Foreign Knowledge Spillovers and Total Factor Productivity Growth:
Evidence from Four ASEAN Countries

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Abstract

This study examines the dynamic relationship between foreign direct investment (FDI) and total factor productivity having controlled for other channels of external openness: exports and imports in four ASEAN countries: Indonesia, Malaysia, Singapore, and Thailand. We employ the panel data analysis PDA (fixed effect and dynamic panel models) as well as the panel cointegration and Granger causality methods, using the data set for the period 1975-2010. The empirical results provide strong evidence on the impact of FDI and other channels of external openness on total factor productivity in ASEAN countries. We also find a short run and long run causality among these variables during the period of our study.
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JEL Classification: C3, F3, O1, I2.

1. Introduction

Liberalization of economic activity worldwide has greatly increased the role of multinational enterprises (MNEs) in stimulating the process of economic development. From the early 1990s onwards foreign direct investment (FDI) made by MNEs grew far more rapidly than both world GDP and world trade. Global Foreign Direct Investment (FDI) flows have increased radically during the last two decades reaching $1.4 trillion by 2010 from $54 billion in 1980 (UNCTAD, 2013). According to the most recent World Investment Report (2013) more than the half of world FDI inflows goes currently to developing

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countries. "In 2012 – for the first time ever – developing economies absorbed more FDI than developed countries, accounting for 52 per cent of global FDI flows" (UNCTAD, 2013, p.ix). These inflows are targeted mainly towards the so-called emerging markets located in East and South-East Asia which accounted for over 24 per cent of global inflows and have shown superior economic performance compared to other developing economies.

The economic success of Asian economies has frequently been attributed to the diffusion of productive knowledge from abroad via FDI. Many studies perceive access to knowledge-based assets possessed by multinational firms as the main source of benefits to host economies. As global leaders in innovation, these firms are viewed as important means of disseminating their knowledge to developing countries for which tapping into the world knowledge stock is critical. In particular, this view became popular in the growth and development literatures. For example, Romer (1993) introduced the concept of the "ideas gap" and argued that developing countries may suffer from a broad range of various handicaps related to the lack of knowledge.[1]

Foreign knowledge diffusion is also behind the catch-up hypothesis which claims that developing countries (followers) tend to grow faster and hence catch up with developed countries (leaders) thereby resulting in economic convergence of countries (Barro and Sala-i-Martin, 1997, 2004).[2]This hypothesis has gained popularity in the recent years mainly due to the claim that Asian economies, in particular China and India, attracted and benefited from FDI (Yao and Wei, 2007).

It has frequently been argued that the "ideas gap "can be effectively bridged by creating an economic environment conductive to the

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1. The concept of the "ideas gap" is closely related to the concept of "intellectual capital" in the business literature stressed, for example, by Roos et al. (1997) and Sullivan (2000) and to the concept of "knowledge capital" used in the modern theory of the multinational firm (Markusen, 2002). According to Romer (1993) ideas include not only production technology but also insights about packaging, marketing, distribution, inventory control, payments systems, information systems, transactions processing, quality control, worker motivation, etc. that are used in the creation of economic value in a modern economy.
2. The idea that the greater backlog of available opportunities to exploit, measured by the distance between the levels of development in the technological leader and the follower countries, the faster the rate at which the backward country can catch up with the developed one is associated with the studies of Veblen (1915) and Gerschenkron (1962). The former applied this hypothesis to Germany while the latter to Russia. This hypothesis was also discussed by Findlay (1978) who used a simple theoretical framework to capture the role of relative backwardness and FDI in technology transfer.

inflow of FDI. One often-claimed possibility is that inward FDI raises the productivity of domestic firms by bringing new knowledge into the host country that is, at least partly, a public good. Similar policy recommendations are also offered by various development agencies. For example, according to the World Bank (1999), if developing economies are to obtain more global knowledge they need to attract more FDI. Following these recommendations, governments in many developing countries introduced special policies aimed at attracting MNEs with the expectation that FDI increases productivity in the host economy both directly at firms receiving FDI and indirectly through positive spillovers on indigenous firms.

In the last decades dozens of countries have altered laws to at least grant multinationals national treatment, if not to favor these firms via policies such as subsidies and tax breaks. Only in 2012at least 53 countries and economies around the globe adopted 86 policy measures affecting foreign investment. "The bulk of these measures (75 per cent) related to investment liberalization, facilitation and promotion. Privatization policies were an important component of this move. Other policy measures include the establishment of special economic zones" (UNCTAD, 2013, p.xviii).Therefore, from the policy perspective it is important to investigate if the MNE activity indeed positively affects host country economies and their indigenous firms to see whether policies aimed at attracting foreign investors are really justified.

The main aim of this paper is to study the relationship between FDI and total factor productivity in the host country, having controlled for some additional channels of external openness, such as exports and imports in four ASEAN countries: Indonesia, Malaysia, Singapore, and Thailand. Thus, there is one key empirical question that we seek to shed light on in this paper: are there any foreign knowledge spillovers in the ASEAN countries? We employ the panel data analysis PDA (fixed effect and the dynamic panel models) as well as the panel cointegration and Granger causality methods using the dataset for the period 1975-2010. Our empirical results provide strong evidence on the positive impact of FDI and other channels of external openness on total factor productivity in the ASEAN countries. We also find a short run and long run causality among these variables during the period of our study.

The reminder of the paper is organized as follows. Section 2contains the review of the relevant literature. Section 3 discusses the analytical framework and estimation issues. Section 4 describes the properties of the dataset. Section 5 presents our empirical findings. Finally, Section 6 summarizes and concludes with the policy guidelines and directions for further studies.

2. Literature Review

The nexus between external openness and economic performance has been extensively studied by both theoretical and empirical economists through a variety of different analytical frameworks and statistical methods. In the neoclassical literature, in the spirit of Solow (1956) and Swan (1956) growth models, the extent to which FDI and trade affect growth was limited. With diminishing returns to capital, external openness may affect only the level of income but not its steady state rate of growth. Thus, in these models the impact of increased external openness is confined only to the short run, the magnitude and duration of which depend on the transitional dynamics to the steady state growth path determined by the exogenously given rate of technological progress.

External openness can be shown to affect growth endogenously in so far it generates increasing returns in production through various externalities and productivity spillovers. The attempts to extend the neoclassical production function in order to capture those elements were made already in the late 1970s and early 1980s. For example, Michaely (1977), Findlay (1978) and Feder (1982) included exports or FDI in the production function as an independent factor of production in addition to capital and labor, respectively. More recently, Ben-David and Loewy (1998, 2003) studied the role of trade in the neoclassical growth model, while Duczynski (2002, 2003) conditioned the total factor productivity on FDI in the Ramsey model. The emergence of the endogenous growth theory in the late 1980s and early 1990s, however, greatly reduced the tendency to rely on the neoclassical framework in studying the effects of FDI and international trade.

The new growth theory frameworks provided microeconomic foundations necessary for understanding of many sources of

externalities and spillovers and the openness-growth nexus. The emergence of this new literature was motivated by two major shortcomings of the neoclassical models. On the one hand, there were diminishing returns to reproducible factors of production and exogenously given technological change on the other. Two main strands in this new growth theory literature can be distinguished.

The first strand attempts to allow capital accumulation permanently affect the rate of growth by eliminating the tendency for diminishing returns. This can be achieved in two ways. The first approach, proposed by Romer (1986), following Arrow (1962) and Sheshinsky (1967), is based on the idea of 'learning-by-doing'. In his model capital accumulation leads to a simultaneous increase in the stock of knowledge that spills over across the economy. The second approach was proposed by Lucas (1988) and Rebelo (1991), following Uzawa (1965). In their models an additional factor – human capital – was added to the production function which prevented the marginal product of capital from falling.

The second strand is based a completely different approach to modeling technological progress. In the seminal contributions of Romer (1987, 1990), Grossman and Helpman (1991), and Aghion and Howitt (1992) changes in the level of technology are due to deliberate and purposeful research and development (R&D) activities of profit seeking firms rather than a side product of investment. In these models increasing returns to scale arise either from the expansion of available product variety or improving quality of existing varieties. According to this strand economic growth is driven by product innovations done by profit seeking entrepreneurs who compare costs of innovating with the discounted stream of profits from innovation. The research and development (R&D) activity occurs in developed countries and international diffusion of knowledge is the driving force of growth in developing countries.

The endogenous growth literature spurred numerous empirical studies. Mayer-Foulkes and Nunnenkamp (2009: 305) noted that: "the empirical growth literature has arrived at the consensus that technological differences play a more important role than physical or human capital in determining income differences across countries". In particular, this literature has focused on the following two questions:

i) does international diffusion of knowledge really occur and ii) what are the exact channels of international knowledge diffusion? It has been argued that in an open economy diffusion of knowledge can occur through a variety of different channels. Two most important channels include international trade and FDI by multinational firms.[1]

The impact of international trade on productivity has already been very well documented in the literature. For example, in the early studies by Coe and Helpman (1995) and Coe et al. (1997) international R&D spillovers are related to imports. Similarly, Keller (2002) finds that if a country imports a lot from technologically advanced countries its productivity growth rises substantially. Other authors stress the role of exporting in international knowledge diffusion. For example, Aw et al. (2000) argue that there might be benefits related to exporting such as knowledge spillovers from buyers while Hobday (1995) and Gereffi (1999) show that export related technology transfers played a vital role in a number of exporting industries in South-East Asia.

The role of international trade in foreign knowledge diffusion and fostering economic growth has also been supported by numerous cross-country growth regressions. The positive relationship between openness to international trade and economic growth was already reported in the early studies of Bhagwati and Srinivasan (1975), Bhagwati (1978) and Krueger (1978). Subsequent studies by Quah and Rauch (1990), Ben-David (1993, 1996), Harrison (1996), Ben-David and Loevy (1998), Frankel and Romer (1999) and Dollar and Kraay (2003) confirmed a positive link between trade and growth. In their survey of empirical evidence Rodriguez and Rodrik (2001: 264) concluded that "the main operational implication is that governments should dismantle their barriers to trade".

The evidence that FDI is an important vehicle for international technology diffusion is also substantial. However, in contrast to the literature documenting the unambiguously positive impact of international trade, the empirical findings on the contribution of FDI to productivity and economic growth seem much less robust. It has often argued that FDI is accompanied by investors' intangible assets

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1. See the survey article by Keller (2004) for a detailed description of these channels.

that allow MNEs to compete in a foreign environment where there are additional costs of doing business. These proprietary firm-specific knowledge-based assets may take the form of management and marketing skills, knowledge of a particular production process or the possession of patents and trademarks. These assets due to their public good characteristics can be easily transferred between subsidiaries of the same firm located in different countries. The possibility for positive spillovers arises because MNEs may find it difficult to prevent the leakage of their knowledge to other firms in the host country.

The theoretical literature identified several channels through which MNEs could potentially generate positive knowledge spillovers affecting local firms in host countries. First, local firms can benefit from the presence of MNEs in the same industry, leading to horizontal (i.e. intra-industry) spillovers. This kind of spillovers may result from hiring current or former employees of MNEs, interactions with foreign managers, demonstration and competition effects, etc. Second, there may be also spillovers from MNEs that operate in different industries, leading to vertical (i.e. inter-industry) spillovers. This kind of spillovers may result from buyer-supplier linkages and may be towards downstream industries (i.e. forward spillovers) and/or towards upstream industries (i.e. backward spillovers). On the one hand, local firms may benefit from the entry of new foreign professional service providers or intermediate input suppliers, and on the other MNEs may act for local firms to improve the quality of their products by demanding higher standards.

However, despite some suggestive case studies, such as those quoted in Moran (2005), the formal empirical evidence on whether FDI facilitates knowledge spillovers is ambiguous and seems country-specific depending on employed econometric techniques and data samples. The majority of empirical studies examine intra-industry spillovers using the standard production function framework. The effect of MNE presence on the productivity of local firms is captured by the coefficient on the share of foreign firms' output or employment in that industry. In one of the first empirical studies Caves (1974) found positive and significant spillovers in the Australian manufacturing sector. However, Germidis (1977), who examined a

sample of 65 multinational subsidiaries in 12 developing countries, found no evidence of technology transfer from foreign to local firms.

Further empirical studies for developing studies based on aggregate data such as Blomström and Persson (1983) and Blomström (1986) found a positive relationship between sectoral productivity and the sectoral level of MNE activity. Moreover, Rhee and Belot (1989) claimed that the entry of foreign firms was largely responsible for the creation and subsequent growth of domestically owned textile firms in Mauritius and Bangladesh. Xu (2000) found a positive correlation between the productivity growth and the ratio of foreign subsidiary value added to host country's GDP while Liu and Wang (2003) found that FDI positively affected TFP of local firms. Using a panel of manufacturing industries from China, Liu (2002) showed that FDI had large and significant impacts on the productivity of manufacturing industries in the domestic sector.

However, studies based on firm-level data such as Haddad and Harrison (1993) and Aitken and Harrison (1999) found either no relationship between the presence of MNEs and the productivity of local firms or even negative correlations. In particular, Haddad and Harrison (1993) found negative spillovers associated with FDI in Morocco. In a study of Venezuelan firms, Aitken and Harrison (1999) found that FDI negatively affected productivity of indigenous firms. To explain these results, they put forward a "market-stealing" hypothesis arguing that, while FDI may promote foreign knowledge transfers, MNEs may compete with indigenous firms and force them to produce smaller outputs at higher average costs. As a result, the overall benefit of FDI can be small or even negative.

The negative intra-industry spillovers were usually interpreted as a result of the low absorptive capacity of indigenous firms in the less developed countries. It has been also hypothesized that that the larger the technology and human capital gaps between indigenous firms and MNEs the less likely the former are to benefit from the presence of the latter but the empirical evidence on these hypotheses still remains mixed. While Kokko (1994) and Takii (2001) found that the bigger the technology gap between local and foreign-owned plants the smaller the spillovers Sjöholm (1999) and Blalock and Gertler (2002) found that the wider the gap the larger the spillovers, all using data for

Indonesia. Moreover, it was also suggested that positive intra-industry spillovers should be expected in industrialized countries rather than in developing countries and in more technologically advanced sectors.[1]

While there are many studies on intra-industry spillovers, there are relatively less empirical studies on inter-industry spillovers in developing countries. Vertical spillovers are more likely to be positive than horizontal spillovers since MNEs have an incentive to improve the productivity of their suppliers rather than of their competitors. In the early study Lall (1980) found a positive backward linkage effect of foreign firms on the Indian trucking industry. The subsequent empirical studies are also consistent with the hypothesis of positive spillovers. For example, Driffield et al. (2002) and Blalock and Gertler (2004, 2005) provide the evidence supports the view of technology transfer through backward linkages in the manufacturing sectors in Indonesia.

The empirical evidence on the FDI-growth nexus in developing countries also remains mixed. On the one hand, Borensztein et al. (1998), De Mello (1999), Oliva and Rivera-Batiz (2002), Ram and Zhang (2002), Bloningen and Wang (2005), Khamar (2005), Chowdhury and Mavrotas (2006), Hansen and Rand (2006), Johnson (2006), Lensink and Morrisey (2006), Zhang (2007), Cieślik and Tarsalewska (2011) find generally a positive nexus between FDI and the host country's growth. On the other hand, however, Choe (2003), Carkovic and Levine (2005), Mayer-Foulkes and Nunnenkamp (2009) provide contrarian evidence.

Unfortunately, most previous empirical studies that investigate the relationship between FDI and productivity growth generally suffer from two major shortcomings. First, few empirical studies refer directly to theoretical models and provide clear interpretation of their results. Second, most studies focus only on one potential channel through which international knowledge diffusion may take place. To our knowledge so far no attempts have been made to investigate the relative importance of FDI having controlled for other channels of

1. Positive spillovers in the developed countries were found, for example, in studies by Grima et al. (2001) and Haskel et al. (2002) for the UK and by Keller and Yeaple (2009) for the US. Grima et al. (2001) show that local firms that are 'technologically' comparable to foreign firms enjoy greater spillovers. Görg and Greenaway (2004) provide an extensive review of those studies.

external openness such as exports and imports, specifically in the context of ASEAN countries. Finally, the majority of the previous studies focused only on the simple relationship between FDI and external openness and did not address the issue of causality.

Therefore, the contribution of this paper to the literature is several fold. First, we aim at providing a direct link between the theory and the estimating equation by referring to the well-established endogenous growth theory. Second, we reexamine the relationship between FDI and productivity growth, having controlled for other measures of external openness and in the single empirical setting. Third, we provide recent empirical evidence on the relationship between FDI and productivity growth in the group of four ASEAN countries. Finally, we provide the causality analysis between FDI and productivity growth.

3. Analytical Framework

In deriving the analytical framework in our paper we refer to the new growth theory. In contrast to the neoclassical theory, this theory endogenizes the productivity growth at the country level. In particular, we concentrate on the second equation from the standard two-sector growth model which explains the production of new knowledge in the context of the follower economy. In particular, in contrast to determinants of productivity growth in the leader economy, which is based on the domestic R&D effort, in the case of the follower economy we assume that productivity growth is mainly based on the foreign R&D effort and diffusion of knowledge developed in the leader economy that occurs through various channels of external openness.

The general idea behind our analytical framework is that FDI is the main channel that can stimulate productivity growth in the host economy through a variety of knowledge spillovers. If these spillovers exist, they should be reflected in their positive impact on productivity of the host economy. While different measures of productivity have been used in the literature, we decided to focus on total factor productivity (TFP).The main focus of our analysis is thus the relationship between TFP and FDI, having controlled for another channels of external openness such as exports and imports.

Moreover, the magnitude of spillovers available to and usable by domestic producers may dependable so on various factors that affect the economic environment in the host country. After incorporating all other determinants of productivity growth in the host country, the theoretical model in its most general form can be written as follows:

$$\dot{A} = F(FDI,X) \tag{1}$$

where denotes $\dot{A}$ total factor productivity growth in the host country, FDI is the net foreign direct investment inflow into the host country, and X is the vector of controls, i.e. the set of all other factors that may affect productivity growth. Unfortunately, there is no unified economic growth theory that would allow determining what the necessary control variables are. Instead various growth theories postulate different variables. A review of relevant theoretical and empirical literatures shows that there are many variables that are possible candidates to be an element of control vector X.

These include, among others, variables such as exports of goods and services, manufacturing value added, gross capital formation that can be related to domestic knowledge spillovers resulting from the manufacturing activity or from learning-by-investing, some additional measures of international openness such as manufactures imports, the share of FDI in capital and telephone lines density capturing informational spillovers (see, for example, Akinlo,2006).[1]

Therefore, in the estimating equation we need to control for potential sources of spillovers related not only to external openness but also to domestic economic activity. With these considerations in mind equation (1) can be expressed in a more specific form as:

$$\dot{A}= F(FDI,EXP,MIM,FDIC,MVGDP,GCF,TEL) \tag{2}$$

In (2) above, EXP is exports of goods and services expressed as a percentage of GDP, MVGDP is manufacturing value added expressed as a percentage of GDP, GCF is Gross capital formation expressed as a percentage of GDP, MIM is manufactures imports expressed as a percentage of total imports, FDIC is the share of FDI in total capital in

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1. For example, it is often argued that telecommunications infrastructure lowers the transaction costs of exchanging information among firms and enforces backward and forward linkages between them [Cieślik & Kaniewska (2004)].

the host country and TEL is the density of telephone lines per 100 people.

To provide comparison with some earlier empirical studies, such as Liu (2008), to seek for the empirical evidence on the nexus between spillovers from FDI and productivity we start with estimating the following econometric static model in levels:

$$\ln\text{TFP}_{ij} = \beta_0 + \beta_1 \ln FDI_{ij} + \beta_2 lnX_{ij} + u_i + \epsilon_i \qquad (3)$$

where u denotes the unobservable country-specific effect and ε denotes the remainder stochastic disturbance. *X*, as defined previously, represents a vector of variables that determine productivity growth. For the purpose of this study the two most important parameters are β₁ and β₂ where the former measures the effect of FDI on TFP while the later measures effect other control variables on TFP as well.

The theoretical insight on the short-term and long-term effects of spillovers from FDI on productivity by Liu (2008) has addressed the problem of mixed results and hence, inconclusiveness of empirical investigations on the subject matter. According to Liu (2008), the reason behind this problem is failure to recognize the opposing short-term and long-term effects of spillovers from FDI on productivity. This is so since the magnitude of the negative short-term and positive long-term effects depends on the length of the time frame (long-time series versus short-time series) of the samples that could easily lead to misleading conclusion unless this is accounted for.

As in Liu (2008), in estimating the model in (3) we make an implicit assumption that the time trend of total factor productivity can serve as an indicator of the long-run rate of TFP growth. To investigate whether inward FDI generates productivity spillovers for domestic firms, we estimate variations of the following basic equation specification.

4. Data

The database for this study is collected from various sources which covered the period 1975–2010 for four ASEAN selected countries: Indonesia, Malaysia, Singapore, and Thailand. This study employs the new dataset for TFP developed by Asia Productivity Organization (APO). The sample period is determined by data availability.

The APO Productivity Data provides a long-term view of comparable data on the economic growth and productivity levels of Asia-Pacific economies in relation to global and regional economies, 1970–2010. Baseline indicators are calculated for 29 Asian economies, representing the 20 APO members and nine nonmembers in Asia. For these data, the APO undertakes three basic activities: first, developing a comparable database based on internationally harmonized methodology; second, assessing and adjusting data quality; and third, improving individual country data. There are various sources of data on FDI inflows. For the purpose of this study, we used the data on NET FDI inflows into the sample of four ASEAN countries obtained from UNCTAD (2012).The data on FDI were expressed in FDI flows which consist of the net sales of shares and loans (including non-cash acquisitions made against equipment, manufacturing rights, etc.) to the parent company plus the parent firm´s share of the affiliate´s reinvested earnings plus total net intra-company loans (short-and long-term) provided by the parent company.

FDI flows with a negative sign (reverse flows) indicate that at least one of the components in the above definition is negative and not offset by positive amounts of the remaining components.

The data for the control variables that are expected to determine the growth of TFP such as exports of goods and services, manufacturing, value added, gross capital formation, manufactures imports, and telephone lines were taken from the World Bank Development database (WDI).

Before discussing the results of empirical analysis, in this subsection, we examine the descriptive statistics that indicates the characteristic features of the economies in the sample. Table 1 presents the summary statistics of the variables considered.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
TFP	164	0.9755488	0.1290896	0.61	1.24
FDI	164	3.70e+09	6.02e+09	-4.55e+09	3.86e+10
EXP	164	80.11835	63.21706	13.45101	241.402
MVGDP	164	23.35342	6.077681	9.166335	35.63192
GCF	164	29.09802	7.447358	11.3674	46.95346
MIM	164	23.35342	6.077681	9.166335	35.63192
FDIC	164	0.1435299	0.1855911	-0.1239539	0.9973457
TEL	164	12.06098	14.16108	0	50

Table 2 presents the correlations matrix between the variables considered.

Table 2: Correlations Matrix

	TFP	FDI	EXP	MVGDP	GCF	MIM	FDIC	TEL
TFP	1.0000							
FDI	0.1922	1.0000						
EXP	0.2205	0.8450	1.0000					
MVGDP	0.5155	0.2397	0.2886	1.0000				
GCF	0.2642	0.2391	0.2587	0.1557	1.0000			
MIM	0.1303	0.4354	0.4890	0.2673	0.3692	1.0000		
FDIC	0.2641	0.9437	0.5789	0.2251	0.0609	0.4395	1.0000	
TEL	0.4173	0.3407	0.2645	0.3187	0.1053	0.2039	0.3391	1.0000

5. Empirical Results

In this section we present the results of our empirical analysis. To investigate the effect of FDI on the total factor productivity of the host country we estimated equation (3) using two different approaches: the standard fixed effect panel data regression (i.e. the static panel model) and the dynamic panel model using GMM. In the subsequent subsections we first report the results obtained for the static panel model, then we discuss the dynamic panel estimates and finally we show the results of the causality analysis.

5.1. Static Model

Following our discussion in the previous sections, if FDI serves as a vehicle of foreign knowledge diffusion this must be reflected in its positive effect on the total factor productivity in the host economy. Furthermore, it can be argued that FDI can have positive effects on the productivity of the economy depending on the time frame considered. To test whether this argument is supported by the data, we first

estimate the fixed effect model. The estimation results obtained from the static regression are reported in Table 3 below.

Table 3: The Effect of FDI on Total Factor Productivity Obtained using the Fixed Effects Model (Dependent Variable lnTFP)

Variable	(1)	(2)	(3)
lFDI	0.0587403	0.0469748	0.0775299
	(11.46)***	(5.21)***	(6.72)***
lEXP	0.0329042	0.0621745	0.2042962
	(2.33)**	(2.31)**	(4.34)**
lMVGDP			0.0029142
			(1.33)
lGCF		0.070852	0.0391722
		(2.01)**	(1.89)
lMIM			0.1796698
			(2.02)**
lFDIC		0.024147	0.0263631
		(2.17)**	(2.67)**
lTEL			-0.0661255
			(-3.89)**
Constant	-1.291552	-1.127054	-2.012975
	(-18.76)***	(-6.78)***	(-6.39)***
Observations	164	164	164
R-squared between	0.513	0.294	0.218

Note: Figures in the parentheses are p-value. * denotes Significant at the 10 percent level, **denotes Significant at the 5 percent level and*** denotes Significant at the 1 percent level.

In column (1) we report estimation results from the benchmark specification in which TFP is regressed on FDI, having controlled only for exports. Both variables display the expected positive signs and are statistically significant although at different levels of significance. The estimated coefficient on the FDI variable is statistically significant already at the 1 per cent level, while the estimated coefficient on the export variable is statistically significant only at the 5 per cent level.

In column (2) we investigate the robustness of the benchmark results presented in column (1) by adding two control variables: the gross capital formation (GFC) and the share of FDI in capital (FDIC) to control for some additional spillover effects. Both of these additional variables are statistically significant at the 5 per cent level. The inclusion of these two variables does not affect the statistical

significance of the estimated parameters on FDI and exports variables.

In column (3) we additionally control for the manufacturing value added as a percentage of GDP (MVGDP), manufacturing imports as a percentage of total imports (MIM) and telephone density (TEL). The former variable is not statistically significant while the latter two variables are statistically significant at the 5 per cent level. However, the telephone density variable displays a counterintuitive negative sign. The inclusion of additional control variables does not affect the statistical significance of the FDI and exports variables. However, the gross capital formation variable loses its previous statistical significance.

Summarizing our results obtained from the static model reported in Table 2, it can be noted that our results show that countries which receive more foreign direct investment, export more and have a larger share of manufacturing value added (% of GDP) experience higher TFP which is in line with the predictions of the theory. Other interesting results include the positive and statistically significant effects of gross capital formation (% of GDP), manufactures imports (% of imports), the share of FDI in capital and telephone line density (per 100 people) on the productivity of the economy.

5.2. Dynamic Model

Recognizing the dynamic nature of economic variables, in general, and the research question at hand, in particular, we also estimated the dynamic panel model using the two step Arellano-Bond (1991) GMM method by including the lagged values of the total factor productivity. This is important since such a specification allows controlling for the potential endogeneity bias and enables testing the Granger causality (see Herzer *et al.*, 2008). Table 3 presents the empirical results obtained using the Arellano-Bond two step GMM estimators. The particular columns in Table 4 are the direct counterparts of the columns in Table 3.

In column (1) we report again estimation results for the benchmark specification. Both FDI and exports display positive signs and are statistically significant at similar levels of statistical significance as in the static regression. The estimated coefficient on the FDI variable is statistically significant already at the 1 per cent level, while the estimated coefficient on the export variable is statistically significant

at the 5 per cent level.

Table 4: Arellano-Bond GMM Two-Step Estimators
(Dependent Variable lnTFP)

Variable	(1)	(2)	(3)
LTFP L1 (lagged TFP)	0.7924741	0.8127798	0.7608966
	(20.57)***	(21.21)***	(16.81)***
lFDI	0.0147389	0.0085677	0.0302554
	(4.48)***	(2.85)**	(3.95)**
lEXP	0.0057284	0.0043134	0.0346928
	(2.37)**	(1.33)	(2.12)**
lMVGDP			0.0348792
			(2.67)**
lGCF		0.0089568	0.0083457
		(1.69)	(1.54)
lMIM			0.0207632
			(1.51)
lFDIC		0.0099146	0.0137473
		(2.15)**	(2.47)**
lTEL			0.0409545
			(3.42)**
Constant	-0.2824354	-0.1026655	-0.8182361
	(-4.52)***	(-1.03)	(-3.72)**
AR(1), (p value)	0.0523	0.0113	0.0396
AR(2), (p value)	0.9673	0.8130	0.8903
Sargan test (p value)	0.1053	0.1341	0.0806

Note: Figures in the parentheses are p-value. * denotes Significant at the 10 percent level, **denotes Significant at the 5 percent level and*** denotes Significant at the 1 percent level.

In column (2) we investigate the robustness of the benchmark results presented in column (1) by adding two control variables: the gross capital formation (GFC) and the share of FDI in capital (FDIC).This time, however, only the share of FDI in capital variable is statistically significant at the 5 per cent level while the gross capital formation is not statistically significant at all. Moreover, this time the inclusion of control variables, affects the statistical significance of both exports and FDI variables. The statistical significance of the FDI variable drops to the 5 per cent level, while the exports variable loses completely its previous statistical significance.

In column (3) we additionally control for the manufacturing value added as a percentage of GDP (MVGDP), manufacturing imports as a percentage of total imports (MIM) and telephone density (TEL). This

time the estimated coefficients on the MVGP and TEL variables are statistically significant at the 5 per cent level while the coefficient on the MIM variables is not statistically significant at all. Moreover, now the estimated coefficient on the TEL variable displays the expected positive sign. The estimated coefficients on both the FDI and exports variables are statistically significant at the 5 per cent level.

As can be seen from Table 3 both FDI and exports, as well as selected control variables are positively related the TFP growth. In general, the econometric results obtained from both the static panel model and the dynamic panel model confirm that FDI and exports are important for the TFP growth of the host economy.

5.3. Causality Analysis
The mere existence of a statistically significant relationship between FDI and TFP growth is not sufficient, however, to argue that more FDI would lead to a higher TFP growth. For the causality analysis between TFP and FDI this study uses the panel unit root, cointegration and causality analyses in order to examine the relationship between these variables. The empirical modeling framework consists of the following steps. First, stationary properties of the dependent and explanatory variables are investigated using the panel unit root tests. Second, the cointegration relationship between them is tested. Finally, causal relationships among the variables are examined based on the panel vector error correction model.

Many recent studies rely on panel unit root tests in order to increase the statistical power of their empirical findings. In this respect, the panel unit root tests developed by Levin *et al.* (2002, henceforth LLC)and Im *et al.* (2003, henceforth IPS) are widely utilized in panel cointegration studies. The panel unit root test of LLC (2002) entails estimating the following panel model:

$$\Delta TFP_{it} = \mu_i + \rho TFP_{it-1} + \sum_{j=1}^{k} \alpha_j \Delta TFP_{it-1} + \delta_i t + \theta_t + \varepsilon_{it} \quad (4)$$

where Δ is the first difference operator, k is the lag length, γ_i and θ_t are unit-specific fixed and time effects, respectively. The null hypothesis of ρ=0 for all i is tested against the alternative hypothesis of $\rho < 0$ for all i. The rejection of the null hypothesis indicates a panel

stationary process. The strong assumption of homogenous ρ in the LLC test is difficult to satisfy due to the fact that cross-sectional units may have a different speed of adjustment process towards the long-run equilibrium. By relaxing this assumption, IPS (2003) proposed a panel unit root test which allows ρ to vary across all i. Therefore, in the IPS (2003) testing procedure, Eq. (4) is re-written as follows:

$$\Delta TFP_{it} = \mu_i + \rho_i TFP_{it-1} + \sum_{j=1}^{k} \alpha_j \, \Delta TFP_{it-1} + \delta_i t + \theta_t + \varepsilon_{it} \quad (5)$$

The panel unit root test results are reported in Table 5. The results do not show a uniform conclusion that the null of unit root can be rejected for the levels of the variables. However, the test statistics for the first-differences strongly reject the null hypotheses, which imply that the variables are stationary in the first-difference form. From the unit root analysis, we can therefore conclude that the variables are integrated of order one, indicating a possible long-run cointegrating relationship among the TFP, FDI and exports. Thereby, what follows is testing for cointegration in the next step of our empirical analysis.

Table 5: Results for Panel Unit Root Tests

	LLC		IPS	
Variable	**Constant**	**Constant trend**	**Constant**	**Constant trend**
LTFP	0.55 (0.2260)	2.55 (0.0002)	2.99 (0.0070)	6.39 (0.0000)
LFDI	-0.805(0.7263)	−2.05 (0.0000)	−6.01 (0.1041)	−2.12 (0.0143)
LEXP	−1.24 (0.0004)	−8.55 (0.0000)	−1.35 (0.0000)	−0.69 (0.0042)
$\Delta LTFP$	−55.22 (0.0000)	−77.61 (0.0000)	−19.75 (0.0000)	−63.19 (0.0000)
$\Delta LFDI$	−19.47 (0.0000)	−98.92 (0.0000)	−59.46 (0.0000)	−42.49 (0.0000)
ΔEXP	−51.88 (0.0000)	−123.99 (0.0000)	−77.22 (0.0000)	−82.22 (0.0000)

Note: Δ is the first difference operator. Numbers in parentheses are p-values. Newey–West bandwidth selection with Bartlett kernel was used for the LLC test. The maximum lag lengths were set to 12 and the Schwarz Bayesian Criterion was used to determine the optimal lag length.

To investigate the existence of the long-run equilibrium relationship among the variables in question, we conduct the panel cointegration tests developed by Pedroni (1999).Results of the panel cointegration tests are reported in Table 6. The tests were performed for constant as well as constant and trend cases. All the test statistics reject the null of no cointegration hypothesis at 1 percent level of

significance. The results show that the statistics provide strong evidence on the existence of cointegration, which implies that the TFP converges to their long-run equilibrium by correcting any deviation from this equilibrium in the short-run.

Table 6: Results for Panel Cointegration Tests

Test	Constant	Constant and trend
Panel ν−statistic	6.48 ***	7.35 ***
Panel ρ−statistic	−7.18 ***	−5.40 ***
Panel PP-statistic	−8.33 ***	−4.32 ***
Panel ADF-statistic	−2.89 ***	−6.13 ***
Group ρ−statistic	−6.44 ***	−9.65***
Group PP-statistic (non-parametric)	−5.42 ***	−5.60***
Group ADF-statistic (non-parametric)	−9.31 ***	−6.41 ***

Note: The tests were carried out with two lags. *** indicates statistical significance at 1percent level of significance. The statistics are asymptotically distributed as standard normal. The panel ν−statistic is a right-tailed test and has critical value of 1.645 at the 5 percent level of significance. The remaining statistics are left-sided tests and have a critical value of −1.645.

Since the cointegration analysis cannot determine the direction of causality, it is common to investigate causal interactions among the variables once cointegration is established. As Engle and Granger (1987) demonstrate, inferences from a causality test based on a vector auto regression (VAR) model in first differences will be misleading when the variables are cointegrated. To overcome this problem, one way is to estimate a vector error correction model (VECM) by augmenting the VAR model with one-lagged error correction term. The panel VECM can be written as follows to investigate causal linkages in a panel data (Apergis and Payne, 2009).

$$\Delta LTFP = \delta_{1i} + \sum_{p=1}^{k} \delta_{11ip}\Delta LTFP_{it-p} + \sum_{p=1}^{k} \delta_{12ip}\Delta LFDI_{t-p} + \sum_{p=1}^{k} \delta_{13ip}\Delta LEXP_{t-p} + \varphi_{1i}ECT_{t-1} + v_{1it}$$

$$\Delta LFDI = \delta_{2i} + \sum_{p=1}^{k} \delta_{21ip}\Delta LFDI_{it-p} + \sum_{p=1}^{k} \delta_{22ip}\Delta TFP_{t-p} + \sum_{p=1}^{k} \delta_{23ip}\Delta LEXP_{t-p} + \varphi_{2i}ECT_{t-1} + v_{2it}$$

$$\Delta LEXP = \delta_{3i} + \sum_{p=1}^{k} \delta_{31ip}\Delta LEXP_{it-p} + \sum_{p=1}^{k} \delta_{32ip}\Delta LFDI_{t-p} + \sum_{p=1}^{k} \delta_{33ip}\Delta LTFP_{t-p}$$
$$+ \varphi_{3i}ECT_{t-1} + v_{3it}$$

Here all variables are as previously defined, Δ denotes the first difference of the variable, and p denotes the lag length. The significance of the first differenced variables provides evidence on the direction of the short-run causation while the t-statistics on the one period error correction term denotes long-run causation. The results from panel Granger causality analysis are presented in Table 7.

Table 7: Results for Panel Granger Causality

	Short-run causality			Long-run causality	
	Δ LTFP	Δ LFDI	Δ LEXP	ECT	
Δ LTFP		52.78 (0.000)***	64.23 (0.0000)***	0.073	(17.26)***
Δ LFDI	27.68 (0.0005)***		51.92 (0.0000)***	0.002	(16.34)***
Δ LEXP	61.14 (0.0000)***	50.38 (0.0000)***		0.005	(18.07)***

Note: The optimal lag length was selected using the Schwarz information criteria. Figures in parentheses are p-values and absolute t-ratios, respectively. *** indicate statistical significance at 1 percent level of significance.

The short-run causality analysis indicates uni-directional causal linkages among the TFP, FDI and exports. The short-run causality analysis thereby implies that the FDI and exports can be used to forecast the TFP. Furthermore, the results provide evidence that TFP and FDI play a role in forecasting the exports in the short-run. Besides, the dynamics of the TFP and exports provide information on the future values of the FDI. The long-run causality analysis on the one hand shows that: i) FDI and exports are the Grangercause of TFP, ii) the TFP and the FDI cause exports, and however iii) the exports and the TFP do cause the FDI. Thereby, the causal linkages among the TFP, FDI and exports have been dominated in the long-run.

6. Conclusions
In this paper we studied the dynamic relationship between FDI and TFP, having controlled for other potential channels of knowledge diffusion in four ASEAN countries: Indonesia, Malaysia, Singapore, and Thailand. We referred to an analytical model leader-follower

belonging to the new strand in the growth theory, in which technological spillovers from FDI from the leader country generated productivity growth in the follower economy. The basic argument in this model was that if FDI exerts a positive spillover effect on the host economy, it must be reflected in the increased productivity of the host economy. To test for the relationship between FDI and TFP we employed the panel data analysis PDA (fixed effect and dynamic panel models) as well as the panel cointegration and Granger causality methods using the dataset for the period 1975-2010.The empirical results provide strong evidence on the positive impact of FDI on total factor productivity in ASEAN countries. Moreover, this paper showed that there is a short run and long run causality between total factor of productivity and foreign direct investment.

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