)	23.03 (6.17)
Pakistan	1.73 (0.80)	8.21 (1.69)	17.08 (1.19)	17.77 (0.12)	18.69 (2.67)
China	1.51 (0.74)	4.82 (0.83)	17.28 (1.11)	20.46 (0.02)	24.43 (3.76)
Brazil	1.66 (0.75)	12.24 (1.64)	17.54 (1.09)	18.39 (0.07)	12.63 (0.99)
Thailand	1.63 (0.76)	8.80 (1.38)	17.37 (1.13)	17.45 (0.04)	62.12 (5.96)
Panama	1.61 (0.75)	8.17 (1.29)	18.01 (1.12)	14.25 (0.09)	72.33 (7.73)
Mexico	1.73 (0.77)	10.87 (1.26	18.11 (1.10)	17.65 (0.09)	28.88 (2.75)
Malaysia	1.63 (0.76)	9.78 (1.20)	17.49 (1.10)	16.23 (0.08)	82.62 (10.26)
Madagascar	0.55 (0.30)	5.66 (1.07)	16.88 (1.22)	16.05 (0.13)	42.97 (9.71)
Armenia	1.51 (0.78)	4.52 (1.35)	16.69 (1.09)	14.18 (0.03)	44.54 (3.53)
Kyrgyz Republic	1.60 (0.75)	4.10 (1.23)	17.10 (1.22)	14.67 (0.08)	68.89 (20.67)
Ukraine	1.50 (0.75)	9.06 (1.15)	16.61 (1.19)	16.96 (0.00)	52.77 (2.81)
Azerbaijan	2.49 (1)	5.72 (1.38)	16.37 (1.51)	15.24 (0.09)	38.56 (17.83)
Belarus	2.58 (1.04)	7.47 (1.38)	16.51 (1.18)	15.33 (0.02)	68.98 (6.37)
Bulgaria	1.78 (0.77)	7.05 (1.30)	16.24 (1.04)	15.05 (0.02)	56.82 (10.32)
Romania	1.58 (0.77)	7.91 (1.35)	16.30 (1.11)	16.11 (0.06)	41.30 (2.94)
Turkey	1.63 (0.76)	9.53 (1.44)	16.85 (1.18)	16.97 (0.08)	26.76 (2.98)
Egypt	1.75 (0.78)	7.88 (1.45)	17.16 (1.10)	17.01 (0.11)	28.67 (5.24)
Tunisia	1.65 (0.76)	7.29 (1.37)	16.53 (1.18)	15.09 (0.06)	50.28 (5.91)

Note : Figures in Parenthesis are Standard Deviation values.

The estimated parameters obtained from equation (1) in Table 2 are highly significant except the foreign knowledge spillovers and import share as a proportion of gross domestic product. The parameter of import share to GDP is positive but insignificant. In the similar way, the contribution of foreign spillovers in augmenting TFP is found to be positive but it is not significant in equation (1).

Table 2: Estimated Coefficient of Fixed Effects Models (Dependent Variable is log TFP)

Equations → Independent Variable ↓	(1)	(2)	(3)	(4)
Constant	-13.28	-14.49	-13.43	0.121
	(-3.08)	(-2.88)	(-2.69)	(0.02)
logRD	0.5165***	0.5181***	0.509***	0.5311***
	(13.76)	(13.71)	(13.63)	(14.98)
logSRD	.0077	0.0537	0.0428	-0.59***
	(0.18)	(0.39)	(0.31)	(-3.47)
HC	0.6378***	0.717**	0.647**	0.00747
	(2.43)	(2.34)	(2.12)	(0.02)
GFCF	.009***	.009***	.009***	0.074***
	(3.28)	(3.24)	(3.58)	(2.84)
IMP	-0.0011	-0.00287	-0.0059	.0077
	(-0.61)	(-0.57)	(-0.81)	(1.04)
logSRD*HC		-0.0039	-0.0049	.0245**
		(0.51)	(-0.64)	(2.74)
logSRD*IMP		.0047	0.140	.0020
		(0.35)	(1.02)	(0.15)
FDI			-0.009**	-0.239***
			(-2.05)	(-3.27)
OPENNESS			0.0023	-0.03***
			(0.73)	(-4.31)
logSRD*FDI				0.137***
				(3.18)
logSRD*OPENNESS				.00159***
				(4.40)
R^2	0.92	0.92	0.92	0.93
N	228	228	228	228

Notes: 1. Figures in parentheses are t-values.
2. *** significant at 1% level; ** significant at 5% level; and *significant at 10% level

As the rate of return to investment in R&D is also affected by accumulation of human capital in a particular economy (Sjorgen, 1998) and the higher level of human capital allows tangible inputs to be used more effectively (Englebrecht, 1997). Thus, human capital enhances absorptive capacity of country's innovation to both national and international spillovers. In additions to it, imports are also a major carriers for foreign knowledge spillovers. Thus, including the interaction terms of import and human capital with foreign R&D spillovers in equation (2) reveals that with the inclusion of these two variables to the basic equation (1), the results remain similar but the coefficient of these two interactions terms are found to be insignificant and it is also negative for human capital which is due to low level of human capital in developing countries fails to absorb new technologies from advanced economies..

Furthermore, although trade has been considered as the most significant channel for the diffusion of technology spillovers across the countries, but after 1991 reforms, there has been a large rise in the inflow of FDI in developing economies (Gill and Singh, 2012), thus it has become an another potential channel for technology transfer and knowledge spillovers. The equation (3) of the table 2 includes the FDI and openness as another two significant channels for international knowledge spillovers. The estimated coefficients for these variables are found to be insignificant but in case of FDI, this coefficient has remained negative which is backed by the reason FDI in developing economies by outward oriented MNC's are not targeted on enhancing the efficiency of locally owned firms. Further, examining the interaction of FDI and Openness to trade with foreign spillovers in equation (4) reveals that both the interaction terms have positive and significant impact on TFP. The inclusion of these interaction terms has also resulted into altering the significance and coefficient of other variables as effect of international knowledge have turned negative and significant whereas impact of domestic R&D has remained positive and significant. The interaction of foreign spillovers with human capital as also turned significant and remained positive, but there has been change in the significance and direction of openness which become negative and turned significant.

However, there are several limitations of the results reported in table 2 which need to be addressed before the final conclusions are drawn. The above results are based on some fundamental assumptions that the error terms are serially uncorrelated. Thus, subsequently checking the robustness of the results reported in the table 2 for autocorrelation by using the Woolridge's test for autocorrelation in panel data confirmed the presence of autocorrelation in above results. To test the robustness of our results, we have estimated the clustered robust standard errors and the results are reported in table 3.

Further, comparing the results in table 3 with table 2, we have found that these results are slightly different from the results reported in table 2, as there has been a change in signs and relative significance of the coefficients whereas magnitude of coefficients of all the variables remained the same. The first equation in table 3, have not reported a major change in the significance and direction of coefficients. But, the results reported in equation (2) reveals a change in the significance of human capital as earlier it was significant but it turned insignificant in table 3. Further, in equation (3) both the coefficients for human capital and FDI have turned insignificant while the direction of these coefficients remained same. Lastly, in equation (4) direction and significance of all the variables remained same except the human capital and interaction of human capital with foreign knowledge spillovers which although remained positive but have turned significant.

When we compare our estimated coefficient with other studies , our estimates are corroborated and supported by several studies. It has been widely observed that most of the new technology and innovations activities are concentrated in the handful of rich industrialized countries; the developing countries have to depend largely on these advanced economies for technological spillovers (Keller, 2004, Saggi, 2002 and Eaton and Kortum, 1999). But, in our study, we have found the negative coefficient for the impact of foreign R&D spillovers on TFP across selected sample of economies. This negative coefficient for foreign R&D spillovers is backed by number of reasons: the positive impact of these foreign R&D spillovers is conditioned by the presence of higher absorptive capacity on the part of an economy to manage knowledge spillovers more efficiently (Escribano, 2009**)**.This absorptive capacity also enhances the elasticity of a country's innovation to both national and international spillovers. Further, the impact of these spillover effects also tend to get weaker for an economy, if there exist a large gap between that economy and the technological leaders, (Mancusi, 2004).Another crucial determinant for the reception of these foreign spillovers is the import pattern of countries, because a country that imports primarily from technological leaders is likely to receive more technology embodied in intermediate goods than another that imports primarily from follower countries (Keller, 1999). In addition to that, FDI brought out by MNC's is not targeted to the development of local innovations and R&D which is an underlying reason for the negative impact of FDI on TFP across developing economies. Further, the growing geographical distance with technological leaders also adversely affect the productivity in recipient countries. (Nishioka and Ripoll,2011). Lastly, regardless of the free movement of labour and capital across the economies, there still exist the strong effects of borders on technology and knowledge transfer (Naveed and Ahmad, 2014).

Table 3: Estimated Coefficient of Fixed Effects Models (Dependent Variable is log TFP)

Equation → Independent Variable ↓	(1)	(2)	(3)	(4)
Constant	-13.28	-14.49	-13.44	0.121
	(-1.40)	(-1.28)	(-1.29)	(0.01)
logRD	0.5165***	0.5181***	0.509***	0.5311***
	(7.40)	(7.28)	(7.45)	(9.76)
logSRD	.0077	0.0537	0.0428	-0.59*
	(0.11)	(0.23)	(0.19)	(-1.94)
HC	0.6378	0.717	0.647	0.0074
	(1.13)	(1.03)	(1.01)	(0.01)
GFCF	.009*	.009*	.009*	0.074
	(1.95)	(1.92)	(1.90)	(1.46)
IMP	-0.0011	-0.0028	-0.0059	.0077
	(-0.44)	(-0.36)	(-0.66)	(0.92)
logSRD*HC		-0.0039	-0.0049	.0245
		(-0.21)	(-0.26)	(1.21)
logSRD*IMP		.0047	0.140	.0020
		(0.19)	(0.61)	(0.10)
FDI			-0.009	-0.239**
			(-1.67)	(2.16)
OPENNESS			.0023	-0.03***
			(0.47)	(-2.18)
logSRD*FDI				0.137**
				(2.07)
logSRD*OPENNESS				.00159*
				(1.86)
R^2	0.92	0.92	0.92	0.93
N	228	228	228	228

Notes: 1. Figures in parentheses are t-values.
2. *** significant at 1% level; ** significant at 5% level; and *significant at 10% level

The elasticity estimated for import share individually in the present study is found negative and significant, thus underlying the significance of developing countries' absorptive capacity in facilitating the effects of imports.(Wang, 2012).These findings imply that the beneficial impact of imports stems not only from competitive pressures arising from the imports of consumer goods but also from technological transfers embodied in the imports of capital goods from developed countries (Kim et al (2007). Further, the estimated elasticity corresponding to the interaction of the international R&D capital stock with both the import share and human capital are estimated to be 0.002 and 0.02 and are positive. These results are similar to the earlier study conducted by Engelbrecht (1996) who has specified the double role of human capital i.e., the importance for domestic innovation and TFP catch-up process in his study. In other words, human capital helps to foster domestic innovation and also in the absorption of international knowledge spillovers.

Further, Table 4 depicts the estimated elasticities of total factor productivity with respect to the foreign R&D capital stocks - which are simply the estimated coefficient from Table 3 multiplied by the import share - for 2001, 2006, and 2012. These elasticities at three points of time for 19 selected economies reveal that there has been a rise in these elasticities over this period of time except Azerbaijan, Malaysia and Bulgaria where there has been decline in this intensity over these three points of time. Further, these elasticities has been found highest for Krgyz_Republic followed by Panama. Thus, across all the selected economies, impact of domestic R&D stock has remained more strong as compared to foreign R&D stock which is due to their low level of human capital and large technological gap with the advanced economies.

Table 4: Country-specific, time varying estimates of the impact of R&D capital stocks on total factor productivity

	Elasticity of total factor productivity with respect to			
		Foreign R&D		Domestic R&D
	2001	2006	2012	2001-2012
India	0.03	0.05	0.06	
Pakistan	0.03	0.04	0.04	
China	0.04	0.06	0.04	
Brazil	0.03	0.02	0.03	
Thailand	0.11	0.13	0.14	
Panama	0.14	0.14	0.16	
Mexico	0.05	0.06	0.07	
Malaysia	0.19	0.18	0.14	
Madagascar	0.06	0.09	0.09	
Armenia	0.09	0.07	0.09	0.53
KyrgyzRepublic	0.07	0.15	0.19	
Ukraine	0.11	0.09	0.11	
Azerbaijan	0.07	0.07	0.05	
Belarus	0.14	0.13	0.15	
Bulgaria	0.08	1.28	0.13	
Romania	0.08	0.08	0.08	
Turkey	0.05	0.05	0.04	
Egypt	0.04	0.06	0.05	
Tunisia	0.09	0.09	0.11	

Summary and Conclusions

In the context of globalization, the role of the spillovers and R&D externalities as the conduits for the economic growth and productivity have remained one of leading issue for research from the last few decades. Thus, a number of studies have been conducted in this sphere till now, which differs in terms of their sample selection, have found out the different impacts of these spillovers on economic growth and productivity across these economies. The present study examined the role of internal as well as external R&D stock, measured as bilateral import-share weighted average of the domestic R&D capital stocks of each country's trading partners, in augmenting the total factor productivity (TFP) taking the case of 19 developing economies covering the period 2001-2012. The estimation procedure in obtaining the coefficients is panel data regression analysis. We have used fixed effects model for estimating the magnitude of coefficient and the choice for fixed effects is made on the basis of Hausman test. In addition to domestic and foreign R&D stock, the study has also probed the impact of human capital, trade, FDI, openness to trade and the interaction of foreign spillovers with all the above mentioned conduits of foreign knowledge spillovers. The results of study reveals that domestic R&D stock, human capital, gross fixed capital formation and the interaction terms of foreign R&D spillovers with trade and human capital have positive and significant impact on the TFP of these developing economies. Thus by trading with advanced countries developing economies can have access to the more advanced technologies developed in their trading resulting into improvement of their total factor productivity. Therefore, liberalization of trade should be stimulated by developing economies to augment their level of TFP In addition to that, this rise in total factor productivity is also determined by the improving level of human capital across these economies which facilitate the absorption of knowledge spillovers. These results are in line with the findings of the earlier studies conducted by Coe and Helpman (1995) and Singh (2001). On the other hand, the impact of foreign spillovers and FDI and openness on TFP has been found to be negative in the present study as R&D spillovers are also determined by distance among these nations, levels of their technological capabilities, inward or outward oriented policies of MNCs and as well as various barriers of language, culture etc. Thus, unlike the earlier studies in which foreign knowledge spillovers just like the domestic R&D stock have positive impact on TFP of an economy, our study found that this perception is context specific instead of being universal. Thus, some countries enjoy positive while others can have negative effects from these foreign knowledge spillovers. An important lesson that emerges from the analysis is that if higher is the level of domestic technological and human capabilities higher is the knowledge spillovers. This implies that developing countries should strengthen their technological policies that generate incentive to invest in research and development and build national innovation system.

References:

Aghion, P. and Howitt, P. (1992).A Model of Growth through Creative Destruction. *Econometrica*, 60(2): 323-351.

Amann, E. and Virmani, S. (2015). Foreign Direct Investment and Reverse Technology Spillovers. *OECD Journal: Economic Studies*. 2014(1): 129-153.

Ang, J. and Madsen J.B. (2013).International R&D Spillovers and Productivity Trends in the Asian Miracle Economics. *Economic Inquiry*, 51(2):1523-1541.

Bayoumi, T. David T. Coe and E. Helpman (1999).R&D Spillovers and Global Growth. *Journal of International Economics*, 47(2), 399-428.

Belitz, H. and F. Molders (2013). International Knowledge Spillovers through high-tech exports and R&D of foreign-owned firms. *DIW Brelin Discussion Paper No*. 1276.
Bottazzi, L. and Peri, G. (2003). Innovation and Spillovers in regions: Evidence from European Patent data. *European Economic Review*, 47(4), 687-710.
Bransletter, Lee (2001). Are Knowledge Spillovers International or International in Scope? Micro-econometric Evidence from US and Japan. *Journal of International Economics*, 53(1), 57-79.
Coe, D. E. Helpman and A. Hoffmaister (2009).International R&D Spillovers and Institutions. *European Economic Review*, 53(7), 723-741.
Coe, D. Helpman, E., A.W. Hoffmaister (1997). North-South R&D Spillovers. *The Economic Journal*. 107(440), 134-149.
Coe, David T. and Helpman, E. (1995).International R&D Spillovers. *European Economic Review*, 39(5), 859-87.
Eaton, J. and Kartum, S. (1999). International Technology Diffusion Theory and Measurement. *International Economic Review*, 40 (3), 537-70.
Engelbrecht, H-J (2002). Human Capital and International Knowledge Spillovers in TFP Growth of a Sample of Developing Countries: An Exploration of Alternative Approaches. *Applied Economics*, 34(7), 831-841.
Engelbrecht, H-J (1997). International R&D Spillovers, Human Capital and Productivity in the OECD. Economics: An Empirical Investigation. *European Economic Review*, 41(8), 1479-88.
Escribano, A., A. Fosfuri and J.A. Tribo (2009). Managing external knowledge flows: The moderating role of absorptive capacity. *Research Policy*, 38(1), 96-105.
Evenson, R.E. and Singh, L. 1997. Economic growth, international technological spillovers and public policy: theory and empirical evidence from Asia, *Centre Discussion Paper no. 777*, Economic Growth Centre.
Accessed from http://aida.wss.yale.edu/growth_pdf/cdp777.pdf on 08.08.2016
Gill, Anita and Lakhwinder Singh (2012). Internationalization of Firms from China and India: Theory, Evidence and Policy. *Millennial Asia: An International Journal of Asian Countries*, 3 (1), 23-44.
Gorg, H. and Greenway, D. (2004), Much advertisement about nothing? Do domestic firms really benefit from foreign direct investment. *World Bank Research Observer*, Vol. 19(2), pp. 171-97.
Grossman, G.H. and Helpman, E. (1990).Comparative Advantage and Long-run Growth. *The American Economic Review*, 80(4), 796-815.
Grossman,G.H. and Helpman, E. (1991).Innovation and Growth in the Global Economy. Cambridge: The MIT Press.
IMF.Direction of Trade Statistics (various years) accessed on 16.08.2016.
Joseph, K. J. (2013). Has Trade been an Engine of Inclusive Growth? India's Experience Under Globalization, Millennial Asia: *An International Journal of Asian Studies*. 4 (2).135-157.
Kokko, A., Zejan, M. &Tansini, R (2001). Trade regimes and spillover effects of FDI: Evidence from Uruguay.*WeltwirtschaftlichesArchiv*, 137(1): 124-149. doi:10.1007/BF02707603
Kao, C., M.H. Chiang and B. Chen (1999). International R&D Spillovers: An application of estimation and Inference in Panel Co-integration. *Oxford Bulletin of Economics and Statistics*, 61(4): 693-711.
Keller, W. (1999). How Trade Patterns and Technology Flows Affect Productivity Growth, *National Bureau of Economic Research*, Working Paper *No*. 6990: 1-57.

Keller, W. (2004).International technology diffusion. *Journal of Economic Literature*, 42 (3) 752-782.

Kim, S. H. Lim and D. Park (2007). The Effect of Imports and Exports on Total factor Productivity in Korea, Discussion Paper NO. 07-E-022, *Research Institute of Economy, Trade and Industry* (RIETI), Tokyo.

Luintel, K. and M. Khan (2004). Are International R&D Spillovers Costly for the United States? *The Review of Economics and Statistics*, 86(4): 896-910.

Madden, G., S. Savage, and J.P. Bloxham (2001). Asian and OECD International R&D Spillovers. *Applied Economic Letters*, 8(7): 431-435.

Mancusi, M.L. (2008) International Spillovers and Alesorptive Capacity: A Cross-country cross sector analysis based on patents and citations. *Journal of International Economics*, 76(2), 155-165.

Naveed, A. and Nisar Ahmad (2014). Technology Spillovers and International Borders: A Spatial Econometric Analysis. *Department of Border Region Studies.*University of Southern Denmark.*Working Paper No*. 02/14.

Nishioka, S and M. Ripoll (2011), Productivity, R&D, and international technology diffusion at the industry level. *Department of Economics, West Virginia University and University of Pittsburgh.*
Accessed from https://editorialexpress.com/cgi- bin/conference/download.cgi?db name=NASM2011&paper _id=765 on 22.08.2016

Nursamsu and Faisal Hastiadi (2015). Analysis of International R&D Spillover from International Trade and Foreign Direct Investment Channel: Evidence from Asian Newly Industrialized Countries. *Journal of Economic Cooperation and Development,* 36(2), 125-154.

Romer, P.M. (1990). Endogenous Technical Change. *Journal of Political Economy*, 98(5): 71-102.

Ruge-Leiva, D. (2015). International R&D Spillovers and Other Unobserved Common Spillovers and Shocks. *Munich Personal Repec Archive*, Paper No. 6285, Accessed on 25.09.2016.

Sjogren, A. (1998). Human Capital, R&D and Economic Growth.Stockholm School of Economics, Working Paper Series in *Economics and Finance* No. 238.

Sadraoui, T (2011). A Co-integration Panel data analysis for International R&D Spillovers and R&D Cooperation: Case Study from Mediterranean Countries. *International Journal of Knowledge and Learning*, 7(3-4): 179-196.

Saggi, Kamal (2002).Trade, Foreign Direct Investment and International Technology Transfer: A Survey. *The World Bank Research Observer*, 17(2): 191-235.

Singh, L. (2001). 'International R&D Spillovers and Economic Growth in Asia' in A. Guha, K.L. Krishna and A.K. Lahiri (eds.) Trade and Industry: Essays by NIPFP-Ford Foundation Fellows, New Delhi: NIPFP and Vikas Publishing House: 1-26.

Singh, L. (2004). Domestic and International Knowledge Spillovers in Manufacturing Industries in South Korea. *Economic and Political Weekly*. 39 (5):498-505.

The Conference Board (2016).The Conference Board Total Economy Database. May 2016.http://www.conference-board.org/data/economydatabase/
Accessed on 10.08.2016.

Ulku, H. and M.Pamukcu (2015).The impact of R&D and Knowledge Diffusion on the Productivity of Manufacturing Firms in Turkey. *Journal of Productivity Analysis,* 44(1), 79-95.

UNESCO (2014).UIS Bulletin on Science and Technology Statistics. *Montreal*: UNESCO Institute of Statistics.

Wang.Y. (2012). Openness and Productivity: The Role of Imports, FDI and International Telecommunications. *Latin Journal of Economics*, 49(1), 125-145.

World Bank. 2015. World Development Indicators. Washington, DC: *The World Bank.* http://data.worldbank.org/data-catalog/world-development-indicators.

Zhu, L. and B.N. Jeon (2007). International R&D Spillovers: Trade, FDI and Information Technology as Spillover Channels. *Review of International Economics*, 15 (5): 955-976.

Centre for Development Economics and Innovation Studies, Punjabi University, Patiala

All discussion papers are accessible on-line at the following website:
http://www.punjabiuniversity.ac.in/cdeiswebsite/index.html

Discussion papers in Economics

1. **Anita Gill**, "Internationalization of Firms: An Analysis of Korean FDI in India", October, 2013.
2. **Lakhwinder Singh and Kesar Singh Bhangoo**, "The State, Systems of Innovation and Economic Growth: Comparative Perspectives from India and South Korea", October, 2013.
3. **Inderjeet Singh and Lakhwinder Singh**, "Services Sector as an Engine of Economic Growth: Implications for India-South Korea Economic Cooperation, October, 2013.
4. **Sukhwinder Singh and Jaswinder Singh Brar**, "India’s Labouring Poor in the Unorganized Sector: Social Security Schemes and Alternatives", October, 2013.
5. **Inderjeet Singh, Lakhwinder Singh and Parmod Kumar**, "Economic and Financial Consequences of Cancer from Patient's Family Perspective: A Case Study of Punjab", October, 2013.
6. **Niharika Sharma**, "Growth and Structural Change in Indian Manufacturing since Liberalisation: An Interstate Analysis", December, 2013.
7. **Anita Gill**, "Agricultural Credit in Punjab: Have Policy Initiatives Made a Dent in Informal Credit Market?" September, 2014.
8. **Inderjeet Singh**, "Service Sector and Economic Growth in Punjab", September, 2014.
9. **Jaswinder Singh Brar**, "Critical Evaluation of Educational Development in Punjab", September, 2014.
10. **Sukhwinder Singh,** "Economic Development and Emerging Health Scenario in Punjab:In the Shadow of Global Forces and State Neglect", September, 2014.
11. **Lakhwinder Singh and Anita Gill**, "Emergence of Innovative Manufacturing Firms across Asian Countries", December, 2015.
12. **Manjinder Kaur and Lakhwinder Singh**, "Knowledge in Economic Growth of Developing Economies", December, 2015.
13. **Shantanu Nevrekar**, "The Cancer Train: Inside the Hidden Tragedy of the Green revolution in Malwa region of Punjab", June, 2016.
14. **Lakhwinder Singh**, "Towards Alternative Strategy of Economic Development in Punjab", November, 2016.
15. **Manjinder Kaur and Lakhwinder Singh**, "Knowledge Spillovers across Developing Economies: Empirical Evidence", November, 2016.