



## Foreign direct investment and productivity: evidence from the East Asian economies



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**Foreign Direct Investment and Productivity:  
Evidence from the East Asian Economies**

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## **Abstract**

In this paper, an examination is made of the linkage between foreign direct investment and productivity in eight East Asian economies—China, Hong Kong SAR, Indonesia, Malaysia, Republic of Korea, Singapore, Taiwan Province of China and Thailand. The Granger causality test and the Toda-Yamamoto version of the Granger causality test are used to test if inflows of foreign direct investment “cause” productivity growth. The results show that only two countries reveal evidence of a one-way causality between inflows of foreign direct investment and total factor productivity growth. Similarly, there is also little evidence that inflows of foreign direct investment cause technical change or efficiency change in the sample economies.

**Keywords:** Total factor productivity, foreign direct investment, East Asia, Granger causality



# **Foreign Direct Investment and Productivity: Evidence from the East Asian Economies**

## **Introduction**

In this paper, an attempt is made to examine the direct impact of foreign direct investment (FDI) on productivity, specifically because the spillover effects of FDI have been hypothesized to be technological and organizational in nature. As the impact of FDI is expected to manifest itself in higher productivity growth, it is necessary to examine the direct relationship between FDI and productivity.

Past research has concentrated on examining the link between FDI and economic growth. Attempts have also been made to quantify the effect that FDI has on economic growth apart from its direct impact on increasing investment. In a sense, such studies attempted to measure the spillover effects of FDI on the economy, albeit indirectly. Currently, research that examines the direct link between FDI and productivity is limited, especially for many developing countries. This is partly due to the lack of data on productivity at the country level.

Recently, UNIDO has embarked on a project to create a database on productivity for a large number of countries, including many developing countries. The results from the UNIDO productivity database have been used here to examine the relationship between FDI and productivity. The productivity estimates from the UNIDO database, obtained from Data Envelopment Analysis (DEA), decomposed the change in productivity into technological change and technical efficiency change. Therefore, in addition to examining whether FDI contributes to productivity overall, one is able to examine how FDI influences these two components of productivity. Does FDI contribute to higher productivity by bringing in newer technology, or does FDI contribute to higher productivity by introducing more efficient management process? These are interesting questions for both academics and policy makers. There are many incentives provided to encourage FDI because it is assumed that FDI can introduce advanced technology to a country. It would be interesting to test if this is indeed the case.

The flow of private capital to developing countries has been increasing in recent years. Between 1990 and 2004, total private capital flows increased from US\$42 billion to almost US\$250 billion. In particular, the growth of private capital flow has been driven mainly by growth in FDI. Between 1990 and 2004, the net flow of FDI to developing countries increased from US\$22 billion to US\$165 billion. This rapid rise in private capital flow means that such flows are becoming a much more important source of financing than official sources, namely, official development assistance. In contrast, official flows to developing countries declined from US\$54 billion to US\$33 billion over the same period.

FDI has been playing an important role in the development process of many countries. In particular, FDI provides both the capital and technology that developing countries lack. Therefore, there are broadly two channels through which FDI can flow. One is by providing capital to build up the productive capacity in the economy, and the other is by providing advanced technology and organizational know-how that will help to increase the efficiency or productivity of investment.

This is, of course, an important issue for policy makers in developing countries. Many governments have taken steps to encourage FDI flows by setting up foreign investment promotion agencies, or even by offering tax and fiscal incentives to foreign firms that invest in the country. These benefits can be quite costly, in terms of tax revenues foregone. Therefore, it is important that the benefits of FDI are clearly identified in order to justify the costs of activities initiated to attract FDI.

In the standard neoclassical model for economic growth, increases in capital stock and labour force contribute to higher economic growth. Therefore, the flow of FDI, by increasing the domestic capital stock, will contribute to increasing the growth of the economy. More importantly, it has often been argued that FDI contributes to growth beyond the direct effect of increasing the capital stock. FDI is also seen to bring to the host country additional benefits, such as new technology, access to foreign markets and managerial know-how. Expectations of these extra benefits are part of the reason why governments in developing countries provide special incentives to attract FDI.

In this paper, the focus is on examining the link between FDI and productivity in eight

East Asian economies – China, Hong Kong Specially Administered Region of China (SAR), Indonesia, Malaysia, Republic of Korea, Singapore, Taiwan Province of China and Thailand. This group of economies has been selected because they received substantial amounts of FDI. Furthermore, they have been relatively successful--some more than others--and they are at different stages of development. This makes it possible to examine if economies at different stages of development respond differently to FDI.

Here, the Granger causality test (1969) and the Toda-Yamamoto (1995) version of the Granger causality test are used to examine the relationship between the inflows of FDI and various measures of productivity that have been compiled by UNIDO. Although it is often assumed that FDI inflows can help to increase productivity in developing countries, limited research has been undertaken to examine the direct link between FDI and productivity at the macro level. This paper attempts to fill that gap. The results from the sample of East Asian countries reveal that only in two countries there is evidence of a one-way causality between FDI inflows and total factor productivity (TFP) growth. Similarly, there is also little evidence that FDI inflows cause technical change or efficiency change in the sample countries.

## **Literature Review**

There is a large body of literature on the impact of FDI. In this literature review, the focus is on reviewing some of the studies on the impact of FDI on technology, economic growth and productivity. This review is not meant to be exhaustive, as large-scale literature surveys, such as JBIC (2002), already exist.

FDI is seen as an important channel for transmitting technology to many developing countries. Findlay (1978) suggests that FDI can increase the productivity of the host country as the more advanced management techniques and technologies of foreign firms spread to local firms. Multinational firms are usually at the technological frontier and have access to the latest and most advanced technologies. It is expected that as they invest in plants in developing countries they will, at the same time, transfer these high-level technologies. It is also hoped that the technology that is

embedded in plants of multinational firms will spread to other plants in the countries. However, based on data from developed countries, van Pottelsberghe de la Potterie and Lichtenberg (2001) show that FDI in the form of technology transfer is only possible if the country invests in foreign countries intensively engaged in research and development (R&D). Inward FDI from R&D-intensive countries does not seem to increase productivity. This suggests that foreign firms invest abroad in order to exploit their technological advantage rather than to diffuse their technology.

There has also been extensive evidence in the literature that documents the contribution of FDI to economic growth. De Gregorio (1992), by examining the experiences of 12 Latin American countries over the period 1950-1985, found that FDI boosted economic growth three times as much when compared with aggregate investment. Blomstrom et al. (1992) arrived at a similar conclusion using a larger sample of developing countries. They not only found that FDI has a strong impact on the economic growth of developing countries, but also that this effect is limited to higher-income developing countries. For lower-income developing countries, other factors, such as secondary education, were more important. Ram and Zhang (2002), using data from the 1990s from a large cross-section of countries, also found that FDI has a positive impact on economic growth.

Carkovic and Levine (2002), who used macro-level data, found little support for the importance of FDI in stimulating growth. They argue that previous studies, which show the benefits of FDI on economic growth, have not fully taken into account the endogeneity problem. Countries with a good economic performance tend to attract more FDI. Therefore, if the endogeneity problem is not taken into account, it is unclear whether FDI drives economic growth, or vice versa. Once the endogeneity problem is considered, it was concluded that growth drives FDI and not the other way around.

This result has been supported by other studies as well. Li and Liu (2005), using a large sample of developed and developing countries, find that since the mid-1980s the relationship between FDI and economic growth has become increasingly endogenous. Both Zhang (2002) and Zhang (1999) find evidence of a two-way Granger causality in the relationship between FDI and China's economic growth. Similarly, Choe

(2003) in a large sample of 80 countries finds evidence of a two-way causality between FDI and economic growth. In addition, he also states that the effects are more apparent from economic growth to FDI.

The evidence that only higher-income developing countries benefit from FDI suggests that there may be other factors that determine how much a country benefits from FDI. Later research attempts to identify these factors. For example, Borensztein et al. (1998) shows that the country needs a certain level of human capital in order for it to benefit fully from FDI. They performed cross-country regressions on a sample of 69 developing countries and found that FDI contributes more to growth than domestic investment. Furthermore, they also found that FDI is complementary with human capital, that is, human capital needs to be above a certain threshold for FDI to be more productive than domestic investment. It would seem that although FDI may bring with it advanced technology and techniques, the country must have sufficient absorptive capacity, in terms of qualified people, to benefit fully from it. Without a sufficient level of human capital, the country will not have the absorptive capacity to take full advantage of FDI. Therefore, FDI cannot be viewed as a perfect cure-all strategy.

This result has been confirmed by Xu (2000) who uses data from United States' multinational enterprises in the manufacturing sector to examine the diffusion of advanced technology. Although this study covers only 40 countries (20 developed and 20 developing), the advantage is that by using high-quality data, such as data on spending on royalties and license fees, it is possible to quantify the intensity of technology transfer of multinational affiliates. The study reveals strong evidence of the impact of technology transfer from affiliates of United States' multinational enterprises in developed countries, but rather weak evidence of the impact in developing countries. However, although there is still evidence of a positive impact of investment by affiliates of the United States in developing countries, it cannot be traced to technology transfer. The main reason for the lack of technology transfer in developing countries is the low level of human capital. The study argues that the human capital threshold must be even higher to benefit from technology transfer as opposed to just benefiting from FDI.

In another paper, Balasubramanyam et al. (1996) emphasise the importance of providing the right economic environment to ensure that FDI is beneficial to the economy. They find that countries with a neutral trade regime, where artificial incentives favour neither export-oriented nor domestic-oriented industries, fare better than countries where a specific industry is favoured. This is because in a neutral regime, firms' decisions are governed by market forces rather than by artificial incentives. Furthermore, a liberal regime also allows for competition between domestic and foreign firms and these in turn provide innovation and learning that contribute to economic growth.

This is further supported by Busse and Groizard (2006) who found that FDI does not have any impact on economic growth in a very highly regulated country. However, it seems that there can be a wide range of regulatory regimes under which FDI can still prove beneficial. This is encouraging as it suggests most countries, even those with a rather restrictive regulatory environment, can benefit from FDI.

However, the belief that FDI provides extra benefits to the economy is not universally shared. Nunnenkamp and Spatz (2003) found, using data of United States FDI stock abroad, that the link between FDI and economic growth is quite weak. On a slightly brighter note, they found that the link tends to be stronger in countries with more favourable characteristics, such as better institutions, more educated workforce and openness to trade. In general, however, they are quite sceptical about the benefits of FDI. They argue that it is easier to attract FDI than to derive benefits from it.

Micro-level studies, using firm-level data, generally have not been as positive. Aitken and Harrison (1999), using data for over 4,000 Venezuelan firms, found that there are very limited spillover effects from foreign firms to domestic firms. There are some benefits to small individual plants from FDI, but for large firms there is no evidence of such benefits, when differences in plant characteristics are taken into account. More disappointingly, they also found evidence of negative spillover effects from foreign to domestic enterprises, that is, productivity in domestic firms decreases as foreign investment increases. This is in contrast with most other studies that find positive spillovers. The reason is that these studies are often estimated at the industry level and do not take into account differences in productivity across industries.

Therefore, if foreign investors are attracted to more productive industries, these could lead to the (wrong) conclusion that foreign investment has positive spillover effects on the economy.

A similarly pessimistic result can be found in Sasidharan (2006) where FDI does not have significant vertical or horizontal spillover effects in a sample of some 2,700 manufacturing firms in India between 1994 and 2002. Although India witnessed large inflows of FDI during this period, it is rather disappointing to see that they appear to have benefited domestic firms very slightly.

Micro studies, for their part, do not universally reveal a negative impact of FDI and productivity growth. Using data from Czech enterprises over the period 1992-1996, Djankov and Hoekman (2000) found that FDI has contributed to increasing the productivity growth of firms. This positive effect continues even after the authors took into account that foreign investment tends to flow into companies that had higher productivity initially. However, it must be noted that the Czech Republic is not a typical case, since it has a strong industrial base and a highly educated workforce. It is, therefore, unclear if the experience there can be readily applicable to other developing countries.

Hale and Long (2006) provide a more positive view of spillover effects from FDI. They use the survey of 1,500 firms in China to examine if there are technological spillover effects from foreign firms to domestic firms in the same city and industry. Indeed positive spillover effects are found from foreign firms operating in China, even though they are unevenly spread. Domestic firms that have relatively higher productivity obtained positive spillover effects from foreign firms, whereas domestic firms with lower productivity derived negative effects.

The paper then proceeds to examine how the positive spillover effects from foreign firms are channelled to domestic firms. One such channel is the movement of high-skilled workers from foreign firms to domestic firms. Another finding is that domestic firms that have a more highly skilled workforce tend to have higher productivity in the presence of increased FDI. Positive spillover effects are also evidenced from technologically advanced firms working mainly through the movement of high-skilled

workers from foreign firms to domestic firms and through the network externalities effect. Hence, a well-functioning labour market is very important for ensuring that the benefits of FDI are fully realized. This could be one reason why most studies contain little evidence of positive spillover effects of FDI in developed and not developing countries, where labour institutions are not so well developed. However, while they do not assume that the spillover effects can be spread to firms outside the industry, this could be the case if the spillovers are in terms of managerial and organizations' ability. The main drawback of these micro-level studies is that they only take into account the effect of spillovers within the sector surveyed. Most of the surveys are carried out on manufacturing firms. Hence, if there are spillover effects from the manufacturing sector into the service sector, these effects will not be fully captured in these studies. Therefore, macro-level data has been used in this paper to examine the spillover effects, so that these effects from FDI can be captured to the fullest extent.

## **Data**

Data on FDI are obtained from the UNCTAD Foreign Direct Investment database on the Internet.<sup>1</sup> Several measures of FDI have been used in the literature. In this paper, the share of FDI in GDP is used as the measure of FDI, as it is believed to be the measure that best represents the impact of FDI on the economy as a whole.

Furthermore, estimates of TFP from the UNIDO productivity database will be used as indicators of productivity at the country level. Full details on the methods used to obtain the TFP estimates can be found in Isaksson (2006). The first step in estimating productivity is the assumption of the existence of an aggregate production function for each country. Without this assumption, it is not possible to measure TFP. Traditionally, TFP has been estimated by using the growth accounting method. However, for this paper, the TFP estimates have been taken from data envelopment analysis (DEA). The main advantage that DEA has over growth accounting is that it does not require too many assumptions. For example, DEA does not assume that countries are technically efficient or that they are perfectly competitive. On the

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<sup>1</sup> <http://www.unctad.org/Templates/Page.asp?intItemID=1923&lang=1>

downside, DEA is more sensitive to outliers and mis-measurement. Another advantage of DEA is that one is able to decompose the change in TFP into a change in technical efficiency and technological change. This has important implications as it can help to identify whether FDI contributes to higher productivity by inducing greater efficiency or through technology transfer, which increases technological change.

In adopting the DEA method for calculating productivity at the country level, the Färe et al. (1994) approach has been followed. Each country's output and inputs, at any given point of time, is treated as a production point in the sample. The production function has GDP as output, and labour and capital as inputs. Technically, DEA uses linear programming methods to construct a non-parametric piece-wise frontier. This frontier can be viewed as the world technology frontier. Movements of the world technology frontier can be viewed as technical change and movements towards the world technology as a change in technical efficiency. The Malmquist Index can then be used to measure TFP growth.

The data for each country's GDP, labour and capital used in the DEA are obtained from the Penn World Tables (6.1). The estimate for capital is obtained from investment data, and follows the assumption of Crego et al. (1998) that capital stock lasts for 20 years with a decay parameter of 0.70.

As already mentioned, the focus in this paper is on examining the link between FDI and productivity in eight East Asian economies—China, Hong Kong SAR, Indonesia, Malaysia, Republic of Korea, Singapore, Taiwan Province of China and Thailand. This group of economies has been selected because it received substantial amounts of FDI, and is considered to have been relatively successful--some more than others. Besides, since these economies are also at different stages of development, one is able to examine if they respond differently to FDI. Data for these economies cover the period 1970-2000, with the exception of China, for which data on FDI were not available prior to 1980.

**Table 1. Productivity and FDI in Selected East Asian Economies, 1970-2000  
(Annual average<sup>1</sup>)**

Country or area	TFP growth (percentage per annum)	FDI (US\$ million)	FDI per capita (US\$)	FDI share of GFCF** (percentage)	FDI share of GDP (percentage)
China	0.9	16,540	13	6.0	2.2
Hong Kong SAR	1.2	5,686	908	20.7	5.5
Indonesia	-1.3	799	5	4.8	1.0
Korea, Republic of	-0.1	1,199	27	2.1	0.6
Malaysia	-0.1	2,092	111	14.3	4.3
Singapore	1.4	3,975	1,173	26.5	9.5
Taiwan Province of China	0.9	803	38	2.4	0.6
Thailand	0.2	1,325	23	5.2	1.4

\* Except FDI indicators for China which are from 1980-2000.

\*\* Gross fixed capital formation.

Table 1 presents an overview of productivity and the various measures of FDI in the sample of East Asian economies. There are some, though not very significant, variations in the productivity performance. Singapore has the best productivity performance in the sample countries, followed closely by Hong Kong SAR. While Indonesia has the worst productivity performance, in terms of the level of FDI inflows, China is the biggest recipient. Inflows of FDI to China are almost three times that of the next largest recipient, Hong Kong SAR. However, relative to the size of the economy, FDI has had the biggest impact on the economy of Singapore, accounting for more than a quarter of its investment and almost 10 per cent of its GDP. For both Singapore and Hong Kong SAR, where FDI represents a substantial fraction of investment, productivity performance has been relatively good. However, although Malaysia also enjoyed substantial FDI inflows, its productivity performance has been rather mediocre.

## **Empirical Analysis**

As a first step, the correlation between FDI and productivity in the sample of eight East Asian economies is examined.

**Table 2. Correlation between FDI as a share of GDP with TFP growth, technical change and efficiency change, 1970-2000\***

Country or area	$\Delta$ TFP	T	
		Technical change	Efficiency change
China	-0.17	0.58	-0.56
Hong Kong SAR	0.09	0.27	-0.10
Indonesia	0.14	-0.47	0.47
Korea, Republic of	0.01	0.42	-0.29
Malaysia	0.11	0.26	-0.22
Singapore	0.37	0.15	0.21
Taiwan Province of China	0.12	0.26	-0.15
Thailand	-0.35	0.43	-0.55

\* Data for China are available only from 1980 to 2000.

Table 2 presents the correlation between FDI as a share of GDP and TFP, technical change and efficiency change for each country in the sample. The results do not change much if a different measure of FDI is applied. Overall, there seems to be little positive correlation between FDI and TFP, with probably one exception, Singapore. However, there is a stronger correlation between FDI and technical change. Finally, the relationship between FDI and efficiency change is weak and often negative. It is important to interpret these results carefully, as these are contemporaneous correlations and the effects of FDI may take several years before they manifest themselves. It is also important to note that correlation here does not imply causation.

To determine whether there is a causal relationship between FDI and productivity, Granger causality tests on FDI and productivity were performed. This test, introduced in Granger (1969), has been widely utilized to examine the direction of causality between two time-series variables. However, to proceed with the Granger causality test, the time series properties of the variables must be checked. In cases where the variables are not stationary, the usual asymptotic distribution of the test statistic may not be valid under the null hypothesis. Therefore, it is important to ensure that the variables are stationary before proceeding.

To check if the variables are stationary, the Phillips-Perron (1988) unit root test has been employed. The advantage of the Phillips-Perron test over the Dickey-Fuller unit root test is that the test statistics from the Phillips-Perron test have been adjusted to take into account the serial correlation by using the Newey-West (1997) covariance matrix. The null hypothesis of the Phillips-Perron unit root test is that the variable has

a unit root. The Phillips-Perron test statistics for each variable and economy in the sample are shown in table 3. Basically, the results show that for the various indicators of productivity–TFP growth, technical change and efficiency change–the null hypothesis of a unit root can be rejected. For most of the economies, FDI/GDP is not stationary in level, although in the first difference it is stationary. The exceptions here are Singapore and Taiwan Province of China where FDI/GDP is stationary in level. In order to maintain comparability with the other economies, the first difference of FDI/GDP is used as the indicator of FDI in the estimation that follows.

**Table 3. Phillips-Perron ( $Z_t$ ) test statistic for unit root**

Country or area	Ln(FDI/GDP)	$\Delta \ln(\text{FDI/GDP})$	$\Delta \text{TFP}$	Technical change	Efficiency change
China	-3.027	-3.993 *	-4.222*	-3.932*	-4.452*
Hong Kong SAR	-3.021	-7.162*	-4.100*	-6.946*	-4.104*
Indonesia	-1.524	-10.258*	-4.770*	-3.332*	-4.305*
Korea, Republic of	-3.472	-7.370*	-4.431*	-6.380*	-5.304*
Malaysia	-2.377	-4.682*	-2.876*	-5.860*	-6.585*
Singapore	-3.607*	-6.610*	-3.754*	-4.202*	-5.251*
Taiwan Province of China	-6.228*	-10.065*	-3.780*	-5.857*	-4.653*
Thailand	-2.786	-5.068*	-3.518*	-4.776*	-4.442*

\* Reject the null hypothesis that the variable has a unit root at the 5 per cent level.

Now that the stationary level of the variables has been checked, one can proceed by carrying out the Granger causality test. The concept of the Granger causality test is based on the idea that events of the past cannot be influenced by current or future events. Therefore, if event A occurred before event B, then event A can be seen as a “cause” of event B. What is done when carrying out the Granger causality test is to test whether variations in one variable occurs before variations in another variable. Variable X is said to Granger cause variable Y if the past sees that variable X can improve the forecast Y. It is also possible that the two variables X and Y, Granger cause each other. If this is the case, then bi-directional Granger causality is observed.

In order to test for Granger causality, a bivariate vector autoregression (VAR) model is estimated for each of the East Asian country in the sample. Formally, one can estimate the VAR for each country as:

$$\begin{bmatrix} FDI_t \\ PROD_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{i=1}^p \begin{bmatrix} \beta_{1i} & \varphi_{1i} \\ \beta_{2i} & \varphi_{2i} \end{bmatrix} \begin{bmatrix} FDI_{t-i} \\ PROD_{t-i} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}$$

where  $t$  is the time subscript,  $p$  is the number of lags for the VAR, FDI is the FDI share of GDP, and PROD represents the various measures of productivity growth.  $\beta_{1i}$ ,  $\beta_{2i}$ ,  $\varphi_{1i}$  and  $\varphi_{2i}$  are the coefficients from the VAR; and  $u_{1t}$  and  $u_{2t}$  are the uncorrelated residuals from the VAR.

In testing for Granger causality, what is done here is to check if past values of a variable are useful for forecasting the present value of another variable. To examine if FDI Granger causes productivity, it is necessary to see if  $\beta_{2i} = 0$  for all values of  $i = 1, 2, \dots, p$ . This can be implemented by means of a Wald test with the null hypothesis that the values of the estimated coefficients ( $\beta_{2i}$ ) are jointly zero. Hence, if the null hypothesis is rejected, then it can be said that FDI Granger causes productivity. Similarly, one can also check if productivity Granger causes FDI. It is quite possible that higher productivity in a country attracts more foreign investors. It is also possible to have the result of bi-directional Granger causality where FDI and productivity Granger causes one another. This would imply that there are feedback effects between FDI and productivity.

Before the VAR is estimated, it is necessary to decide on the lag length for each of VAR. The maximum lag length for the VAR is set at 5, and the Akaike Information Criterion is used to select the appropriate lag length. This is an important step before estimating the VAR as the choice of lag length could influence the results obtained from the Granger causality test. The results of the lag length selection process for the VARs with TFP growth, technical change and efficiency change as the dependent variables are shown in table 4.

**Table 4. Optimal lag length for the Granger Causality Test**

Country or area	TFP growth	Technical change	Efficiency change
China	3	1	3
Hong Kong SAR	1	1	3
Indonesia	1	2	3
Korea, Republic of	1	1	1
Malaysia	1	1	1
Singapore	3	1	3
Taiwan Province of China	2	2	2
Thailand	1	2	2

Once the lag length for each VAR was determined, tests were carried to see if FDI Granger causes TFP growth, and if TFP growth Granger causes FDI. The results are shown in table 5.<sup>2</sup> The 5 per cent level was selected as the threshold for the significance of the test results. From the table, one can see that for most of the East Asian economies FDI does not Granger cause TFP growth. Only Singapore and Taiwan Province of China show evidence of Granger causality from FDI to TFP growth. In China there is bi-directional Granger causality between FDI and TFP growth. This suggests that there are feedback effects between FDI and TFP growth in China. In the case of Malaysia, it was found that TFP growth Granger causes FDI. This suggests that higher productivity can be used to predict future flows of FDI.

**Table 5. Granger Causality Test for FDI and TFP growth**

Country or area	$\Delta$ FDI $\rightarrow$ TFP growth	TFP growth $\rightarrow$ $\Delta$ FDI
China	Yes	Yes
Hong Kong SAR	No	No
Indonesia	No	No
Korea, Republic of	No	No
Malaysia	No	Yes
Singapore	Yes	No
Taiwan Province of China	Yes	No
Thailand	No	No

In addition to examining the relationship between FDI and TFP growth, the relationship between FDI and one of the components of TFP growth—technical change—is also analysed. This component of TFP growth can be viewed as measuring the increase in technological capability of a country. Another way to see it is that technical change measures the shift of the technological frontier that a country faces. One of the oft-stated benefits of FDI is that it helps to transfer technology to developing economies. The Granger causality test for FDI and technical change is performed to examine if FDI leads to technical change. The results of the Granger causality test (table 6), show that only Indonesia reveals evidence of bidirectional Granger causality between FDI and technical change. None of the other economies in the sample exhibit any evidence of Granger causality between FDI and technical change. Therefore, there appears to be little evidence that FDI affects technological transfer.

<sup>2</sup> For ease of presentation, the test statistics are not presented. The threshold for the significance of the Granger causality test has been set at the 5 per cent level.

**Table 6. Granger Causality Test for FDI growth and technical change**

Country or area	$\Delta$ FDI $\rightarrow$ Technical change	Technical change $\rightarrow$ $\Delta$ FDI
China	No	No
Hong Kong SAR	No	No
Indonesia	Yes	Yes
Korea, Republic of	No	No
Malaysia	No	No
Singapore	No	No
Taiwan Province of China	No	No
Thailand	No	No

Next, the relationship between FDI and efficiency change is analysed. The concept of efficiency change can be thought of as improvements in the productivity of the economy from non-technological improvements in the economy, such as organizational or management change. It can also be viewed as a movement by a country towards the technological frontier. The results of the Granger causality test between FDI and efficiency change (table 7) shows no evidence that FDI Granger causes efficiency change. However, in many economies, there is evidence that efficiency change Granger causes FDI. In Singapore, there is evidence of bidirectional Granger causality between FDI and efficiency change. Hence, the experience of the East Asian economies does not seem to support the assumption that FDI brings about improved efficiency through the introduction of advanced management or organizational ideas. However, it would seem that countries that are more efficient are more likely to attract FDI.

**Table 7. Granger Causality Test for FDI and efficiency change**

Country or area	$\Delta$ FDI $\rightarrow$ Efficiency change	Efficiency change $\rightarrow$ $\Delta$ FDI
China	No	Yes
Hong Kong SAR	No	Yes
Indonesia	No	Yes
Korea, Republic of	No	No
Malaysia	No	Yes
Singapore	Yes	Yes
Taiwan Province of China	No	No
Thailand	No	No

One of the shortcomings of the Granger causality test procedure used so far is that one must ensure that the variables used in the test are stationary. As a result, the first difference of FDI inflows must be used as a share of GDP as the indicator of FDI. It is

possible that it is not the change in FDI in flows but rather the size of FDI inflows that affects productivity in the country. In order to test this possibility, the modified version of the Granger causality test, Toda and Yamamoto (1995) is used to examine the relationship between FDI and productivity. The main advantage of this test is that it allows for the variables in the VAR to be non-stationary or even cointegrated. It therefore allows one to test for causality between the levels of FDI inflows as a share of GDP with various measures of productivity even though the level of FDI inflows, as a share of GDP, is known to be non-stationary.

The first step in implementing the Toda-Yamamoto test is to determine the maximum order of integration of the variables to be tested. In this case, the results from the test for stationary level have determined that the maximum order of integration for the variables is one. Toda and Yamamoto (1995) have shown that the standard asymptotic theory holds for the results from the VAR, if extra lags of the variables equal in number to the maximum order of integration are added. Since the maximum order of integration has been determined as one, an extra lag is added to the VAR to be estimated. The next step is to determine the optimal lag length for the VAR. Following the same procedure, the optimal lag length for the VAR is determined by using the Akaike Information Criterion. The optimal lag length for the VAR for the various measures of productivity are shown in table 8 below.

**Table 8. Optimal lag length for the Toda-Yamamoto Test**

Country or area	TFP growth	Technical change	Efficiency change
China	5	5	5
Hong Kong SAR	2	5	3
Indonesia	1	5	5
Korea, Republic of	1	1	1
Malaysia	1	2	1
Singapore	3	1	1
Taiwan Province of China	4	1	1
Thailand	1	2	1

One can then proceed to estimate the VAR for each country for TFP growth and the level of FDI/GDP by using the optimal lag length plus one extra lag. Then the Wald test is used to test whether the lagged coefficients of FDI/GDP (excluding the extra lag) are jointly zero in the TFP growth equation. Again the 5 per cent level is used as the threshold for significance. If the null hypothesis that the lagged coefficients are

jointly zero is rejected, this means that the level of FDI/GDP Granger causes TFP growth. Similarly, tests have been carried out to see if the lagged TFP growth coefficients (excluding the extra one) are jointly zero. If the null hypothesis is rejected in this case, then this means that TFP growth Granger causes FDI/GDP. The results of the Toda-Yamamoto version of the Granger causality test are shown in table 9.

The results from the Toda Yamamoto test on the causality between FDI and TFP growth is broadly similar to that of the Granger causality test. One exception is that there is currently evidence that FDI causes TFP growth in the case of Hong Kong SAR. The other exception is that in Taiwan Province of China there is no longer a causality running from FDI to TFP growth, but instead from TFP growth to FDI. Overall, the results are not that different from before. Only in three of the eight sample countries is there any causality running from FDI towards TFP growth. Therefore, in the sample economies there is still no strong evidence that FDI inflows drive productivity growth.

**Table 9. Toda-Yamamoto Causality Test for FDI and TFP growth**

Country or area	FDI → TFP growth	TFP growth → FDI
China	Yes	Yes
Hong Kong SAR	Yes	No
Indonesia	No	No
Korea, Republic of	No	No
Malaysia	No	Yes
Singapore	Yes	No
Taiwan Province of China	No	Yes
Thailand	No	No

The results from the Toda-Yamamoto test on the relationship between the level of FDI inflows and technical change are shown in table 10. Quite a number of differences are obtained from these results compared with those from the Granger test. In particular, there is evidence of a two-way causality between the level of FDI inflows and technical change in China and Hong Kong SAR. In the Granger causality test, no evidence of causality was found in those two economies. In addition, the results also show that the level of FDI inflows causes technical change in Indonesia and Thailand. Therefore, the results from the Toda-Yamamoto test are more supportive of the idea that FDI inflows can contribute to technical change in the

economies. It should also be noted that, with the exception of Hong Kong, the results show that FDI causes technical change that are at a lower level of development in the sample. This suggests that FDI may be more effective in transferring technology when the economy benefits from FDI is less technologically developed. For a country that is more technologically developed, FDI may not be that important as a source of technology transfer.

**Table 10. Toda-Yamamoto Causality Test for FDI and technical change**

Country or area	FDI → Technical change	Technical change → FDI
China	Yes	Yes
Hong Kong SAR	Yes	Yes
Indonesia	Yes	No
Korea, Republic of	No	No
Malaysia	No	Yes
Singapore	No	No
Taiwan Province of China	No	No
Thailand	Yes	No

Finally, table 11 presents the results from the Toda-Yamamoto test on the relationship between FDI and efficiency change. Overall, the results are quite similar to that of the Granger causality test. Besides, none of the economies, for which the level of FDI inflows causes efficiency, changes. However, there are two economies—China and Indonesia—where there is bi-directional causality between FDI and efficiency change. Therefore, the results confirm the findings from the Granger causality test that there is no evidence that FDI helps to increase efficiency in the East Asian economies.

**Table 11. Toda Yamamoto Causality Test for FDI and efficiency change**

	FDI → Efficiency change	Efficiency change → FDI
China	Yes	Yes
Hong Kong SAR	No	No
Indonesia	Yes	Yes
Korea, Republic of	No	No
Malaysia	No	No
Singapore	No	No
Taiwan Province of China	No	No
Thailand	No	No

## **Concluding Remarks**

The Granger causality test and the Toda-Yamamoto version of the Granger causality test have been used to examine the relationship between FDI and productivity in an economy at the aggregate level. Previously, most research on the relationship between FDI and productivity is based on firm-level data. The drawback of using firm-level data is that it may not be possible to capture the spillover effects that occur outside the industry. By using productivity data for the whole economy, it is possible to capture the spillover effects of FDI on the whole economy. Using a sample of eight East Asian economies that received substantial FDI, evidence of one-way Granger causality from the change in FDI inflows to TFP growth was found only in two economies—Singapore and Taiwan Province. There is also little evidence from the Granger causality test that changes in FDI/GDP contribute to technical or efficiency change in the economies.

The Toda-Yamamoto test, which can be used to test the relationship between the levels of FDI inflows and the various indicators of productivity growths, also shows similar results as the Granger causality test. The main difference is that the Toda-Yamamoto test shows stronger evidence that the level of FDI inflows causes technical change.

In terms of the country results, China stands out as the country where there is strong evidence of a two-way causality between FDI inflows and the various measures of productivity growth. Meanwhile, for the Republic of Korea, FDI does not appear to have any impact on the various measures of productivity growth there.



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