The Role of Economic Freedom in R&D Spillovers via Student Flows

Tee Chee Lip
Department of Economics
Faculty of Economics and Management
Universiti Putra Malaysia
E-mail: teecheelip@gmail.com

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

Saifuzzaman Ibrahim
Department of Economics
Faculty of Economics and Management
Universiti Putra Malaysia
E-mail: saifuzzaman@upm.edu.my

ABSTRACT
This paper examines the mediating effect of economic freedom on the research and development (R&D) spillovers effect via the international student flow channel in a panel of 75 developing countries. The empirical results, based on generalized method-of-moment system estimator, found that spillovers effects through import and international flow are both positive and significant. Nevertheless, the strength of spillovers is different from previous findings, where spillovers through international student flow is found greater. It provides evidence for the view that importance of human capital mobility in technology diffusion is increasing nowadays since globalization lead the mobility across border become easier. Meanwhile, the results also suggest that countries with greater economic freedom would benefit more from disembodied spillovers.

Keywords: R&D spillovers, total factor productivity, trade, international student flow

INTRODUCTION
Many economists believe that technological progress is an important determinant for long-run output growth because it is very fundamental to the economy and affects all areas of economic activities (Le, 2012). The new growth models (see for example, Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1992) suggest that technological progress is not a free gift from heaven but a direct result of human capital accumulation.
outcome of innovation process. This is in contrast with neo classical model in which treats technological progress as exogenous. Therefore, when an economy invests in innovation activities, it would enjoy technological progress, greater productivity, and leading to the expansion of economic growth.

Since the pioneering work of Coe and Helpman (1995), many studies have recognized the importance of international R&D spillovers. Due to the non-rival characteristics of technology, R&D investment would contribute to the stock of knowledge as it is publicly available to everyone. Hence, R&D of one country impacts would not only affect domestic firms but also foreign firms. This suggests that countries which hardly invest in R&D activities would benefit from new knowledge developed by R&D leaders. The theory suggests that the extent to which local firms can benefit from foreign knowledge depends on many factors such as trade volume (Coe and Helpman, 1995), characteristics of traded products (Coe, Helpman, and Hoffmaister, 1997), flow of foreign direct investment (van Pottelsberge and Lichtenberg, 2001), and human capital mobility (Park, 2004).

Among the factors highlighted above, human capital mobility is a newly established channel for knowledge spillovers across borders. It is argued that some knowledge is difficult to be expressed in words or language (Koskinen, Pihlanto and Vanharanta, 2003) and therefore exchange of goods or investment for spillovers will not help its diffusion across borders (Lee, 2005). Instead, spillovers of this type of knowledge require direct communication. Therefore, international students flow is viewed as conduit for knowledge transmission because students are able to absorb foreign knowledge when they study abroad or through post schooling job experience and transfer it back to domestic country when they return (Park, 2004).

R&D via students flow has been hardly investigated. Two exceptions are Park (2004) and Le (2010). Park (2004) shows that international student flow is an important spillover channel among developed countries while Le (2010) complements the finding for spillovers from developed to developing countries. However, they found that spillover effects through import are relatively stronger than student flow. Recent literatures show that globalization has led to improved communication and mobility across border, and this therefore suggests that disembodied spillovers channel (such as international student flow) today could be as important as embodied channel in past decades (Filatotchev, Liu, Lu and Wright, 2011). Hence, a study on recent period could lead to different findings on the relative importance of various spillover channels.

Several recent papers suggest that knowledge spillovers are not automatic consequences of direct or indirect contact with R&D leaders. They argue that host countries must have certain quality which allow them to absorb and internalize the technology generated abroad. For instance, Azman Saini, Baharumshah, Law (2010) show that only countries with sufficient freedom of economic activities are able to absorb and internalize new technologies associated with FDI inflow. In an economically freer environment, firm are more willing to engage in risky investment project, such as trying out new ideas and new technologies, it will motivates domestic firm to absorb the foreign technology in local market.

The aim of this paper is assess whether international student flows serve as an important channel for R&D spillovers from developed to developing countries in recent decades. It fills the gap by exploring whether economic freedom make a difference to the way knowledge is transmitted across borders via student flows. To achieve these objectives, data from 75 developing countries over 2000-2008 period are chosen. It employs generalized method of moment (GMM) panel estimator which has several advantages over other alternatives.

The rest of the paper is structured as follows. The next section presents a brief literature review. Then, empirical framework is presented. The next section discusses the empirical results. The last section concludes.

**BRIEF LITERATURE REVIEW**

Since the work of Coe and Helpman (1995), R&D spillover is considered as one of the major factors that affect productivity growth. It is not only found significant between developed countries (Coe and Helpman, 1995), and from developed countries to developing countries (Coe, Helpman and Hoffmaister, 1997). Other scholars then expand the findings by include other spillovers channels like foreign direct investment (van Pottelsberge de la Porterie and Lichtenberg, 2001), international student flow (Park, 2004), worker migration (Le, 2008) and etc. Domestic countries will get the occasion to learn and contribute to own stock of knowledge since such interaction grant access to foreign countries’ accumulated body of research and knowledge.
Although many literatures focus on spillovers through trade, some knowledge are difficult to be transmitted via this channel as they cannot be expressed in word or language (Koskinen, Pihlanto and Vanharanta, 2003). Meanwhile, intangible knowledge does not need exchange of goods or investment to spillovers (Lee, 2005). Many knowledge spillovers are not simply generate by the knowledge or capital good alone, but relationship and social connection between two parties are crucial condition (Almeida and Kogut, 1999). Moreover, knowledge is tacit and complex and embedded in individual and makes human mobility as an effective way to transfer knowledge (Song, Almeida and Wu, 2003). Without human capital mobility, the knowledge might not spillovers to others (Almeida and Kogut, 1999) as human capital mobility is a significant mechanism for knowledge diffusion (Le, 2008; Filatotchev et al., 2011). This study focus on the role of international student flow in technology transfer as student study abroad would acquire external knowledge through education and post schooling job experience, and bring the knowledge back to home country when they return (Park, 2004). At the same time, student study abroad also learns the foreign country’s knowledge of technology, material, production method and organizational structure (Le, 2010).

Nevertheless, existence of spillovers channel does not necessary grant technology transfer. It has been found that the effect could be varies among countries. R&D spillovers among developed countries have both positive and negative influence on productivity (Engelbrecht, 1997); increase activities of MNE lead to lower productivity in Venezuela (Aitken and Harrison, 1999); among the 40 studies on the impact of FDI, 22 report significant positive impact on growth, some report no significant impact while some report negative impact (Gorg and Greenaway, 2004). Since technology would not automatically leverage to domestic and only those with sufficient ability to learn will gain (Liu and Buck, 2007), recent studies look at the role of absorptive capacity to explain the different spillovers effect. Country which lack of absorptive capacity will benefit less as it cause asymmetric impact on knowledge diffusion among countries (Detragiache, 1998). Recent studies have mention the importance of economic freedom in many areas. Hence, this study examines the role of absorptive capacity in technology transfer, and focus on economic freedom as it is a key to overall things and capable to capture some aspect that institution factor cannot.

**EMPIRICAL FRAMEWORK**

To measure the R&D spillovers through international student flow, this paper constructs student embodied foreign R&D capital stock ($S_{fs}$) as Le (2010) suggestion:

$$S_{fs} = \sum \left( \frac{s_{ij}}{n_j} \right) S_d$$

where $s_{ij}$ is the number of tertiary students originating from country $i$ and studying at country $j$, $n_j$ is the total number of tertiary students enrolled in country $j$. $S_d$ is total domestic R&D stock in country $j$. The weight reflects the concept where country $i$ benefits from country $j$’s R&D investments depend on the degree of access by students from country $i$ to knowledge available in country $j$.

At the same time, this paper also considers the spillovers through import as suggested by literature, to see whether the inclusions of other spillovers channel would alter the findings. The import embodied foreign R&D capital stock ($S_{fm}$) is construct as van Pottelsberghe de la Porterie and Lichtenberg’s (2001) method:

$$S_{fm} = \sum \left( \frac{m_{ij}}{y_j} \right) S_d,$$

where $m_{ij}$ is the value of imported goods and services of country $i$ from country $j$. It might be interpreted as embodied with R&D intensity of source country (country $j$), $y$ is gross domestic product of country $j$, $S_d$ is total domestic R&D stock in country $j$. To study the R&D spillovers effect on domestic total factor productivity (TFP) and in order to address the possible role played by economic freedom (EF), this paper studies the following regression:

$$\text{TFP} = f(S_{fm}, S_{fs}, EF)$$

Nevertheless, TFP measurement use in this paper is different from many previous studies in this field. This paper follows suggestion by Klenow and Rodrigues Clare (1997) and Hall and Jones (1999) which using human capital augmented labor instead of only labor. Therefore, this measurement includes the consideration of labor quality. To highlight the computation of total factor productivity ($A$), let assume the following production function:
Y = AK α H^{1-\alpha}

where Y is output, K is capital stock, \(\alpha\) is share of capital income in GDP and H is augmented labor based on Mincerian’s function:

\[ H = \exp^{\alpha E} L \]

where the labor, L, is assumed as homogenous and each is trained with E years of schooling.

It shows that labor force is multiplied by efficiency, E represents years of schooling and derivative \(\phi'(E)\) is the return to education where labor force with no schooling is \(\phi(0) = 0\). Years of experience and sum of human capital with different education and experience level are found to have only little effect (Klenow and Rodriguez Clare, 1997) and therefore are not pursued in this paper. The regression is adjusted based on the suggestion in Hall and Jones (1999). First of all, the measures of output have to be adjusting for natural resource so that the countries would not be ranked as top productivity country due to the rich resource. Thus, value added in the mining industry will be subtracted from GDP. Secondly, \(\alpha\) is set to 1/3 as standard neoclassical approach suggests. Thirdly, \(\phi(E)\) is assumed as piecewise linear. Rate of return is 13.4 percent for the first four years (average of sub Saharan Africa), 10.1 percent for the next four years (average of world), and 6.8 percent for more than eight years (average of OECD). These figures come from Psacharopoulos (1994) survey on return to schooling from many countries.

Spillovers through import (lsfm) and spillovers through international student flow (lsfs) are expected to have positive sign based on the findings in literatures. It is suggested that both channel would significantly affect domestic productivity. Nevertheless, previous studies found that former channel would have relatively stronger effect. The sign of interaction term between lsfs and economic freedom, however, is not clear. If it is positive, it would mean that countries with higher economic freedom will benefit more from the spillovers through lsfs; in contrast, economic freedom will reduce the spillovers effect when the sign is negative.

Difference GMM was proposed by Arellano and Bond (1991) to eliminate country specific effect through transform equation into first difference, and use lagged levels of regressors as instruments to tackle endogeneity and correlation problem. System GMM then expand the method by combines the difference and level equations (Arellano and Bover, 1995) thus reduce biasness and imprecision associated with different estimator (Blundell and Bond, 1998). This strategy estimate the regression as a system with two equations: first difference and levels. Instrumental variables used to allow the consistency of parameter estimation even when measurement error and endogenous explanatory variables are present. Lagged first differences and lagged levels are the instruments used for equations in levels and first differences respectively. Two specification tests are then needed. The first test is Sargan Test which examine over – identifying restrictions with the null hypothesis of joint validity of all instruments. The second test examines the hypothesis of no second – order serial correlation in the error term of the regression in difference (Arellano and Bond, 1991). Existence of second – order serial correlation indicates that original error term is serial correlated and instruments are mis-specified. The failure results failed to reject both null hypotheses indicates that the model is adequately specified and the instruments are valid.

This paper utilizes annual data series from 75 developing countries over the 2000-2008 period. The data for TFP computation (GDP, gross fixed capital formation, labor force) were obtained from the World Development Indicators database except for human capital which uses average education for age above 25 as reported in Barro and Lee (2012). Foreign R&D for each developing country is the domestic R&D from G7 countries which collected from OECD Main Science and Technology Indicators database. Bilateral data for import was obtained from United Nations Commodity Trade (UN Comtrade) database. GDP for the weighted purpose in spillovers through international trade is same data to construct TFP, while contribution of mining activity to total value added was obtained from United Nations Statistics Division National Accounts Main Aggregates Database. Finally, total number of students enrolled in tertiary level education and number of international students enrolled was collected from the OECD Education and Training Database and economic freedom index was obtained from the Fraser Institute.

\[ ^1 \text{It set as 0.33 based on careful cross country estimated by Gollin (2002) which range from 0.25 to 0.35. } \alpha \text{ and } 1-\alpha \text{ generally vary over time and such variation is relatively unimportant for estimation (Baier, Dwyer and Tamura, 2006)} \]
EMPIRICAL FINDINGS

The main objective of this paper is to estimate R&D spillovers through international student flow, and how economic freedom of host country could affect the spillovers effect. Meanwhile, import which considered important in spillovers also include in the analysis to see whether include of other spillovers channel will affect the conclusion draw. Estimation results are provided in Table 1. The diagnostics are satisfied across regressions. Sargan test does not reject over identification problem while absence of second order serial correlation is not rejected. Lagged dependent variable in all four regressions is positive and significant. These estimations provide evidence to conclude that dynamic system GMM is appropriate estimator in this case, and the statistical inference carried out is reliable.

Regressions (1) and (2) include import and international student flow as spillovers channel separately. Import is found as significant channel as previous studies suggest, while the significance of international student flow also similar with literatures. The results suggest that foreign R&D would help to enhance domestic productivity through import or international student flow. This relationship does not changed when combine both channel together, as shown in regression (3), the sign and significance of channels remain. Therefore, the findings support the view of Le (2010): both import and international student flow would act as bridge between foreign R&D and domestic productivity.

Nevertheless, the results in Table 1 show some different with previous studies: spillovers through international student flow are stronger than import. Both Park (2004) and Le (2010) found that although international student flow is a significant channel in spillovers between developed countries and from developed to developing countries, import is found has greater impact. Thus, the findings support the view that importance of disembodied channel is increasing in recent decade since globalization makes mobility across border nowadays is easier than decades before (Filatotchev, Liu, Lu and Wright, 2011).

The next issue is whether economic freedom would changes the impact of R&D spillovers. The estimations are shown in Table 2. Economic freedom is included in regressions to investigate its direct effect on productivity. Regression (4) includes only interaction of R&D spillovers through international student flow with economic freedom. The result suggests that countries with higher economic freedom will gain more from the spillovers. Regression (5) extend regression (4) by includes together the interaction of spillovers through import with economic freedom. Although it did not alter the conclusion, degree of economic freedom is found do not differentiate the spillovers effect through import. Thus, the regressions suggest that economic freedom has only impact on disembodied channel instead of embodied channel.

CONCLUSION

This study examines whether international student flow channel spillovers of foreign R&D and contribute to the domestic productivity besides import, and whether economic freedom differentiate the spillovers effect. With different measurement of productivity is used, which consider the quality labor in computation, international trade remains an important spillovers channel, but international student flow is found to have greater spillovers effect. This is contrast to previous studies that study both channels together. Hence, although different productivity computation strategy would not alter the sign and significance level of spillovers channels, conclusion draw on the relative strength of spillovers channel would be different. This could be a reason why literatures in this subject found international trade has greater spillovers effect. In addition, economic freedom is found able to differentiate the spillovers effect through international student flow. Thus, countries that actively promote freedom of economic activity could gain more in enhance productivity through this channel. Nevertheless, there is no enough evidence that the role is exists in international trade. These results cast doubt on the role of economic freedom in embodied channel.

In short, human capital mobility is found more important in technology diffusion and has greater impact than traditional channel such as international trade in recent decade. Government policies that encourage study abroad would help to enhance domestic productivity and economic performance indirectly. Meanwhile, countries that promote freedom of economic activity would provide better environment for domestic firm to internalize these foreign technologies.
REFERENCE

TABLE 1: R&D Spillovers via Import and Student Flows

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{sfm}$</td>
<td>0.0833***</td>
<td></td>
<td>0.0658***</td>
</tr>
<tr>
<td>$L_{sfs}$</td>
<td></td>
<td>0.0163***</td>
<td>0.1055***</td>
</tr>
<tr>
<td>Lagged dependent variable</td>
<td>0.1981***</td>
<td>0.0431***</td>
<td>0.3405***</td>
</tr>
<tr>
<td>Sargan test (p-value)</td>
<td>0.327</td>
<td>0.684</td>
<td>0.921</td>
</tr>
<tr>
<td>AR (2) test (p-value)</td>
<td>0.212</td>
<td>0.725</td>
<td>0.916</td>
</tr>
<tr>
<td>Number of observations</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is TFP. $L_{sfm}$ and $L_{sfs}$ are respectively R&D spillovers through import and international student flow. All variables are expressed in logarithmic form. *** indicate statistical significance at the 1% level.

TABLE 2: R&D Spillovers and Interaction with Economic Freedom

<table>
<thead>
<tr>
<th></th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{sfm}$</td>
<td>0.0643***</td>
<td>0.0647***</td>
</tr>
<tr>
<td>$L_{sfs}$</td>
<td>0.0987***</td>
<td>0.1088***</td>
</tr>
<tr>
<td>$l_{ef}$</td>
<td>0.3451***</td>
<td>0.3989***</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td>0.0028</td>
</tr>
<tr>
<td>$L_{sfm} \times l_{ef}$</td>
<td>0.5139***</td>
<td>0.3436***</td>
</tr>
<tr>
<td>$L_{sfs} \times l_{ef}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged dependent variable</td>
<td>0.4799***</td>
<td>0.5063***</td>
</tr>
<tr>
<td>Sargan test (p-value)</td>
<td>0.830</td>
<td>0.925</td>
</tr>
<tr>
<td>AR (2) test (p-value)</td>
<td>0.331</td>
<td>0.447</td>
</tr>
<tr>
<td>Number of observation</td>
<td>600</td>
<td>600</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is TFP. $L_{sfm}$ and $L_{sfs}$ are respectively R&D spillovers through import and international student flow. All variables are expressed in logarithmic form. *** indicate statistical significance at the 1% level.