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Globalisation and Innovation Activity in Developing Countries

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Abstract: *This paper is an empirical assessment of the impacts of globalisation on innovative activity across developing countries. The focus is on the role of trade and capital account openness. Extreme-Bound-Analysis (EBA) approach is applied to analyse data from 58 countries over the 1996-2011 period. Though globalisation leads to greater interaction between countries through trade and Foreign Direct Investment (FDI), not all of these interactions affect domestic innovation activities. The result reveal only imports of machinery and equipment promote domestic innovation activity while there is insufficient empirical evidence to suggest that this relationship exists for imports of manufactured goods and FDI inflows. This finding is consistent with the view that import is a more important channel for technology transfer than FDI.*

Keywords: FDI; Import; Extreme Bound Analysis; Developing Countries
JEL Classification: F14, F21, O31

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1. Introduction

There is greater trade interactions between countries compared with decades ago due to globalisation, which means physical distance is no longer a barrier (Borchert & Yotov, 2017). This is coupled with liberalisation of trade and investment policies in most countries. During 2001-2015, 78% of the 1,536 policies worldwide were aimed at liberalisation and promoting investment (UNCTAD, 2016) while the average world tariff rate reduced from 9.68% in 2001 to 6.18% in 2010, thus, creating a more favourable environment for trade.

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As a result of these policy changes, foreign direct investment (FDI) and trade in goods and services grow faster than the world output in recent decades. According to United Nations Conference on Trade and Development Statistics (UNCTADstat), the average growth rate of global world trade activities (both export and import) is 6% while the average growth of FDI inflow is 13% between 1981-2015 compared with the average output growth of 2% in the same period. Additionally, both trade and FDI registered higher growth rate among developing countries than developed countries. The average growth rate of trade and FDI in developing is 8% and 18% respectively but only 5% and 14% respectively among developed countries. In other words, developing countries gain relatively more from globalisation. This coincides with the presence of multinational corporations (MNCs) in emerging markets, such as China (Fabre, 2014) and India (Jha & Krishnan, 2013) in order to improve their competitiveness while accessing local market.

Policies related to trade liberalisation are motivated by the expectation that the domestic economy will gain from a greater volume of trade and capital inflow (Coe & Helpman, 1995; Potterie & Lichtenberg, 2001). Many empirical studies confirm the cumulative impact of foreign technology through trade, FDI and other channels as an important determinant of growth in the host country. This is crucial for developing countries as, though innovation activities are found to play a significant role in enhancing technological improvement (Aghion & Howitt, 1992; Romer, 1990), limited investments in innovation among developing countries mean technology transfer plays a vital role in productivity growth (Coe, Helpman & Hoffmaister, 1997).

Additionally, technology transfer can, however, affect domestic innovation effort. Domestic firms could adopt foreign technology with less uncertainty instead of developing their own technology and could learn from the transfer of technological knowhow and improve their own knowledge base. It then encourages innovation activity as it is now easier than before. Without understanding the impacts of technology transfer, policies related to trade and investment could be less effective. For instance, globalisation process might not only benefit the country in term of promoting productivity but it also has potential negative effects on domestic innovation activity. Nevertheless, little is known about the impact of technology transfer on domestic innovation activity. This is especially important for emerging market as the limitation of traditional export-led growth model had been proven in the recent global crisis (Fabre, 2014). The gap of knowledge in this area has therefore motivated this paper to address the impacts of technology transfer induced by globalisation on domestic innovation.

The objective of this paper is to investigate the relationship between technology transfer channels (i.e. trade and FDI) and domestic innovation activity in developing countries. This paper analyses the imports by disaggregating data based on technology components as discussed by Coe et al. (1997). In order to achieve the objective of this paper, the Extreme-Bound-Analysis (EBA) approach introduced by Leamer (1983, 1985) and modified by Xavier (1997) is used on data from 58 countries during the period 1996 to 2011. The findings reveal that among all spillover channels (i.e. total import, import of manufactured goods, import of machinery and equipmentand FDI), only import of machinery and equipment is found to be significant and has a positive effect on domestic innovation activities. These findings shed new lights on the complex nature of linkages between globalisation and innovation.

The remainder of this paper is organised as follows. Section 2 reviews literature related to this topic while Section 3 reviews the methodology used to test the hypothesis. Section 4 presents the empirical results of using while the last section summarises and concludes the paper.

2. Literature Review

The importance of technology inflow for developing countries has been debated extensively in the literature. In a study on developed countries, Coe and Helpman (1995) showed empirical evidence that foreign technology promotes domestic productivity via trade. Complementing this, Coe et al. (1997) discussed this further in the context of developing countries and confirmed the significance of import as an important channel for knowledge spill overs to developing countries. They found that import of capital goods and high-tech products, such as machinery and equipment, have a greater impact on productivity than imports of other types of goods. These studies suggest that openness to trade enhances domestic productivity through four channels: access to a variety of products and equipment, a communication channel that stimulates cross-border learning, adopt foreign technology to local conditionsand imitate foreign technology or even develop new technology from it (Coe et al., 1997). Meanwhile, Potterie and Lichtenberg (2001) argued that foreign technology does not only spill over to domestic economy through trade but also via FDI. Specifically, domestic firms have the opportunity to imitate technology from foreign firms, as they are forced to improve efficiency due to greater domestic competition. In essence, the local firms will learn to engage in international trade through collaboration or imitation. Additionally, domestic workers will also acquire new skills when they work in a foreign firm and this new knowledge may spill over to local firms once they join local firms (Gorg & Greenaway, 2004). There are many studies that have discussed the importance of technology transfer on domestic productivity. However, only a few focused on the impacts of technology transfer on domestic innovation activity. Most studies that have analysed domestic innovation activity examined the internal factors. For instance, higher income implies greater allocation and incentives for the firms to engage in R&D in order to improve profitability (Bebczuk, 2002; Braconier, 2000; Cumming & Macintosh, 2000). At the same time, a bigger market acts as an incentive for the firm to get involved in R&D investment and consumers prefer differentiated products if they are wealthier (Wang, 2010). Other than promoting domestic innovation, it is also crucial to promoting technology transfer as internal demand which can attract foreign knowledge provider such as MNCs (Pueyo, García, Mendiluce & Morales, 2011). Nevertheless, not all agree with this theory. It is suggested that income might have a limited role in determining allocation for R&D if the latter's target is exogenously set by the government, such as European Council (Wang, 2010). Besides, greater income also leads to greater risk aversion and thus, discourage risky R&D investment (Cumming & Macintosh, 2000).

Human capital is also positively related with economic development, which in turn promotes innovation activity (Cheung & Lin, 2004) for both developing countries (Bebczuk, 2002) and developed countries (Wang, 2010). This has made the stock and intensity of human capital as a major determinant for innovation activities in previous studies. Meanwhile, Teitel (1987) has linked this with the income level of an economy as more scientists and engineers are prefer to work in higher income countries.

Rate and level of investment are important determinants of innovation. They complement R&D investment from the view of aggregate production. It also substitutes R&D investment as both compete for limited resources (Bebczuk, 2002; Wang, 2010). Thus, the investment rate of an economy could have both complementary and substitute effects on the innovation effort and it may also depend on the characteristic of the country. For instance, a negative relationship was shown by Bebczuk (2002) and an insignificant one by Wang (2010).

The population also matters as a country with a large population has greater manpower for innovation (Teitel, 1987, 1994) although Furman, Porterand Stern (2002) argued that greater population discourage innovation activity due to lower GDP per capita. Hu and Mathews (2005) explained the insignificant relationship where the population in latecomer countries is not expected to have a significant impact on early-stage innovation. Meanwhile, after controlling for prosperity and technological sophistication, greater population size could discourage innovation due to lower GDP per capita (Furman et al., 2002).

Previous studies have highlighted the role of government in innovation activity: it creates both crowding-in and crowding-out effects on private expenditures (Linnemann & Schabert, 2004). Government spending in R&D also reinforces innovation in infrastructure and promote private investment in innovation (Bebczuk, 2002; Furman et al., 2002) though it has substitution effect, especially among latecomer countries which rely more on public R&D investment (Hu & Mathews, 2005). Thus, there is less innovation activity in countries with deficit budget Wang (2010).

There are, however, limited studies that have analysed the influence of external factor on domestic innovation activity, i.e. technology transfer from foreign countries. Arguably, technology transfer has both positive and negative impacts on domestic innovation activity (Lu, Tao & Zhu, 2017). The theory predicts that both trade and financial liberalisation will promote competition in domestic market. Domestic firms are therefore, expected to innovate in order to stay competitive by improving the quality of their products (Wang, 2010). Nevertheless, it might work in another way. Since R&D investment is risky, domestic firms would reduce their spending for R&D activity due to lower profit and greater competition (Veugelers & Houte, 1990).

The impacts of technology transfer on innovation activity are also ambiguous due to access to foreign knowledge base. On one hand, technology transfer generates opportunity for domestic firms to learn about the foreign knowledge which is absent in domestic knowledge base. The domestic economy is therefore encouraged to involve in R&D activity that otherwise is impossible, or at least difficult, due to the lack of necessary skills and knowledge. On the other hand, foreign technology precludes the need for one’s own R&D. Domestic firms can adopt foreign technology with less uncertainty instead of developing their own technology (Un & Cuervo-Cazurra, 2008). As suggested by Wang (2010), the main source of new technology is OECD countries (Wang, 2010).

3. Methodology and Data

3.1 Model and variable measurement

This paper adopts EBA approach, which was first developed by Leamer (1983). The advantage of using this methodology is that it provides robustness and sensitivity analysis of the variables (Wang, 2010). This approach involves varying the subset of control variables included in regression to find the widest range of coefficient estimates on the variables of interest. By varying the subset of control variables and repeating the estimations, it generates a more robust result of the parameter estimates of the hypothesis to be tested.

Based on Wang (2010), the general specification of the estimated model is as follows:

$$Y = \beta_i I + \beta_m M + \beta_z Z + \varepsilon \tag{1}$$

where Y is the dependent variable, which is domestic R&D intensity representing host country's innovation effort, I represent the variable that is an important determinant to the dependent variable, M is the variable of primary interestand Z is explanatory variables.

These explanatory variables (i.e. I and Z) are selected based on literature findings. The endogenous growth theory suggests human capital as a major determinant of innovation capacity and therefore, it is considered as I variable. It is represented by the ratio of the population aged above 25 years having tertiary education. Meanwhile, the Z variables consist of several other variables which are hypothesised to influence R&D activity. Variables proposed in previous studies such as income (Bebczuk, 2002; Braconier, 2000; Cumming & Macintosh, 2000), population density (Furman et al., 2002; Hu & Mathews, 2005; Teitel, 1987, 1994), ratio of fixed capital formation to GDP and its growth rate (Bebczuk, 2002; Wang, 2010), the role of government including expenditure, imbalances and spending in R&D (Bebczuk, 2002; Furman et al., 2002; Hu & Mathews, 2005; Linnemann & Schabert, 2004), indicators of business cycle including inflation and unemployment rate (Aghion & Howitt, 1992, 1994; Bean & Pissarides, 1993; Wang, 2010) are included in the model.

The variable of interest, M, is the main focus of this paper which is to analyse the impact of technology transfer on domestic innovation. It consists of two technologies spill over channels namely, import and FDI. Thispaper examines both channels since they are viewed as major technology transfer channels in many studies (Azman-Saini, Baharumshah & Law, 2010; Azman-Saini, Law & Ahmad, 2010; Coe & Helpman, 1995; Coe et al., 1997; Coe, Helpman & Hoffmaister, 2009; Durham, 2004; Tee, Azman-Saini, Ibrahim & Ismail, 2015). There are three measures of imports: i) ratio of total import to GDP; ii) ratio of manufactured goods import to GDP; iii) ratio of machinery and equipment import to GDP. The rationale to include three different import channels is to analyse if the influence differs if there is higher technology level (Coe et al., 1997). Thus, the following hypothesis is developed:

Hypothesis 1: *Technology transfer has no impact on domestic innovation activity.*

The hypothesis is then being extended to provide a clearer picture regarding the influence of technology transfer by analysing different spill over channels as discussed earlier:

Hypothesis 1a: *Technology transfer through total import has no impact on domestic innovation activity.*

Hypothesis 1b: *Technology transfer through the import of manufactured goods has no impact on domestic innovation activity.*

Hypothesis 1c: *Technology transfer through the import of machinery and equipment has no impact on domestic innovation activity.*

Hypothesis 1d: *Technology transfer through FDI has no impact on domestic innovation activity*.

3.2 Model and variable measurement

The EBA estimation involves several important steps. It begins with the estimation of “base regression” which includes only variables I and M. Then, regression equations for all possible linear combinations is estimated up to three Z variables. The next step is to identify the highest value and lowest value for the variable of interest (βm) which cannot be rejected at the 5% significance level (Levine & Renelt, 1992) or 10% significance level (Wang, 2010). After that, extreme bound is defined by a group of Z variables - maximum and minimum values of βm plus two standard errors. This extreme bound is used to infer the confidence of partial relationship between dependent variable (i.e. R&D intensity) and independent variables. The relationship is considered as “robust” if βm remains significant and has the same sign within the extreme bound. If it is not the case, where βm does not remain significant or the sign is different, the relationship is indicated as “fragile” since alternation in conditioning information set changes statistical inference regarding dependent variable and variables of primary interest.

Nevertheless, this criterion has been criticised by Xavier (1997) as too stringent. The author argues that if the distributions of parameters have some positive and some negative support, then one would find at least one regression with a changed sign if enough regressions are run (Dreher, Sturm & Haan, 2010). Thus, this paper uses the alternative criterion proposed in Xavier (1997) which is based on the entire distribution of the parameters, or cumulative distribution function (CDF) across regressions. Instead of only “robust” vs. “non-robust” classifications, this approach would assign some levels of confidence to the variables. Compare a parameter with 95% and 50% of density function respectively lies right to the zero; the former is considered more likely to correlate with dependent variable than another. Following this approach, a variable is considered as robust when 90% confidence interval around the parameters is entirely on one side of zero, i.e. CDF (0)3 above 0.95 (Ahrend, 2012). All these estimation steps can be achieved through the utilisation of the R Project as it provides an excellent flexibility for statistical analysis.

3.3 Data sources

This paper uses cross-country data from 58 developing countries covering the period of 1996-2011[4](see Appendix 1). The dependent variable is R&D intensity which is defined as the ratio of R&D expenditure to GDP. Data was collected from the *United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute of Statistic database*. The human capital (i.e. *I* variable) is proxy for the ratio of the population above 25 having tertiary education and adopted from Barro and Lee (2013).

The variables of interest in the model (i.e. *M* variables) include the two technology transfer channels: import and FDI. The former channel, proxy by the ratio of total import to GDP and its sub-categories (i.e. ratio of manufactured goods imports to GDP and ratio of machinery and equipment import to GDP) were obtained from *United Nations Conference on Trade and Development database* while the latter channel, proxy by ratio of FDI inflow to GDP, was obtained from *World Development Indicators database*.

The *Z* variables consist of several other variables which are hypothesised to influence R&D activity: income, population density, the ratio of the fixed capital formation to GDP and its growth rate, the role of government (i.e. expenditure, imbalancesand spending in R&D) and the indicators of macroeconomics (i.e. inflation and unemployment). All these variables are extracted from the *World Development Indicators database* except government spending in R&D which was obtained from *UNESCO Institute of Statistic database*.

4. Empirical results

The results of EBA with different combinations of independent variables are presented in tables 1 to 4 corresponding to hypothesis 1a to 1d. In each table, columns (1) and (2) respectively present averages of estimated coefficients and standard error overall regressions. Column (3) shows the percentage of regressions in which the respective variable is significant at least at 5% level. Column (4) reports the p-value of coefficients. CDF (0)s are reported in column (5). Based on Xavier (1997)'s suggestion, a variable is considered robust if 90% confidence interval condition is fulfilled[5] (i.e. CDF(0) is above 0.95) as the variable turn out significant in a very large fraction of the regressions. Finally, column (6) and (7) provides Learmer's lower and upper bounds. In each table, there are four models estimated. In the first model, the whole set of control variables is included. Nonetheless, some of the variables measure similar perspectives of an economy, such as government expenditure and government imbalance; or fixed capital formation and fixed capital formation growth. These variables may be inappropriate to be included in regression together. Therefore, model 2 restricts government expenditure and government imbalance not to appear together in the set of control variables while model 3 restricts the simultaneous presence of fixed capital formation and its growth. Finally, model 4 shows the result when both restrictions are implemented[6].

First of all, human capital is found to be positive and statistically significant in all regressions where p-values for human capital are lower than 0.01 in all regressions. This relationship is found to be robust under Leamer's criterion as shown in Table 1 and 4: positively significant within the range of high value and low value of the coefficient in all regressions. At the same time, results in Tables 2 and 3 also suggest the robustness of this relationship under Xavier's criterion: CDF for human capital is greater than 0.95 in all regressions. These findings are in line with literature which suggests that human capital is a major determinant of domestic innovation effort. This also justifies the inclusion of human capital as *I*-variable in the EBA model.

Table 1 shows the results of using total import as spill over channel. In all four regressions with different restrictions being imposed, no significant relationship is found as both Leamer's and Xavier's criterion does not indicate any robust relationship between total import with R&D intensity. Findings of the present study show that some products included in the total import, such as raw material, do not indicate advanced technology and therefore, restrict the spill over potential. This is similar to Chang et al. (2013) where import is found to have no impact on domestic innovation.

Table 1: Impact of total import on domestic innovation effort

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Variables	**Avg. Beta**	**Avg. SE**	**% Sign.**	**P-value**	**CDF (0)**	**Lower**	**Upper**
Regression one							
HC	0.015	0.004	100	0.0004	99	0.001	0.029
Import	-0.004	0.003	38	0.1888	92	-0.026	0.011

Table 1: (Continue)

Variables	(1) Avg. Beta	(2) Avg. SE	(3) % Sign	(4) % Sign	(5) CDF (0)	(6) Lower	(7) Upper
Regression two							
HC	0.015	0.004	100	0.0004	99	0.001	0.029
Import	-0.004	0.003	39	0.1888	93	-0.026	0.011
Regression three							
HC	0.015	0.004	100	0.0004	99	0.001	0.029
Import	-0.004	0.003	38	0.1888	93	-0.026	0.011
Regression four							
HC	0.015	0.004	100	0.0004	99	0.001	0.029
Import	-0.004	0.003	39	0.1888	93	-0.026	0.011

Notes: Regression one has no restriction in select control variables; regression two restricts that either government expenditure or government imbalance will be included; regression three restricts that either fixed capital formation or fixed capital formation growth will be included in control variables; regression four implements both restrictions.

In order to understand better the impact of import channel, this paper disaggregates the import channel into a narrower channel. Table 2 presents the results of using a narrower definition of import: import of manufactured goods. The Leamer's criterion did not support the existence of a robust relationship but according to Xavier's criterion, import of manufactured goods is found to be robust in three out of four regressions but only significant with positive signs at the 10% level. Overall, there is weak evidence to support a robust relationship between the import of manufactured goods and R&D intensity.

Table 3 shows the result of using the import of machinery and equipment which has higher technological contents as a channel for technology transfer. The Leamer's criterion indicates that there is no robust relationship as lower bounds and upper bounds for this coefficient in all four regressions have different sign. Xavier's criterion, however, suggests that the relationship could be considered as robust where the CDFs in all four regressions are above 95. This suggests that the variable maintain its positive sign at least 95% in all combination estimation, regardless of with or without restriction imposed in the model. The findings provide sufficient evidence to support the robustness of a positive and significant relationship between the import of machinery and equipment and domestic innovation effort in developing countries.

Table 2: Impact of manufactured goods import on domestic innovation effort

Variables	(1) Avg. Beta	(2) Avg. SE	(3) % Sign.	(4) P-value	(5) CDF (0)	(6) Lower	(7) Upper
Regression one							
HC	0.016	0.004	99	0.0002	99	-0.001	0.029
Manu	0.007	0.004	46	0.0855	94	-0.043	0.036
Regression two							
HC	0.016	0.004	99	0.0002	99	-0.001	0.029
Manu	0.008	0.004	46	0.0503	95	-0.043	0.036
Regression three							
HC	0.016	0.004	99	0.0002	99	-0.001	0.029
Manu	0.008	0.004	47	0.0503	95	-0.043	0.036
Regression four							
HC	0.016	0.004	99	0.0002	99	-0.001	0.029
Manu	0.008	0.004	47	0.0503	95	-0.043	0.036

Notes: Regression one has no restriction in select control variables; regression two has restriction that either government expenditure or government imbalance will be included; regression three restricts that either fixed capital formation or fixed capital formation growth will be included in control variables; regression four implements both restrictions.

The findings are in line with Coe et al. (1997) regarding the significance of import of machinery and equipment compared with its alternative. This paper shows that only import of machinery and equipment promote domestic innovation, while Coe et al. (1997) found that it “does a marginally better job” than its alternatives in improving domestic productivity. The role of imported machinery and equipment is mainly due to the fact it contains a greater technological component. Thus, it creates more opportunity for domestic firms to learn from technology transfer. Wang (2010) however, found a negative relationship among developed countries. The difference could be attributable to the technology base of the host countries. Developing countries with a significant technology gap have a greater learning opportunity to learn from foreign technology and thus, willing to invest in innovation activity. In contrast, developed countries would prefer to adopt foreign technology since their learning opportunity is limited and therefore, innovation investment is no longer needed.

Table 3: Impact of machinery and equipment import on domestic innovation effort

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Variables	**Avg. Beta**	**Avg. SE**	**% Sign.**	**P-value**	**CDF(0)**	**Lower**	**Upper**
Regression one							
HC	0.015	0.004	99	0.0004	99	-0.001	0.028
Mac	0.015	0.006	72	0.0153	98	-0.020	0.062
Regression two							
HC	0.015	0.004	99	0.0004	99	-0.001	0.028
Mac	0.015	0.006	71	0.0153	98	-0.020	0.062
Regression three							
HC	0.015	0.004	99	0.0004	99	-0.001	0.028
Mac	0.015	0.006	73	0.0153	99	-0.020	0.062
Regression four							
HC	0.015	0.004	99	0.0004	99	-0.001	0.028
Mac	0.015	0.006	72	0.0153	99	-0.020	0.062

Notes: Regression one has no restriction in select control variables; regression two has restriction that either government expenditure or government imbalance will be included; regression three restricts that either fixed capital formation or fixed capital formation growth will be included in control variables; regression four implements both restrictions.

Finally, this paper looks at alternative technology spill overs channel, namely FDI. The results are presented in Table 4 where both Leamer's and Xavier's criteria do not indicate the presence of any robust relationship between FDI and R&D intensity. The findings are consistent in all four regressions which indicate that domestic innovation of developing countries is not affected by FDI inflows. This is consistent with Chang et al. (2013) and Lu et al. (2017). The insignificant relationship could be due to the absorptive capacity among host countries which enables them to benefit from FDI inflows, e.g. research capacity of the destination (Zhang, 2017) This supports the increasingly popular view that knowledge spill over is not an automatic consequence of MSCs presence but requires host country to have certain level of absorptive capacity in order to benefit from it, e.g. institutional development (Durham, 2004), economic freedom (Azman-Saini, Law, et al., 2010) and financial development (Azman-Saini, Law, et al., 2010), among many others.

In sum, only hypothesis 1c (technology transfer through the import of machinery and equipment exerts no impact on domestic innovation activity) is rejected. The results are very similar to Chang et al. (2013) where import and FDI are both found to be insignificant towards domestic innovation activities. This paper discusses in depth the import channel by disaggregating it. Two of the import channels (total import and import of manufactured goods) are considered in previous studies to have a lower level of technology component than import of machinery and equipment. Thus, the host country's decision in innovating is not affected by these two channels due to their limited spill over effect. A significant effect can, however, be observed with the import of machinery and equipment and its spill over effects. In the meantime, the insignificant impact from the FDI requires further analysis to examine the possible factor, e.g. the role of absorptive capacity. Many studies have found that FDI is less likely to have a direct impact on the host country but certain characteristics within the host country must be present to benefit from it. The inclusion of these factors in the analysis will provide a clearer picture regarding this relationship.

Table 4: Impact of FDI on domestic innovation effort

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Variables	**Avg. Beta**	**Avg. SE**	**% Sign.**	**P-value**	**CDF(0)**	**Lower**	**Upper**
Regression one							
HC	0.015	0.004	100	0.0004	99	0.001	0.028
FDI	-0.009	0.019	2	0.6376	68	-0.081	0.062
Regression two							
HC	0.015	0.004	100	0.0004	99	0.001	0.028
FDI	-0.009	0.019	1	0.6376	68	-0.081	0.062
Regression three							
HC	0.015	0.004	100	0.0004	99	0.001	0.028
FDI	-0.009	0.019	2	0.6376	68	-0.081	0.062

Notes: Regression one has no restriction in select control variables; regression two has restriction that either government expenditure or government imbalance will be included; regression three restricts that either fixed capital formation or fixed capital formation growth will be included in control variables; regression four implements both restrictions.

5. Conclusion

Globalisation process is viewed by many countries (especially the developing ones) as a major source of technology spillovers. Although technology transfer is found to enhance the productivity and growth of host country, its impacts on the other aspects of the economy are however, ambiguous. On one hand, technology transfer complements domestic innovation through improving domestic knowledge base. On the other hand, technology transfer substitutes innovation activity since it is easier to adopt foreign technology than investing in R&D. The studies in this field are, however, very limited as most studies focus on the relationship between technology and economy performance (i.e. productivity and growth). This paper, therefore, aims to fill this gap in knowledge by examining if the technology transfer would influence the economy indirectly, specifically its impact on domestic innovation activity, besides its direct impact on productivity and growth.

The EBA approach is implemented to investigate the impact of import and FDI on domestic innovation activity in 58 developing countries between 1996 and 2011. The FDI inflows and three categories of import-total import, import of manufactured goodsand import of machinery and equipment - are included as the technology transfer channel in the analysis. The findings suggest that though interactions between countries are greater nowadays, only import of machinery and equipment has a positive and significant impact on domestic innovation activities. In other words, the import of machinery and equipment is found to bring more benefits to host country than its alternatives where it promotes domestic innovation activity and productivity as suggested in the literature.

The findings are crucial for policymakers when formulating trade and investment policies. There has to be greater attention to the import of machinery and equipment since it does not only improve the host country's productivity but also promote domestic innovation activities which in turn enhances long-run economic growth. Thus, a proper trade policy that encourages the trade of machinery and equipment does not only provide an opportunity to learn from foreign technology but improves domestic capacity to develop its own technology base.

Though both import and FDI are viewed as significant channel for technology transfer, only the former (specifically import of machinery and equipment) is found to have a significant impact on domestic innovation. It is very likely that lack of sufficient absorptive capacity (e.g. economic freedom, financial development, institutional quality, just to name a few) has led to insignificant direct impact from FDI as suggested by many studies. The study only looks at imports but export is found to influence innovation activities in recent studies. Therefore, the next logical step in future research is to examine the impact of export on domestic innovation activity.

Notes

1. World Bank data.
2. The share of middle and low-income countries is only 30.7% of world gross expenditure in R&D during 2013 (UNESCO, 2016).
3. Following Xavier (1997), the area under density is divided into two parts which lie on each side of zeroand the larger area is called CDF (0), irrespective of whether it is above or below zero.
4. The sample period is restricted due to data limitation, especially data related to research and development expenditure.
5. The test proposed by Xavier (1997) is basically a one-sided test.
6. These restrictions are imposed in order to address the possible multicollinearity issue since these variables (i.e. government expenditure and government imbalance, fixed capital formation and fixed capital formation growth) tend to strongly correlate with each other.

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References

Aghion, P. & Howitt, P. (1992). A model of growth through creative destruction. *Econometrica, 60*(2), 323-351.

Aghion, P. & Howitt, P. (1994). Growth and unemployment. *The Review of Economic Studies, 61*(3), 477-494.

Ahrend, R. (2012). Understanding Russian regions' economic performance during periods of decline and growth—an extreme bound analysis approach. *Economic Systems, 36*(3), 426-443.

Azman-Saini, W. N. W., Baharumshah, A. Z. & Law, S. H. (2010). Foreign direct investment, economic freedom and economic growth: international evidence. *Economic Modelling, 27*(5), 1079-1089..

Azman-Saini, W. N. W., Law, S. H. & Ahmad, A. H. (2010). FDI and economic growth: new evidence on the role of financial markets. *Economics Letters, 107*(2), 211-213.

Barro, R. J. & Lee, J. W. (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics, 104*, 184-198.

Bean, C. & Pissarides, C. (1993). Unemployment, consumption and growth. *European Economic Review, 37*(4), 837-854.

Bebczuk, R. N. (2002). R&D expenditure and the role of government around the world. *Estudios de economia, 29*(1), 109-121.

Borchert, I. & Yotov, Y. V. (2017). Distance, globalization and international trade. *Economics Letters, 153*, 32-38.

Braconier, H. (2000). Do higher per capita incomes lead to more r&d expenditure? *Review of Development Economics, 4*(3), 244-257.

Chang, C.-L., Chen, S.-P. & McAleer, M. (2013). Globalization and knowledge spillover: international direct investment, exports and patents. *Economics of Innovation and New Technology, 22*(4), 329-352.

Cheung, K.-y. & Lin, P. (2004). Spillover effects of FDI on innovation in China: evidence from the provincial data. *China Economic Review, 15*(1), 25-44.

Coe, D. T. & Helpman, E. (1995). International R&D spillovers. *European Economic Review, 39*(5), 859-887.

Coe, D. T., Helpman, E. & Hoffmaister, A. W. (1997). North-south r & d spillovers. *The Economic Journal, 107*(440), 134-149.

Coe, D. T., Helpman, E. & Hoffmaister, A. W. (2009). International r&d spillovers and institutions. *European Economic Review, 53*(7), 723-741.

Cumming, D. J. & Macintosh, J. G. (2000). The determinants of r&d expenditures: a study of the canadian biotechnology industry. *Review of Industrial Organization, 17*(4), 357-370.

Dreher, A., Sturm, J.-E. & Haan, J. d. (2010). When is a central bank governor replaced? evidence based on a new data set. *Journal of Macroeconomics, 32*(3), 766-781.

Durham, J. B. (2004). Absorptive capacity and the effects of foreign direct investment and equity foreign portfolio investment on economic growth. *European Economic Review, 48*(2), 285-306.

Fabre, G. (2014). 1 - The real leap forward: China's r&d and innovation strategy a2 - Taylor, Robert *The Globalization of Chinese Business* (pp. 3-25). Oxford: Chandos Publishing.

Furman, J. L., Porter, M. E. & Stern, S. (2002). The determinants of national innovative capacity. *Research Policy, 31*(6), 899-933.

Gorg, H. & Greenaway, D. (2004). Much ado about nothing? do domestic firms really benefit from foreign direct investment? *The World Bank Research Observer, 19*(2), 171-197.

Hu, M.-C. & Mathews, J. A. (2005). National innovative capacity in east asia. *Research Policy, 34*(9), 1322-1349.

Jha, S. K. & Krishnan, R. T. (2013). Local innovation: the key to globalisation. *IIMB Management Review, 25*(4), 249-256.

Leamer, E. E. (1983). Let's take the con out of econometrics. *The American Economic Review, 73*(1), 31-43.

Linnemann, L. & Schabert, A. (2004). Can fiscal spending stimulate private consumption? *Economics Letters, 82*(2), 173-179.

Lu, Y., Tao, Z. & Zhu, L. (2017). Identifying fdi spillovers. *Journal of International Economics, 107*, 75-90.

Potterie, B. v. P. d. l. & Lichtenberg, F. (2001). Does foreign direct investment transfer technology across borders? *The Review of Economics and Statistics, 83*(3), 490-497. h

Pueyo, A., García, R., Mendiluce, M. & Morales, D. (2011). The role of technology transfer for the development of a local wind component industry in Chile. *Energy Policy, 39*(7), 4274-4283.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5), S71-S102.

Tee, C. L., Azman-Saini, W. N. W., Ibrahim, S. & Ismail, N. W. (2015). R&D spillovers and the role of economic freedom. *International of Economics and Management, 9*(S), 41-60.

Teitel, S. (1987). Science and technology indicators, country size and economic development: An international comparison. *World Development, 15*(9), 1225-1235.

Teitel, S. (1994). Patents, R & D expenditures, country size and per-capita income: An international comparison. *Scientometrics, 29*(1), 137-159.

Un, C. A. & Cuervo-Cazurra, A. (2008). Do subsidiaries of foreign mnes invest more in r&d than domestic firms? *Research Policy, 37*(10), 1812-1828.

UNCTAD. (2016). World investment report 2016:investor nationality: policy challenges. Retrieved from http://unctad.org/en/PublicationsLibrary/wir2016_ en.pdf.

UNESCO. (2016). *UNESCO science report: towards 2030*. Retrieved from http://unesdoc.unesco.org/images/0023/002354/235406e.pdf.

Veugelers, R. & Houte, P. V. (1990). Domestic R&D in the presence of multinational enterprises. *International Journal of Industrial Organization, 8*(1), 1-15.

Wang, E. C. (2010). Determinants of r&d investment: the extreme-bounds-analysis approach applied to 26 OECD countries. *Research Policy, 39*(1), 103-116.

Xavier, X. S.-I. M. (1997). I just ran two million regressions. *The American Economic Review, 87*(2), 178-183.

Zhang, L. (2017). The knowledge spillover effects of FDI on the productivity and efficiency of research activities in China. *China Economic Review, 42*, 1-14.

Appendices

Appendix 1: List of Countries

Algeria	Iran (Islamic Republic of)	Poland
Argentina	Iraq	Romania
Armenia	Kazakhstan	Russian Federation
Azerbaijan	Kyrgyzstan	Saudi Arabia
Belarus	Latvia	Serbia
Bolivia (Plurinational State of)	Lesotho	Seychelles
Bosnia and Herzegovina	Lithuania	South Africa
Bulgaria	Macedonia, The former Yugoslav Republic of	Sri Lanka
Burkina Faso	Madagascar	Sudan
Burundi	Malaysia	Tajikistan
China	Mauritius	Thailand
Colombia	Mexico	Trinidad and Tobago
Costa Rica	Mongolia	Tunisia
Croatia	Montenegro	Turkey
Democratic Republic of the Congo	Morocco	Uganda
Ecuador	Myanmar	Ukraine
Egypt	Pakistan	Uruguay
Georgia	Panama	Zambia
Guatemala	Paraguay	
Hungary	Peru	