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GCBER 2017
August 14-15, UPM, Malaysia
Global Conference on Business and Economics Research

Governance and Sustainability on Global Business Economics

Global Conference on Business and Economics Research (GCBER) 2017
14-15 August 2017, Universiti Putra Malaysia, Malaysia

Foreign Direct Investment, absorptive capacity and technological innovation: Empirical evidence in developing economies

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Abstract

This study investigates the impact of high inflows of FDI and absorptive capacity on technological innovations in developing economies. Utilizing panel data from 1997-2014 for a sample of 39 developing countries and applying the System-GMM estimator, we reached important conclusions. The estimated results show that FDI and absorptive capacity do not have significant effect on technological innovation when estimated separately. However, the effect changes when we consider the interaction of the variables. This indicates that FDI inflows induce technological innovation in the country with an adequate level of absorptive capacity. The results also imply that both FDI inflows and absorptive capacity are necessary in order to increase technological innovations in the host developing countries.

Keywords: FDI, absorptive capacity, technological innovations, System-GMM

1. INTRODUCTION

Foreign direct investment (FDI) is considered as one of the most important factors that stimulate economic growth, especially in developing countries in recent years (Cheung & Lin, 2004). Developing countries are trying to attract more FDI inflows while at the same time they are also importing high technology from developed economies. It has been proven from the existing literature (see for example, Erdal & Göçer (2015); Lee & Tan (2006); Ning, Wang & Li (2016) and Li et al. (2016)) that FDI stimulates technological innovation. The FDI inflows transmit the technological innovation to host country either through backward linkages (technology transfer from foreign customers to local suppliers) or through forward linkages (technology transfer from higher quality of inputs or equipment's from foreign suppliers to local firms), human capital mobilisation as well as demonstration effect (Cheung & Lin, 2004). However, the transmission of technological innovation process may also depend on other factors that influence the transmission capacity of technology which is known as absorptive capacity of technological innovation. According to Cohen & Levinthal (1990), the absorptive capacity is the capacity in absorbing, assimilating and transforming new knowledge into innovation. Absorptive capacity is intangible in nature, yet, when coupled with FDI inflows, they become the twin important factors in the decision of resource allocation for innovation activities (Nieto & Quevedo, 2005).

According to the World Bank (2016), FDI inflows to developing economies are 55% of the world total of FDI inflows. Even though global FDI inflows annihilated by 16 per cent in 2014, significantly decreased from $1.47 trillion in 2013 to $1.23 trillion in 2014, however, FDI inflows into developing economies increased by 2 per cent

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in 2014, reaching to an absolute amount of $681 billion FDI inflows into Asian countries is increasing while on the other hand, the inflows to Latin America and the Caribbean is decreasing. The inflows to Asia rose by 9 per cent in 2014, leading to an amount $465 billion. The increased inflows are especially observed in East Asia, South-East Asia and South Asia. For example, the inflows to China amounted to $129 billion, increased by 4 per cent from 2013, mainly because of an increase in FDI in the services sector. Likewise, India also experienced a significant increase in FDI inflows of 22 per cent to $34 billion in the same period (UNCTAD, 2015).

The above fact exemplifies a significant volume of inflows which motivates studies on the relationship of FDI and various macroeconomics variables. One of the issues debated in the literature is the expected spill over effects from FDI in the form of new technological innovation from developed to developing economies. FDI inflows may benefit a country through its spill over effect, such as technological imitation which is influenced by absorptive capacity. The sufficient amount of absorptive capacity of the country facilitates the country to exploit the spill over effect efficiently. The technology diffusion from FDI inflows could be limited with low level of absorptive capacity in the recipient countries. Also, the level of absorptive capacity in the firms depends on existence level of absorptive capacity and can be enhanced by learning and investment efforts such as research and development (R&D) activities.

In the extensive perspective, the importance of absorptive capacity can easily be explained by giving an example of two countries which receiving almost similar volume of FDI inflows but eventually achieving a different status in the level of technological innovation. The differences in the country's level of absorptive capacity demonstrate different approaches in identifying the new knowledge, exploiting and transforming the technology into innovation. The higher absorptive capacity of a country, the greater its innovation would be, as the country depends on these capabilities to create greater innovation from technologies absorbed. Similarly, Rueda Maurer (2017) and Shamsub (2014) pointed out that while some countries receive the same technology, yet they may not that successful in transforming these factors and exploiting them into greater innovations. Therefore, an adequate level of absorptive capacity plays a very important role in absorbing and assimilating new knowledge, as well as transforming new technology into a great innovation (Cohen & Levinthal, 1990; Shamsub, 2014; Girma, 2005; Blalock & Gertler, 2009).

In recent years, there is an increasing trend of FDI inflows, R&D expenditure as well as technological innovation in developing countries (World Bank, 2016). Theoretically, if there is an increase in FDI inflows and high allocation in R&D expenditure as inputs, the expected output would be improvement in technological innovation. This is verified by Cheung & Lin (2004), where they argued that FDI inflows stimulate technological innovation as a result of spill over effect. FDI inflows may stimulate the innovation through three ways, firstly through reverse engineering; local firms gain new knowledge on design and apply the knowledge when inventing their own product. Secondly, the mobilisation of skilled workers from foreign firms to local firms may also transfer the technology to the local firms. Thirdly, through demonstration effects that explain the existence of foreign products that may stimulate a creative thinking hence generate the new innovation in local product.

However, there is a limited research that investigates the conditioning effect of absorptive capacity on technological innovation through FDI inflows. The dearth of evidence on the relationship motivates us to further investigate whether FDI inflows and absorptive capacity can accelerate technological growth in host countries. Notably, we fill the research gap by extending the previous studies to combine these two factors and examine if the spill over effect is significant in stimulating technological innovation. Our objective is twofold; first, we analyse the direct effect of FDI and absorptive capacity on technological innovation. In addition to that, we will also examine the joint impact of the two factors and analyse the indirect effect of FDI on technological innovation through absorptive capacity.

Our results show that FDI has negative impact on technological innovation while the effect of absorptive capacity is insignificant. When we take into account the interaction between the two factors, FDI is positive and significant while the interaction term shows that FDI inflows impart a positive spill over effect on developing economies subject to sufficient level of absorptive capacity in these countries. The rest of the study is as follows: section 2 briefly presents related literature while section 3 reports the empirical model, data and estimation strategy. Section 4 presents the estimated results and discussions, while the last section concludes this study with some policy implications.

2. LITERATURE REVIEW

Several studies have shown that FDI inflows stimulate innovation activities in a country through their spill over channels such as the turnover of skilled labour, reverse engineering, demonstration effects as well as customersupplier relationship (Cheung & Lin, 2004). Host country would get the benefit and knowledge from the technology carried together with FDI inflows. The FDI inflows into host country normally would be brought forth with expertise and skilled worker and it is a widely recognized that this condition would give an advantage to the host country as these skilled workers would transfer the skill, expertise and experience to the local workers. In addition to this, FDI inflows into host country would stimulate host country to generate new processes as well as new products. Hence, host country will be more creative in producing its own products. According to Cheung & Lin (2004) and Li-Ming, Rui & Rui (2016), the relationship between FDI inflows and innovation is positive and statistically significant in China. In addition to this, Wang & Kafouros (2009) used a large sample which compiled 138 sectors in China that investigate FDI inflows, R & D as well as trade with technological innovation. The authors concluded that FDI inflows, R & D as well as international trade play important complementary role in technological innovation in China's industries. Thus, they suggested the policy makers to consider FDI inflows and focus for these key factors in enhancing the technological innovation.

There are also several studies that examine the relationship between absorptive capacity with technological innovation. It has been suggested that R & D expenditure of a country may increase the country's ability, knowledge and creation of innovation. According to Wang & Kafouros (2009), the impact of R & D expenditure on the innovation in their research is higher than the spill over effect from FDI inflows and trade. In other words, R & D expenditure plays an important role in enhancing the technological innovation in the sample country. A number of studies (see for example, Álvarez & Marin (2013); Wang & Kafouros (2009)) have found that R&D activity is a catalyst for innovative industries; as the higher R&D expenditures allocated by the industry, the more benefit will be generated by the industry. This emphasised that, greater R&D activities promote better adoption of new knowledge and innovation in creation of new product (Hsu, Lien & Chen, 2015).

Lau & Lo (2015) whom used Hong Kong as sample country found that in order to improve the innovation performance in the firm, the firm must take a step ahead in enhancing the absorptive capacity. Thus, the authors concluded that improvement in absorptive capacity is very important in order to increase country's capacity in exploitation of technology, assimilate and transforming the technology into innovation. One of the imminent studies that discussed about absorptive capacity is Cohen & Levinthal (1990) which explain the concept of absorptive capacity as the capacity to identify new knowledge, assimilate it and transform from technology into a great innovation.

According to Lai, Peng, & Bao (2006), the existence of more absorptive capacity is required to adapt more invention in developing country. Using China as a sample country, from the year 1996 until 2002, the authors concluded that technology spill over in China is influenced by human capital level which shows absorptive capacity of the host country. The study of Teixeira & Fortuna (2010) reveals that technology absorption capacity shows the highest figure which concluded by authors as an evidence of highly educated of human capital would effectively adapting technology from foreign country. The authors used the data from 1960 to 2001 from Portugal and concluded that human capital and domestic R&D are as a key for technological absorptive capacity for Portuguese.

A study done by Fu, Pietrobelli, & Soete (2011) emphasized absorptive capacity as the important factor that determined the adequate level of technological innovation for five selected countries (Brazil, China, India, South Africa and Russia). In addition to that, the authors found that the technology diffusion as well as adoption is subjected on the absorptive capacity in emerging economies and complementary asset. On the other hand, Castellacci & Natera (2013) proposed that, the country's absorptive capacity may promote to dynamic innovation if supported by productive of R&D and encouraged of technology innovation in country's policy making. The authors observed that combination of three elements of absorptive capacity's factors such as international trade, human capital together with well-developed infrastructure and three innovative capacity factors such as output of technology, scientific output as well as innovative input are crucial factors in augmenting technological innovation. Nieto & Quevedo (2005) also concluded that an adequate level of absorptive capacity would determine the actual performance of the company in creating technological innovation and hence would provide a greater ability in generating a company's profit.

3. DATA, MODEL AND METHODOLOGY

Our empirical model is an extension of the existing model from the literature (Shamsub (2014); Cheung & Lin (2004). Our model is different since we are not only analysing the direct impact of absorptive capacity on technological innovations but we also examine the joint impact of absorptive capacity and FDI on technological innovation. We employ panel data from 39 developing countries from the year 1997 to 2014. These specific countries are selected based on availability of the R&D expenditures data.[1] Importantly, these countries are an interesting example of the studied issue as they are an emerging example of on-going inflows of FDI, coupled with absorptive capacity and the achievement of technological innovation. The results based on such an interesting sample can be utilized further for the remaining emerging and developing countries. To eliminate business uncertainty we averaged the data into three years average.

The model function is illustrated as follows:

TI = f (FDI, AC, HC, OPEN, GDP) (1)
TI = f (FDI, AC, FDI*AC, HC, OPEN, GDP) (2)

The first expression explains the technological innovation (TI) as a function of net inflows of FDI (FDI), absorptive capacity (AC), human capital (HC), trade openness (OPEN) and economic growth (GDP). Besides the direct influence of absorptive capacity on technological innovation, the main contribution of this occurs here in the conditional effects of absorptive capacity on technological innovation through its interaction with FDI by following Girma (2005). The purpose behind such exercise is to underscore the indirect effect of absorptive capacity, mediated through FDI inflows. Generally, it is evidenced that FDI inflows augmented with absorptive capacity will render significant effect on innovation. Thus, in the second function, we include the interaction term between FDI and absorptive capacity. Consequently, the interaction term is included to account for the spill over effects of absorptive capacity on technological innovation where the impact of FDI inflows on technological innovation would depending on some critical value of absorptive capacity (Girma, 2005). We expect positive sign for the interaction term, indicating that higher level of absorptive capacity complemented with the rising inflows of FDI will bring up technological innovation.

Our proposed model is as follows:

$$LTI_{it} = \beta_{0i} + \beta_1 LTI_{it-1} + \beta_2 LFDI_{it} + \beta_3 LAC_{it} + \beta_4 LHC_{it} + \beta_5 LOPEN_{it} + \beta_6 LGDP_{it} + u_{it} + \varepsilon_{it} \quad (3)$$

$$LTI_{it} = \beta_{0i} + \beta_1 LTI_{it-1} + \beta_2 LFDI_{it} + \beta_3 LAC_{it} + \beta_4 LFDI_{it} * LAC_{it} + \beta_5 LHC_{it} + \beta_6 LOPEN_{it} + \beta_7 LGDP_{it} + u_{it} + \varepsilon_{it} \quad (4)$$

$i = 1, 2, 3, \ldots i$; $t = 1, 2, 3, \ldots, t$

Where LTI_{it} stands for the technological innovation rate of country i at time t, βs are the parameter to be estimated, u_{it} is country specific effect and ε_{it} is the error term. To investigate the concerned effect, in equation (3), the coefficient of $\beta 2$ will explain how FDI affect the technological innovations directly in selected developing economies while $\beta 3$ will explain how absorptive capacity influences the technological innovations. Again, it is reminded that the interaction term between FDI inflows and absorptive capacity is included in equation (4) to examine the indirect effect of absorptive capacity on FDI inflows in influencing technological innovation.

The independent variable R&D expenditure as percentage of GDP (LAC) is a proxy to measure the absorptive capacity and FDI inflows (LFDI) is measured as net inflow of foreign direct investment as percentage of GDP. In addition to that, we use GDP per capita (LGDP) as a proxy of economic growth (constant 2010 US dollar) growth to account for different stages of economic development in their level of technological innovation. Trade openness (LOPEN) is measured as trade % of GDP as a proxy of trade. Average years of schooling will be used as a proxy of human capital (LHC) and the data is obtained from Penn World Table data (version 9.0). Others macroeconomic data are obtained from World Development Indicator (WDI) and all variables are in the log form.

This equation is a linear dynamic panel model as introduced by Arellano & Bond (1991). Thus, the model contains the lagged dependent variable as illustrated by LTI_{it-1} which is correlated with error term. The use of panel ordinary least square (OLS) and fixed and random effect estimators are not appropriate. However, by using GMM, several problems especially unobserved country-specific heterogeneity and endogeneity can be tackled easily. Based on our model, GMM is the best estimator as it uses first different transformation which eliminates country-specific effects, endogeneity and other specification issues.

[1] See appendix A for the list of countries included in the sample.

4. EMPIRICAL RESULT

Table 1 presents the results for both Model 1 and Model 2.[2] In Model 1, FDI inflows are negative and statistically significant at 10% level. However, absorptive capacity does not have significant impact on technological innovation. There is a positive impact of human capital on technological innovation at and 10% level of significance. GDP per capita is negative and significant at 10% significance level. The estimated results imply that a 1% increase in FDI inflows and GDP per capita reduce technological innovation by 0.578% and 0.316% respectively in the sample countries. Technological innovations increases by1.853% as a result of 1% increases in human capital.

The result is consistent with existing empirical literature such as Shamsub (2014) which concludes that there is a nexus between FDI and innovation, especially in developing countries. It is can be argued that increasing innovation leads to increase in FDI, still, more inward FD flows reduce technological innovation. The main reason behind this negative nexus is that indigenous innovation can be increased only through absorptive capacity in the form of R & D expenditures. Furthermore, the existing negative sign for the coefficient of economic growth is still in accordance to the mainstream empirical literature as the effects generally hold positively from technological innovations towards economic growth. Thus, it is not necessary that increasing growth will be coupled with high technological innovation as there are many other factors which enhance technological innovation such as R & D expenditures, human capital and government effectiveness.

The results for model 2 where we consider the interaction term between FDI inflows and absorptive capacity are shown in column 2. The estimated results show that there is a positive and significant effect of FDI inflows and the interaction term on technological innovation. The absorptive capacity is not significant when analysed separately, but the effect maybe indirect through the interaction with FDI inflows. This implies that absorptive capacity is positively affecting the technological innovation through its favourable impact on FDI inflows. This result is consistent with Erdal & Göçer (2015) which concluded that FDI inflows increase innovation with the increase in absorptive capacity in host countries. Overall, it signifies that the coexistence of FDI and absorptive capacity is necessary in enhancing technological innovation. The control variables on the other hand, are positive and significant at 5% and 10% significance level respectively. It implies that, 1% increase in FDI inflows leads to increase innovation by 0.758% in its direct effect and will increase by 0.434% when its interaction with FDI inflows.

It is necessary to check whether the estimated results are carried out by the correct estimator. The result for AR(2), Sargan and Hansen test, confirmed that there is no autocorrelation and invalidity of instruments. According to Arellano & Bond (1991) Sargan test is usable to test over identifying restriction and if significant in probability value of Sargan Test means the model or instrument that we used may be miss-specified. From Table 1, we found that there is no evidence of miss-specification in our model due to probability value is more than 10% significance. The Hansen test also points out that the instruments are valid.

Table 1: FDI inflows and absorptive capacity estimations for 39 developing economies - System GMM

Variables	**Model 1**	**Model 2**
L.LTI	0.643***	0.321*
	(0.084)	(0.185)
LFDI	-0.578*	0.758**
	(0.305)	(0.355)
LAC	0.402	0.228
	(0.292)	(0.604)
LFDI_LAC	-	0.434*
		(0.241)
LHC	1.853*	1.943**
	(1.001)	(0.850)
LOPEN	-0.395	0.303
	(0.367)	(0.261)
LGDP	-0.316*	0.236*
	(0.173)	(0.139)
Constant	5.259	-0.773
	(2.001)	(1.756)
AR(1) P-value	0.002	0.002
AR(2) P-value	0.267	0.219
Sargen test (p-value)	0.291	0.564

[2] We have already run fixed effect and random effect and the results are in accordance with System-GMM but not reported here and are available upon request.

Hansen test (p-value)	0.380	0.363
Diff in Hansen (P-value)	0.114	0.583
No of countries	39	39
No of observations	169	169
Number of instruments	32	33

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Time dummies included.

5. CONCLUSION

This study is motivated by the observation of high inflows of FDI and rapid increase in number of pattern application as well as R&D expenditure in developing economies. Our objective of the study is to analyse whether FDI inflows and absorptive capacity have a direct significant impact on technological innovation. Consequently, through interaction term between FDI inflows and absorptive capacity, we examine the spill over effect of absorptive capacity with its impact on FDI inflows in influencing technological innovation.The results reveal that FDI and absorptive capacity are having unfavourable and even give insignificant effects on technological innovations if they revealed in their individual impact. However, when we consider their interaction, it yields positive and significant impact on technological innovations. Thus, it can be derived that the impact of absorptive capacity is conditional through its impact on FDI. Further, the control variables are also significant with expected signs.

We draw some important conclusions from the findings. Firstly, FDI inflows lead to increase in technological innovation in the developing economies. Positive coefficient from interaction term between FDI inflows and absorptive capacity can be concluded that FDI inflows induce technological innovation in the country which has an adequate level of absorptive capacity. This findings support the evidence that FDI inflows generate a positive spill over effect on developing economies provided there is sufficient level of absorptive capacity in these countries. In addition, Human capital and GDP per capita contribute positively to the technological innovations. On the other hand, it is observed that trade openness is not significant in determining the level of technological innovations for the sample countries. The results imply that both FDI inflows and absorptive capacity are necessary in order to increase technological innovations in the host developing countries. Further work is needed to encounter the impact of absorptive capacity on technological innovations conditioned with other factors.

ACKNOWLEDGEMENTS

This work was supported by Fundamental Research Grant Scheme (FRGS: 5524722) provided by Ministry of Education (MOE) Malaysia.

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Appendix A

List of countries included in the sample

Argentina, Armenia, Brazil, Bulgaria, China, Colombia, Ecuador, Egypt Arab Rep., Guatemala, India, Indonesia, Iran, Jordan, Kazakhstan, Kenya, Kyrgyz Rep., Malaysia, Mexico, Moldova, Mongolia, Morocco, Mozambique, Pakistan, Panama, Paraguay, Philippines, Romania, Russian Fed., Serbia, South Africa, Sri Lanka, Sudan, Tajikistan, Thailand, Tunisia, Turkey, Ukraine, Vietnam and Zambia.