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The Impact of FDI Inflows on R&D Activities in Developing Countries: A Panel Data Analysis

M.Z.M Farhan
Department of Economics,
Faculty of Economics and Management
Universiti Putra Malaysia
E-mail: farhan.zakaria@ymail.com

W.N.W Azman-Saini
Department of Economics,
Faculty of Economics and Management
Universiti Putra Malaysia
E-mail: wazman@upm.edu.my

S.H. Law
Department of Economics,
Faculty of Economics and Management
Universiti Putra Malaysia
E-mail: lawsh@upm.edu.my

ABSTRACT

This study investigates the impact of FDI inflows on R&D activities in 48 developing countries for the 1996-2013periods. The results based on the system Generalized Method of Moment (GMM) estimator show that FDI inflows tend to discourage R&D activity in developing countries. Additionally, there is evidence that R&D activity benefits from import and stronger legal protection.

Keyword: Foreign Direct Investment, Research &Development, Generalised Method of Moment;

ABSTRAK

Kajian ini mengkaji impak kemasukan FDI ke atas aktiviti R&D di 48 negara sedang membangun, bagi tempoh 1996 sehingga 2013. Berdasarkan kepada pendekatan sistem generalized method of moment (GMM), analisis data panel menunjukkan kemasukan FDI bertindak mengurangkan aktiviti R&D di Negara sedang membangun. Selain itu, terdapat juga bukti menunjukkan aktiviti R&D menikmati manfaat daripada import dan kekuatan perlindungan undang-undang.

Kata Kunci: FDI, R&D, Sistem GMM, Negara Membangun.

INTRODUCTION

Foreign direct investment (FDI) by multinational corporations (MNCs) is regarded as an important ingredient for development strategies in many countries. FDI acts as an important link for host countries to access new technologies available at the world's frontier. It is viewed as a way of increasing the efficiency with which the world's scarce resources are used. MNCs are known for their huge investment in research and development (R&D) activities and they also hire a large number of professional and technical employees (Markusen, 1995). In addition, they invest substantially to improve the quality of their workforce through extensive trainings (Fosfuri et al., 2001). MNCs have always been linked to superior technologies, patents, trade secrets, brand names, management techniques and marketing strategies (Dunning, 1993). Since knowledge cannot be completely internalized, some of the benefits linked to FDI may be transmitted to local firms once MNCs have established their subsidiary in host countries. This is expected to promote domestic productivity and also the expansion of business activities. Generally, FDI is viewed as an important channel for host countries to access new technologies that are available at the world's frontier, on top of its usual role as a prime source of external financing and employment.

Since the 1980s, many countries have liberalized their policies on FDI by relaxing the restriction on foreign firms and adopting FDI-enhancing policies. According to UNCTAD (2013) there are 106 changes in FDI-related policies for the period 2002 to 2012. The biggest changes (79.08 per cent) are made on liberalization, promotion and facilitation to create a more favourable environment for investment prospect. The largest share of new restrictions or regulations is in developed countries (31 per cent), followed by developing countries (23 per cent) and transition economies (10 per cent). On the other hand, the world investment report published in 2012 showed a huge increase in the number of FDI inflows around the world since 1970. The total FDI inflows were approximately USD 13,032 in the 1970s and increased to USD 1,360,446 in 2000. The increase in FDI inflows is contributed by the success of developed countries in attracting more FDI. In 1980, 1990 and 2000, FDI inflows to these countries contributed more than 80 per cent of the world FDI. Meanwhile, FDI inflows to the developing countries contributed only 15 to 36 per cent of world FDI by 2005. However, in the middle of 2011, FDI inflows to the developing countries were recorded higher than the FDI inflows to the developed countries. By 2012, the developing countries had accumulated 52 per cent of the world FDI, while developed countries only received 44 per cent of world FDI.

Given that FDI flows have increased significantly in the past few decades, several studies have examined the impact of FDI on host country economic performance. However, most studies have mainly focussed on the impact of FDI on domestic output growth. The relationship has been tested using different procedures, data sets and time periods, and the findings show mixed evidence. While there is a plethora of research on the growth-effect of FDI, the potential impact of FDI on other sector of the economy such as research and development (R&D) activity has been largely ignored. Despite the importance of R&D activity for long- run growth, it is surprising that the impact of FDI on R&D activity has not been analysed as rigorously as the growth-effect of FDI. Also, ignoring the impact of FDI on R&D activity may lead to a significant underestimation of the overall impact of FDI on the economy. Arguably, FDI can have both positive and negative impacts on domestic R&D activity. MNCs presence in the developing countries is expected to promote competition in the domestic market and adds pressure to local firms to provide better products and services. Therefore, local firms are encouraged to take part in R&D activities. However, some may argue that FDI discourages R&D activities when local firms merely imitate newly introduced imported products which eventually diminish the creativity and innovation in the long run. However, whether FDI has any influence on R&D activity is an empirical matter and this is the issue that we are interested in.

The purpose of this study is to provide an empirical assessment on the impact of FDI on R&D activity in developing countries. It employs a system generalised method of moment (GMM) estimator proposed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The choice of this estimator over other alternatives is because of its ability to control for country-specific effects, dynamic effects, as well as endogeneity problem.The findings show that FDI has a negative impact on R&D activity. Meanwhile, import and protection of intellectual property right appear to have positive impacts on domestic R&D.

The rest of the paper is organised as follows. Next section highlights the empirical model. Then, the descriptions of methodology and data are provided. After that, empirical results are presented. The last section concludes.

MODEL SPECIFICATION

This study utilizes a model which is similar to Wang (2010). However, some modifications are made due to data availability. The model can be expressed as follows:

$$RD_{i,t}=\beta_1 RD_{i,t-1}+\beta_2 FDI_{i,t}+\beta_3 Z_{i,t}+\mu_i+\varepsilon_{it} \quad (1)$$

Where i is country index, t is time index, RD is R&D intensity, FDI is foreign direct investment, Z is a vector of conditional variables which are believed to affect R&D activity, u_i is country-specific effect and ε_{it} is the usual error term. The group of conditional variables includes human capital, import of high technology products, investment in physical capital, intellectual property right and income growth.

METHODOLOGY

This study employs the generalized method-of-moments (GMM) panel estimator which was first proposed by Holtz-Eakin et al. (1990). This method was then extended by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). This estimator has several advantages. It can control country-specific effects, dynamic effects and simultaneity bias caused by the endogenous explanatory variables. Arellano and Bond (1991) suggested that the country-specific effect to be eliminated by transforming Equation 1 into first differences, as follows:

$$(RD_{i,t}-RD_{i,t-1}) = \beta_1 (RD_{i,t-1}-RD_{i,t-2}) + \beta_2 (FDI_{i,t}-FDI_{i,t-1}) + \beta_3 (Z_{i,t}-Z_{i,t-1}) + (\varepsilon_{i,t}-\varepsilon_{i,t-1}) \quad (2)$$

Furthermore, Arellano and Bond (1991) proposed the use of lagged levels for the regressors to identify the possible simultaneity bias of explanatory variables and the correlation between $(y_{i,t-1}-y_{i,t-2})$ and $(\varepsilon_{i,t}-\varepsilon_{i,t-1})$. However, this is only valid under the condition where the error terms are not serially correlated. However, Alonso-Borrego and Arellano (1999) and Blundell and Bond (1998) argued that the lagged levels of the variables can be inefficient when the explanatory variables are persistent. This may lead to biased parameter estimates in small samples and a larger asymptotic variance. Blundell and Bond (1998) developed a procedure that transforms these instruments to become exogenous to the fixed effects. Under this procedure, it is assumed that changes in any instrumenting variable are uncorrelated with the fixed effects in Equation 1.

There are two specification tests to determine the consistency issue of the GMM estimators. First, the Hansen (1982) J-test overidentifies the joint validity of the instruments. The null hypothesis is that the instruments are not correlated with the residuals. Under the null hypothesis of joint validity in all instruments, the empirical moments have zero expectations and the J-statistic is distributed as a χ^2 with degrees of freedom equal to the degree of overidentification. Secondly, in order to identify autocorrelation besides the fixed effects, the Arellano-Bond test is applied to the residuals of the first difference. The Arellano-Bond test for autocorrelation examines the hypothesis of no second-order serial correlation in the error terms of the first difference. Failure to reject the null hypotheses in both tests provides support to the estimated model.

DATA DESCRIPTION

The aim of this study is to examine the impact of FDI on R&D activity in developing countries. This data set covers 48 countries for the period 1996 to 2013, where the average data are taken for every three years. This study uses the annual ratio of gross expenditure on R&D (GERD) to GDP as a proxy for R&D intensity. This proxy is widely used in the literature (Wang, 2010; Ghazalian, 2012) data are retrieved from the UNESCO Institute of Statistics (UIS) data centre. We employ a ratio of FDI inflows to GDP as a proxy for FDI intensity and the data are retrieved from the World Development Indicators database by the World Bank. Additionally, we include import of machinery and equipment expressed as a ratio to GDP and the data is retrieved from World Trade Organization (WTO) database. There are two indicators for human capital. First, we use the number of workers that are directly employed in Science &Technology sector. Secondly, we employ the human development index (HDI) where the index is calculated by taking the average of two indicators, the schooling years and the return on education. These data are obtained from the Penn World Table (PWT) while, data on researcher intensity is measured by taking the total researchers to the total employment ratio, available from the UIS database. Furthermore, we include the intellectual property right (IPR) index published by the Global Competitiveness Report 2014. The data are collected based on a survey on 150 partner institutes of recognized departments of economics in national universities, independent research institutes, or business organizations (WEF, 2013). These data are retrieved from the Economic Freedom of World Index. In order to measure expectation, Braconier (2000) propose the use of the growth rate of GDP per capita. However, we employ the lag of GDP per capita growth rate to avoid the simultaneous bias problem. Finally, we also include gross fixed capital formation to GDP (GFCF) as a proxy for investment in physical capital and the data are taken from the World Bank Database.

EMPIRICAL FINDINGS

This section presents the empirical findings of this study. Table 1 present the results of estimating the impact of FDI and other variables on domestic R&D activity. Results in Column 2 are based on the one-step estimator, while results in Column 3 are obtained from the two-step estimator. All variables are found to be significant in both one-step and two-step estimators, except for human capital, which is only found to be significant in the one-step estimator. Looking at the core variable, FDI intensity shows a negative effect on R&D activities in host countries with the elasticity range between 0.8952 and 0.8998. Meanwhile, import intensity shows a positive effect on R&D activities with the elasticity range between 0.2495 and 0.2609. This finding supports the substitution effect[1] between FDI and trade. IPR and research intensity are found to have the highest magnitude effect in enhancing R&D activities in developing countries. The elasticity for IPR is between 0.9141 and 0.9210, while the elasticity for research intensity is between 0.6203 and 0.7151. Government investment in facilities is also found to increase domestic R&D with the magnitude effect range between 0.2048 and 0.3020. We further employ the Sargan[2] and serial-order correlation (Arellano-Bond)[3] tests and our estimated model does not reject the null hypothesis at five per cent level of significance. This suggests that the equation is adequately specified with valid instruments[4]. We also estimate the model by using robust standard errors and results are presented in the last two columns of Table 2. With respect to our core variable, there is evidence showing a negative impact of FDI inflows on R&D activities. This suggests that developing countries with high FDI inflows tend to spend less on R&D, possibly due to their focus in product imitation rather than product innovation. Additionally, import and protection of intellectual property right and income growth also appear important for domestic R&D. However, the result shows that investment, human capital and researchers have no impact on R&D activities.

As a robustness check, we identify potential outliers in our sample and to ensure that the link between our variables of interest and R&D is robust and not driven by outlier observations. We compute the DFITS statistics as suggested by Belsley et al., (1980). Figure 1 shows the combinations of leverage points and residuals of 48 countries. The test shows that Jordan and Ukraine are true outliers as the absolute DFITS scores for these countries are 1.9933 and 1.2220, respectively, which is greater than our threshold value of 0.8433. This means that Jordan and Ukraine have high combinations of residuals and leverage points that fall relatively far from the rest of the observations.

Then, we re-estimate a new sample with the exclusion of Jordan and Ukraine. The results are presented in Table 3. Interestingly, the results show that the impact of FDI on R&D remains intact as the *p*-value for the coefficient is less than one per cent for both one-step and two-step estimators. In addition, almost all explanatory variables are found to be significant at the one per cent level. However, GFCF is found to be not significant in the one-step estimator and HC is insignificant in the two-step estimator. More importantly, the specification tests indicate that the model is adequately specified and the result is not affected by simultaneity bias. Therefore, this supports our previous interpretation regarding the impact of FDI inflows in discouraging R&D investment in the host countries. The result also shows that the link is robust and not driven by outlier observations. The finding is consistent with Fan and Hu (2007), Kathuria (2008) andWang (2010) who found a negative impact of FDI inflows on domestic R&D. Accordingly, our finding supports the substitution effect of foreign technology transfer through MNCs on domestic R&D activities. MNCs are superior in terms of efficiency, technology, financial, knowledge and management than domestic firms in developing countries. Meanwhile, domestic firms may have advantages in terms of resource access and market adoption. However, as most developing countries tend to change their policy to support FDI, this provides more opportunities for MNCs to penetrate the domestic market and gain access to their resources. Although MNCs can introduce new technology and innovation through their products which results in a spillover effect, domestic firms tend to merely imitate new products due to poor technological absorption and innovative capability. Consequently, domestic firms are further discouraged from engaging in R&D activities.

On the other hand, our finding on imports of machinery and equipment shows a positive and significant effect on R&D. The findings contradict the results from other previous studies that suggested the existence of a negative[5] relationship between import technology and R&D. Our finding suggests that an increase in imports can enhance the market competition and puts pressure on domestic producers to improve their product quality, reduce management inefficiency, and increase technological progress. As more intermediate goods and high technology machineries are imported into a developing country, this improves the productivity of domestic firms. It then encourages domestic producers to participate in R&D activities and improvise or add value to their products. The sign of the coefficient for the IPR implies a positive effect on R&D activities in developing countries. This finding

[1]See Harris and Schmitt (2000).
[2]The Sargan test is done to identify the overidentifying assumptions in instrumental variable estimations. Rejection of the null hypothesis indicates that the instrumental variables cannot be used for the estimation process.
[3] The null hypothesis of the AB test states that there is no autocorrelation in the first difference disturbances. Rejection of the null hypothesis indicates the existence of autocorrelation.
[4] In estimating system GMM, we use 45 instrumental variables for both one-step and two-step estimators.
[5]Bezbczuk (2002), Okabe (2003) and Funk (2003) find a negative relationship between trade and R&D.

is found to be in line with previous studies such as Varsakelis (2001), Alvi et al. (2007) and Zhang and Zhang (2003). This implies that IPR protection in a country motivates domestic firms to engage in R&D activities. This finding highlights the importance of protective policies. The coefficients for income growth in both current and previous year show positive signs and are statistically significant, which are consistent with Braconier (2000) and Hartman (2003). This result implies that there is a positive influence of current economic performance on a firm's decision to engage in R&D activities. The predictions of future GDP growth also demonstrate the same effect. However, there is evidence of a greater magnitude effect in the current economic performance.

CONCLUSION

R&D and innovation are important in promoting productivity and economic growth. Through globalization, many developing countries tend to liberalize their foreign investment and trade policies to enhance their economic performance. However, there are some concerns about the potential effect of FDI inflows in immobilizing the growth of domestic firms. In examining the impact of FDI inflows on R&D activities using a data set comprising 48 developing countries for six average periods from year 1996 to 2013, our analysis shows some interesting findings. It is found that FDI inflows tend to discourage domestic R&D activities. Besides attracting FDI as a source of capital funds and knowledge gain, individual governments should provide an environment conducive for domestic firms to grow. Thus, there is a need to further restrict the foreign investment policies to protect the local firms. Meanwhile, importing technology-embodied products and strengthening legal protections are found to enhance R&D activities. Developing countries should embrace trade liberalization as it provides more technology-embodied products and new technologies. Through R&D, this further enhances the efficiency of local firms. In addition, the strengthening of legal protection policies, such as IPR and patent law, can encourage firms to engage more in R&D.

REFERENCES

Alonso-Borrego, C. and Arellano, M., (1999).Symmetrically normalised instrumental-variable estimation using panel data.*Journal of Business and Economic Statistics*, 17: 36–49.

Alvi, E., Mukherjee, D. and Eid, A. (2007). Do patent protection and technology transfer facilitate R&D in developed and emerging countries? A semiparametric study. *Atlantic Economic Journal*, 35 (2): 217-231.

Arellano, M. and Bond, S., (1991). Some tests of specification for panel data: Monte Carlo evidence with an application for employment equations. *Review of Economic Studies*, 58: 277–297.

Arellano, M. and Bover, O., (1995).Another look at the instrumental-variable estimation of error-components models.*Journal of Econometrics,* 68: 29–52.

Belsley, D., Kuh, E. and Welsh, R., (1980). Regression diagnostics.Wiley, New York.

Bebczuk, R. N. (2002). R&D expenditures and the role of government around the world.*Estudios de Economia*, 29 (1), 109–12.

Blundell, R. and Bond, S., (1998). Initial conditions and moment restrictions in dynamic panel data models.*Journal of Econometrics,* 87: 115–143.

Braconier, H., (2000). Do higher per capita incomes lead to more R&D expenditure? *Review of Development Economics.* 4 (3): 244–257.

Dunning, J., (1993). Multinational Enterprises and the Global Economy. Addison-Wesley, Wokingham.

Fan, C.S. and Hu, Y., (2007). Foreign direct investment and indigenous technological efforts: Evidence from China. *Economics Letters*, 96 (2): 253-258.

Fosfuri, A., Motta, M., Ronde, T., (2001). Foreign direct investment and spillovers through workers' mobility. Journal of International Economics 53, 205–222.

Funk, M. (2003). The effects of trade on research and development. *Open Economy Review* 14: 29–43.

Ghazalian, P. L. (2012). Assessing the effects of international trade on private R&D expenditures in the food processing sector, *Industry and Innovation*, 19(4): 349-369.

Hartman, G.C., 2003. Linking R&D spending to revenue growth.*Research Technology Management,* 46 (1): 39–46.

Hansen, L. (1982). Large sample properties of generalized method of moments estimators. *Econometrica,* 50: 1029–1054.

Harris, R.G. & Schmitt, N. (1997).Export-Investment Subsidies in the Presence of Import Protection. Discussion Papers, 97-08.

Holtz-Eakin, D., Newey, W. and Rosen, H., (1990).Estimating vector autoregressions with panel data.*Econometrica*, 56(6): 1371–1395.

Kathuria, V. (2008).The impact of FDI inflows on R&D investment by medium- and high-tech firms in India in the post-reform period.*Transnational Corporations,* 17(2): 41-66.

Markusen, J. (1995). The boundaries of multinational enterprises and the theory of international trade.*Journal of Economic Perspectives,* 9: 169–189.

Okabe, M. (2003). Relationship between domestic research and development activity and technology importation: an empirical investigation of Japanese manufacturing industries. *Asian Economic Journal* 17: 265–280.

UNCTAD (2013). World Investment Report: Global value chains. Retrieved from http://unctad.org/en/publicationslibrary/wir2013_en.pdf.

Varsakelis, N.C. (2001). The impact of patent protection, economy openness and national culture on R&D investment: A cross-country investigation. *Research Policy,* 30: 1059-1068.

Wang, E.C. (2010). Determinants of R&D investment: The extreme-bounds-analysis approach applied to 26 OECD countries. *Research Policy*, 39: 103–116.

WEF (2013) 2013 Economic Freedom Dataset, published in Economic Freedom of the World: 2013 Annual Report, Fraser Institute, Retrieved from http://www.freetheworld.com/datasets_efw.html.

Zhang, X. and Zhang, K. H. (2003). How does globalization affect regional inequality within a developing country? Evidence from China.*Journal of Development Studies*, 39: 47–67.

TABLE 1: One-step and two-step system GMM estimations.

	System GMM		System GMM with White Std Error	
Variables	One-Step	Two-step	One-step	Two-step
Lag RD	0.8998[a]	0.8952[a]	0.8998[a]	0.8952[a]
	(0.0535)	(0.0213)	(0.1574)	(0.1235)
FDI	-0.8333[a]	-0.8194[a]	-0.8333[a]	-0.8194[a]
	(0.1740)	(0.0619)	(0.2070)	(0.2505)
IMP	0.2609[a]	0.2495[a]	0.2609[c]	0.2495[c]
	(0.0922)	(0.0353)	(0.1580)	(0.1484)
IPR	0.9141[a]	0.9210[a]	0.9141	0.9210[b]
	(0.3157)	(0.1678)	(0.6045)	(0.4613)
GFCF	0.3020[c]	0.2048[a]	0.3020	0.2048
	(0.1715)	(0.0553)	(0.2374)	(0.2094)
HC	0.1498[c]	0.0517	0.1498	0.0517
	(0.0820)	(0.0387)	(0.1230)	(0.0733)
RSH	0.7151[b]	0.6203[a]	0.7151	0.6203
	(0.2885)	(0.1607)	(0.5360)	(0.5572)
IG	0.2008[b]	0.1821[a]	0.2008	0.1821[c]
	(0.0879)	(0.0376)	(0.1247)	(0.1021)
Lag IG	0.1252[a]	0.0905[a]	0.1252[c]	0.0905[c]
	(0.0459)	(0.0197)	(0.0675)	(0.0507)
Sargan test (p-value)	0.0000	0.6999		
AR (2) test (p-value)		0.2995		0.3426
observation	235	235	235	235

Note: a, b, c indicate significance levels of 1%, 5%, and 10%, respectively. Figures in parentheses are standard errors. All variables are in logarithmic forms.

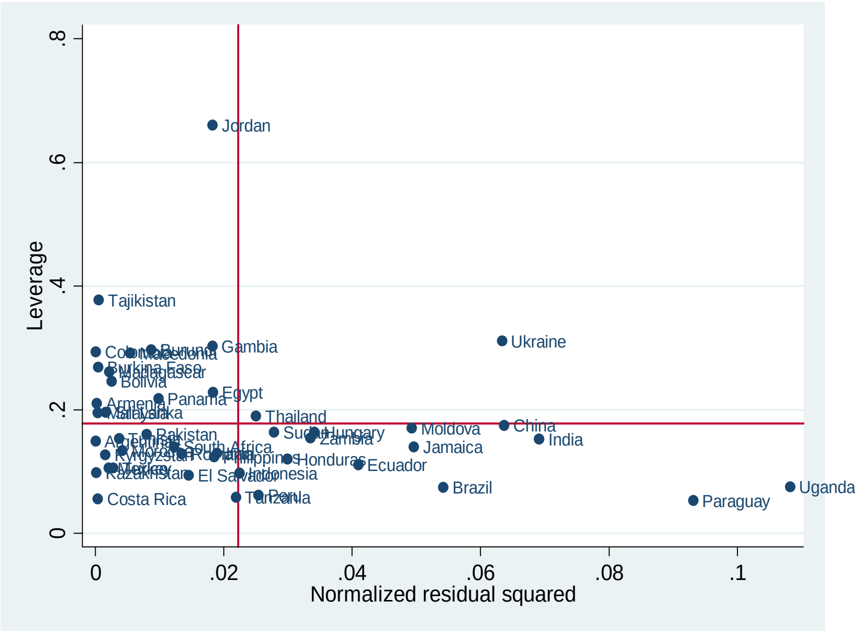

FIGURE 1: Scatter plot of leverage and residual squared.

TABLE 2: GMM estimation with exclusion of outliers

Variables	One-step	Two-step
Lag RD	0.9268[a]	0.8838[a]
	(0.0518)	(0.0283)
FDI	-0.7428[a]	-0.8043[a]
	(0.1815)	(0.0789)
IMP	0.2419[a]	0.3001[a]
	(0.0914)	(0.0366)
IPR	0.7857[b]	0.7765[a]
	(0.3205)	(0.167)
GFCF	0.2834	0.1838[a]
	(0.1723)	(0.0523)
HC	0.1784[b]	0.0369
	(0.0861)	(0.0505)
RSHR	0.8337[b]	0.779[a]
	(0.3524)	(0.1092)
IG	0.166[c]	0.1902[a]
	(0.0946)	(0.0416)
Lag IG	0.1385[a]	0.1237[a]
	(0.0496)	(0.0161)
Sargan test (p-value)	0.0000	0.7747
AR (2) test (p-value)		0.3309
Observations	223	223

Note: a, b, c indicate significance levels of 1%, 5%, and 10%, respectively. Figures in parentheses are GMM standard errors. All variables are in logarithmic forms.