# FDI, Exports, and Growth in East and Southeast Asia
# --Evidence from Time-Series and Panel Data Causality Analyses

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# FDI, Exports, and Growth in East and Southeast Asia --Evidence from Time-Series and Panel Data Causality Analyses

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**Abstract of the Paper:**

Using time-series and panel data from 1986 to 2004, this paper examines the Granger causality relations between GDP, exports, and FDI among China, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Philippines, and Thailand, the eight rapidly developing East and Southeast Asian economies. After reviewing the current literature and testing the properties of individual time-series data, we estimate the VAR and VECM of the three variables to find various Granger causal relations for each of the eight economies. We then construct the panel data of the three variables for the eight economies as a group and then use the fixed effects and random effects approaches to estimate the panel data VAR equations for Granger causality tests. The panel data causality results reveal that FDI has unidirectional effects on GDP directly and indirectly through exports, and there also exists bidirectional causality between exports and GDP for the group. Economic implications of our analysis are then explored in the conclusions.

## I. Introduction

In the neoclassical growth model, technological progress and labor growth are exogenous, inward foreign direct investment (FDI) merely increases the investment rate, leading to a transitional increase in per capita income growth but has no long-run growth effect. The new growth theory in the 1980s endogenizes technological progress and FDI has been considered to have permanent growth effect in the host country through technology transfer and spillover. As the world FDI inflows increased steadily and tremendously from US$ 200 billion in 1990 to almost US$ 1,400 billion in 2000 (UNCTAD, 2003, and various years; Hsiao and Hsiao, 2004), there is ongoing discussions on the impact of FDI on a host country economy, as can be seen from recent surveys of the literature (Fan, 2002; Lim, 2001; de Mello, 1997, 1999). Most of the studies find positive effects of FDI on transitional and long run economic growth through capital accumulation and technical or knowledge transfers, especially under open trade regime (e.g., Basu, Chakrabort, and Reagle, 2003).

However, some studies show that these positive effects may be insignificant or the effects may even be negative (Carkovic and Levine, 2005), possibly due to crowding out of domestic capital or development of enclave economies. Some even point out that the multinational corporations (MNC) tend to locate in more productive, fast growing countries or regions, thus FDI inflows could be attracted to the growing economies and markets. In short, the causality of FDI and economic growth can run bidirectionally, and may pose simultaneity problems to single-equation regression analysis.

In an open economy, technology and knowledge may also be transferred through trade, especially through exports and imports, and thus promote economic growth (Grossman and Helpman, 1997, Chapter 9; Frankel and Romer, 1999; Frankel, Romer, Cyrus, 1996). However, growth also has effects on trade (Rodriguez and Rodrik, 2000). In the development literature, this is known as the relation between trade regime/outward orientation and growth (Edwards, 1993). In empirical analysis, the policy of outward orientation is generally measured by exports (Greenaway and Morgan, 1998). As such, the topic of exports-growth nexus has been a subject of extensive debate since the 1960s, as can be seen from a recent comprehensive survey of more than 150 papers by Giles and Williams (2000). They found surprisingly that there is no obvious agreement to whether the causality dictates export-led-growth or growth-led-exports, although the early cross-section studies favor the former.[1]

The observations on the FDI-growth nexus and the exports-growth nexus lead us to examine the third side of a triangular relations: the FDI-exports nexus. Perhaps, because the FDI-exports relation affects economic growth indirectly, the FDI-exports nexus has received less attention in academic discussion, and a comprehensive survey of the topic does not seem to exist. Like the previous nexuses, the direction whether FDI causes exports or exports cause FDI is also a matter of dispute (Petri and Plummer, 1998). The Heckscher-Ohlin theorem in the trade theory indicates that FDI as a factor of production is a substitute, rather than a compliment, of commodity trade. However, the "new trade theory" predicts FDI and trade are complimentary between asymmetric countries and substitute between symmetric countries (Markusen and Venables, 1998). They also depend on whether FDI is market-seeking (substitutes) or efficiency-seeking (compliments) (Gray, 1998), "trade-oriented" or "anti-trade-oriented" (Kojima, 1973), or at the early product life-cycle stage (substitute) or at the mature stage (Vernon, 1966). Thus, the relation may be positive or negative, if there is one at all.

The above three kinds of nexus have been studied separately using methods of correlation, regression, or Granger's bivariate causality tests. Very few studies have taken all three variables together, nor have used panel data analysis. The purpose of this paper is to find the causality relations between FDI, exports, and economic growth (GDP) among the eight economies in Asia: four East Asian economies, China, Korea, Taiwan, and Hong Kong, and four Southeast Asian countries, Singapore, Malaysia, Philippines and Thailand. In addition to time-series analysis for individual economy, we propose to use panel data causality analysis, available only in recent years, for group causality test.

In what follows, in Section II, we presents briefly the analytical framework of the interdependence of the three variables in an economy using the mini-general equilibrium Keynesian-type demand oriented open economy model. This is the basis of the vector autoregression analysis in Sections VI and VII. In Section III, we explain and justify the choice of the eight economies by examining their historical performance of real GDP per capita from the global economic perspectives. The eight economies are known for their rapid growth

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[1] Using cointegration and causality tests, Wernerheim (2000) found bidirectional causality between exports and growth.

through the promotion of exports and encouragement of FDI inflows. We could expect some kinds of causality relations among these three variables in these economies. Section IV examines the statistical characteristics of the data in each economy and also among the eight economies. In Section V we review some recent empirical literature on the causality relations among the three variables in a country or a group of countries. In Section VI, we first assess the Granger causality relations of each economy using time-series data from 1986 to 2004. In Section VII, we construct the panel data from all eight economies and then apply the fixed effects model and the random effects model to estimate the panel data VAR and perform the Ganger Causality tests. The last section concludes by summarizing our findings and discusses the policy implications.

## II. Analytical Framework

While it is rather intuitively clear that FDI and exports may promote growth of GDP, and that exports and FDI are somehow related, when all three variables are combined, it is rather obscure how they are related in the context of an economic model. The general practice in the literature routinely takes the relations as given in an ad hoc manner,[2] or expands a production function linearly to make connections. However, here we show that the theoretical underpinning of the econometric method can be very simple. It is the national income model.

For simplicity, we assume equilibrium in the money sector and the government sector. Then the equilibrium condition of the Keynesian model of aggregate demand and aggregate supply is

$$Y = C(Y) + I(Y, r) + F + X - M(Y, e) \qquad (1)$$

where Y, C, I, F, X, M, r, and e are real GDP, real consumption, real domestic investment, real FDI inflows, real exports, real imports, interest rate, and exchange rate of foreign currency in term of the domestic currency, respectively. $X - M(Y, e)$ is the current account surplus in domestic currency of the domestic country.

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[2] A sophisticated ad hoc argument is that when testing the effects of "openness" on growth, both exports (or trade) and FDI should be considered for the true sense of "openness." Omitting one will commit the omission of variable error, rendering the causality relations ambiguous. See Ahmad, Alam, and Butt (2004), Cuadros, Orts, and Alguacil (2004).

Since we are interested in the real aspect of the economy, ignoring the financial variables, and writing in more general implicit function form,[3] we have

$$F(Y, X, F) = 0 \qquad (2)$$

Thus, we are interested in examining the causality relations among the real variables Y, X, and F. If certain regularity conditions are satisfied, the non-linear functions C(Y), I(Y, r), and M(Y, e), or more directly, equation (2), can be expanded logarithmically around the origin by the Taylor expansion. Taking the linear part of the variables, regressing each of three variables on the other two variables, and taking the lags of each variable for the purpose of econometric analysis, we have the prototype of vector autoregression (VAR) form for the Granger causality tests. Equation (3) shows the final form of the VAR model, which may be written either in level form or difference form.

## III. East and Southeast Asia in the World Economy

Instead of lumping countries with different backgrounds and stages of development in cross-section analysis, this paper deals only with eight Asian economies. To show the unique development position of the eight economies in the world economy, Figure 1 presents real GDP per capita of the eight economies and other world geographic regions[4] compiled by Maddison (2003). The lines are rather cluttered and hard to distinguish. However, our purpose here is only to show how rapidly the real GDP per capita levels of the eight Asian countries have grown and stand out in the world economy. Japan and the USA are included in the figure for comparison.

<Place Figure 1 here>

Indeed the diagram shows vividly that the growth of the so called Asian Newly Industrializing Economies (NIEs), Taiwan, Korea, Singapore, and Hong Kong, are conspicuous, especially compared with other Asian countries, or the average of eight Latin American countries (8LA), or seven East European countries (7EEC), or the world average (Wld). While the two

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[3] Our theoretical underpinning points out that interest rates and exchange rates are not controlled in the VAR model, and thus points to a shortcoming of this VAR analysis in the literature as a whole. Note that, to be consistent in this formulation, there is no room for product terms and other physical variables.

[4] All the data are taken directly from Maddison (2003), measured in internationally comparable 1990 Geary-Khamis dollars (also see Hsiao and Hsiao, 2003a). 8LA consist of Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, and Venezuela; 7EEU are Albania, Bulgaria, Czechoslovakia, Hungary, Poland, Romania, Yugoslavia; and 12WEU are Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and U. K.,

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small city-state economies, Singapore and Hong Kong, had already caught up with the average of 12 Western European countries (12WEC), Taiwan and Korea are growing closely to each other and are also poised to catch up with the average real GDP per capita levels of Western European countries (also see Hsiao and Hsiao, 2004).

It is interesting to see that in 1950, the levels of real GDP per capita of Japan, Singapore, Hong Kong, were almost the same as that of the world. However, after 50 years of development, they exceeded the average of 12 Western European countries between late 1980s and early 1990s. Taiwan and Korea started well below the world average, grew side by side (Hsiao and Hsiao, 2003a), and accelerated considerably in the 1980s. Malaysia, Thailand, Philippines, and China also grew after mid-1980s. However, Malaysia and Thailand are only slightly above the world average, China and Philippines are still well below the world average.

In 1950 the average real GDP per capita of the eight Asian economies (8ESA) was only about 60% of the world average or only 50% of the average of the eight-Latin American economies, but they surpassed the world average by 1978, and the Latin American average by 1983. In 1984, it surpassed the average of seven East European countries (7EEC) and it has been growing continuously. By the end of the 1990s, it is poised to catch up with the average of the 12 West European Countries (12WEC). Figure 1 shows clearly that the eight East and Southeast Asian economies as a whole really took off relative to other world regions after the mid-1980s. Clearly, the period of the mid-1980s is the bifurcation point the eight Asian economies forked out from the other regions, like an open scissors, and have become the most dynamic region in the world. In view of their success, it is of a great interest to find the sources of the rapid growth of these eight economies. By examining their dynamic phase, instead of prolonged period, we wish to reduce the possible heterogeneity problems among the countries in the process of estimation: this heterogeneity problem has been pointed out by Nair-Reichert and weinhold (2000). Thus, we have chosen the data from 1986 to 2004 for our study.

Furthermore, during the dynamic development phase of these eight economies, they alone were largest recipients of inward FDI among the developing countries, about 50% of the inward FDI which went to the developing countries in the world (Hsiao and Hsiao, 2004). Their intra-regional exports and inter-regional exports to other regions also grew considerably (Hsiao and Hsiao, 2003b). Thus, it is also of great interest theoretically and empirically to examine the causality relations of FDI, exports and GDP in the development process of these eight economies during the period from 1986 to 2004.

## IV. Characteristics of the Country Data

Since Maddison's data consist of only GDP per capita, for our purposes, we use the data from ICSEAD (2006), as explained in the Appendix on the data sources. The four charts in Figures 2 and four charts in Figure 3 are the time series of real GDP (rGDP), real merchandize exports (rEX), and real inward foreign direct investment (rFDI) for each of the eight economies from 1986 to 2004 (see the explanation of construction of real variables in the Appendix). All three variables are drawn in US$ billion, so the magnitude of each variable within each economy is comparable over time. The vertical axes of Taiwan and Hong Kong, and those of Singapore, Malaysia, Philippines, and Thailand, are the same, and so the heights of the curves among the same scale of axis are also comparable across the countries. Note that the vertical axis shows that China and Korea have much larger economies than the other six economies.

<Place Figures 2 and 3 here>

Except Philippines, the real GDP levels of all other economies increase overtime, and except China, all other economies were affected by the Asian financial crisis of 1997, and the real GDP levels have become more fluctuating after 1997, although less so in Taiwan and Hong Kong. Exports play an important role in these economies. The real exports have exceeded real GDP in Hong Kong and Singapore, almost the same in Malaysia. In other countries, the amount of exports ranges from about 30% of the GDP level in China and Korea to about 50% in Taiwan, Philippines, and Thailand, indicating the possible impact of export activities on real GDP, or vise versa, in all these economies. The Asian financial crisis of 1997 also had impact on the export activities, and exports became more volatile afterward. However, the exports of all economies, except those of Philippines and Thailand, kept increasing and even surpassed those of the pre-1997 levels. In general, the comparison of the trend of rGDP and rEX lines shows that real GDP and real exports are strongly correlated.

Compared with export activities, real FDI in each economy has much lesser weight, almost negligible, in terms of its amount, except in China and Hong Kong, and possibly in Singapore. Thus, one may doubt the degree of impact of technological spillover effects of FDI in an economy. Furthermore, except China and, to a lesser degree, Hong Kong, real FDI tends to decrease after the Asian financial crisis, prompting one to wonder whether inward FDI in these other countries were redirected to China, and thus reducing the influence of FDI on GDP. It should be pointed out, however, that, while the size of FDI may be very small compared with the level of GDP and even exports, it has been observed that FDI generally goes to the key industries like electric and electronic and high-tech manufacturing sectors of these economies, and plays a crucial role in promoting exports and technology transfer in these sectors. Thus, FDI may have a strong influence on the growth of GDP in a country.

We have seen that Asian financial crisis of 1997 exert influence on the time-series of rGDP, rFDI, and rEX. They had decreased significantly in 1998, although most of these economies recovered very quickly. After 1997 financial crisis, these economies have gone through economic reforms and structural changes. To take into account of the effects of Asian financial crisis, we introduce a dummy variable with the value equals to zero for 1986 to 1997 and the value equals to one for 1998 to 2004 in Granger causality test equations in Sections VI and VII below.

## V. A Review of Recent Empirical Literature

In the current literature, most of the published works examine bivariate relations either theoretically or empirically between GDP and exports, GDP and FDI, or exports and FDI, as we have reviewed in the introductory section. Relatively few published works deal with the causality relations among these three variables, and even fewer papers use panel data causality analysis.

There are several papers on individual country study examining Granger causality of these three variables. Liu, Burridge, and Sinclair (2002) found bidirectional causality[5] between each pair of real GDP, real exports, and real FDI for China using seasonally adjusted quarterly data from 1981:1 to 1997:4; Kohpaiboon (2003) found that, under export promotion (EP) regime, there is a unidirectional causality from FDI to GDP for Thailand using annual data[6] from 1970 to

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[5] In their paper China's quarterly inward FDI and exports were deflated by the GDP deflator (1990=1), monthly GDP was approximated by monthly gross industrial output, and quarterly EXs are taken from IMF.

[6] There is no indication that the data were deflated.

1999; Alici and Ucal (2003) found only unidirectional causality from exports to output[7] for Turkey using seasonally unadjusted quarterly data from 1987.1 to 2002.4; Dritsaki, Dritsaki and Adamopoulos (2004) found a bidirectional causality between real GDP and real exports, unidirectional causalities from[8] FDI to real exports, and FDI to real GDP, for Greece using annual IMF data from 1960 to 2002; in addition, Ahmad, Alam, and Butt (2004) found unidirectional causalities from exports to GDP and FDI to GDP for Pakistan using undeflated annual data from 1972 to 2001.

For studies of a group of countries, Nair-Reichert and Weinhold (2000) found that the Holtz-Eakin causality tests show FDI, not exports, causes GDP using data[9] from 24 developing countries from 1971 to 1995 applying mixed fixed and random (MFR) model; Makki and Somwaru (2004) found a positive impact of exports and FDI on GDP using World Development Indicators database of 66 developing countries averaged over ten year periods, 1971-1980, 1981-1990, and 1991-2000 and the instrumental variable method; Cuadros, Orts, and Alguacil (2004) found unidirectional causalities from real FDI and real exports to real GDP in Mexico and Argentina, and unidirectional causality from real GDP to real exports in Brazil using seasonally adjusted quarterly data from Mexico, Brazil, and Argentina from late 1970s to 2000; in addition, Cho (2005) find only a strong unidirectional causality from FDI to exports, using annual data from nine economies (the same economies as ours plus Indonesia) from 1970 to 2001. In Cho's model, GDP is taken as the Malmquist productivity index.

Note that, as Basu, Chakrabort, and Reagle (2003) have pointed out, the first two papers, Nair-Reichert and Weinhold (2000) and Makki and Somwaru (2004), and like some other papers not reviewed here, only look at the one-way determinants of FDI rather than at the two-way causality linkages between GDP, exports, and FDI, and so they are not strictly comparable with our causality analysis.

In general, our survey of recent empirical literature shows that the causality relations vary with the period studied, the econometric methods used, treatment of variables (nominal or real), one-way or two-way linkages, and the presence of other related variables or inclusion of interaction variables in the estimation equation. The results may be bidirectional, unidirectional,

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[7] They use Turkish industrial production index as GDP, export price index as EX, along with real FDI.
[8] There is no indication that FDI data were deflated in their paper.
[9] The paper does not specify the sources of data, whether the data were deflated, and does not check stationarity.

or no causality relations. Thus, it is very important that the assumptions, the treatment of variables, the sample period, estimation models and methods should be clearly indicated in the analysis. In any case, the above brief survey also seems to indicate that there may be some causality relations among exports, FDI, and GDP. Our study follows.

## VI. Individual Economy's Granger Causality Tests

The econometric technique requires transforming the values of all real variables into logarithmic values. The transformed variables are denoted by lower case letters, gdp, ex, and fdi. Thus, fluctuations of the variables are considerably mitigated. The econometric technique also calls for taking the first-difference between consecutive logarithmic values, which are continuous growth rates of the variables, and are denoted by dgdp, dex, and dfdi in this paper.

In this section, we will explain the procedures to examine Granger causality relations between exports, FDI, and GDP for each economy using its time-series data. Before analyzing the causality relations, we first employ the unit root test to check the stationarity of each series, and if needed, the cointegration test among the three series will be employed. Based on the characteristics of the time-series data for each economy, we then select an appropriate model from the vector autoregressions (VAR) and vector error correction model (VECM) for Granger causality test.

### A. Unit Root and Cointegration Tests

We use the Augmented Dickey-Fuller (ADF) unit root test to examine the stationarity of each time series. In Table 1, we first presents the ADF unit root test results for the level series, that is, ex, fdi, and gdp, respectively. For Korea, Hong Kong, Singapore, Malaysia, Philippines, and Thailand, the test results show that we cannot reject the null hypothesis that the series has a unit root at the 5% level of significance, that is, all the level series are non-stationary. For China and Taiwan, we have the mixed results. China's fdi and gdp are non-stationary series, but ex is a stationary series. Taiwan's gdp is a non-stationary series, but ex and fdi are stationary series. Therefore, we need to continue to apply the ADF unit root test on the first-difference series (i.e., the growth rate series), dex, dfdi, and dgdp for each economy. The test results are also presented in Table 1. We find that all the first-difference series are stationary at the 10% (or less) level of significance, except that China's dex and Korea's dfdi are significant at the 15% level and Singapore's dex and dgdp are significant at the weak 20% level.

<Place Table 1 here>

Furthermore, since all the level series, ex, fdi, and gdp, are non-stationary for Korea, Hong Kong, Singapore, Malaysia, Philippines, and Thailand, we have also applied Johansen cointegration test to the level series for these six economies. Table 2 summaries Johansen cointegration test results. Both the trace test and the maximum-eigenvalue test indicate that the level series are cointegrated for Korea, Singapore, Malaysia, and Thailand, but not cointegrated for Philippines. The test results are mixed for Hong Kong, so we consider it as not cointegrated.

<Place Table 2 here>

Based on the above results from the unit root and cointegration tests and for the purpose of comparison among economies, we have chosen to use the first-difference series, dex, dfdi, and dgdp in the estimation. Table 3 presents the descriptive statistics (mean, maximum, and minimum values) of the first-difference series for each economy and the eight economies' panel data set, respectively.

<Place Table 3 here>

**B. The VAR and VECM Granger Causality Tests**

Since each economy's time-series data set has different characteristics, we explain the selection of using VAR or VECM estimation for each economy. For China and Taiwan, their level series are some stationary and some non-stationary, hence, we can bypass the cointegration test and use the stationary first-difference series in VAR model for causality tests. For Hong Kong and Philippines, their level series are all non-stationary, but they are not cointegrated, so we can also use the stationary first-difference series in VAR model for causality tests.

For Korea, Singapore, Malaysia, and Thailand, their level series are all non-stationary and they are cointegrated. We use Johansen cointegrating equation to generate the error correction series for each economy and then apply the ADF unit root test to check its stationarity. For Korea, we have positive error correction series, but it is non-stationary, so we cannot include its lag series into the stationary first-difference series in VECM. Hence, the VAR model is appropriate to use in Korea's causality tests.

For Malaysia, it has negative error correction series and it is stationary. When we included the lag one-period of error correction series into the stationary first-difference series in VECM, the estimated results show negative or positive insignificant coefficients for the error correction terms. This contradicts with the cointegration and convergence of the level series. Therefore, the lagged error correction series has been dropped and the VAR model is used for Malaysia's causality tests.

For Singapore, it has negative error correction series and it is stationary. When we included the one-period lag of error correction series into the stationary first-difference series in VECM, the estimated results show positive and significant coefficient for the lag error correction term in all three equations. This shows, for Singapore, the VECM is the appropriate model for causality tests.

Lastly, for Thailand, it has positive error correction series and it is stationary. When we included the one-period lag of error correction series into the stationary first-difference series in VECM, the estimated results show negative coefficient for the lag error correction term in all three equations. Hence, for Thailand, the VECM is also the appropriate model for causality tests.

We have multivariables, dex, dfdi, and dgdp, in the VAR(p) model to take into account the interactions among their p-lagged variables in testing the Granger causality relations. The VAR(p) model involves the estimation of the following equation system (Greene, 2003, Hsiao & Hsiao, 2001) :

$$y_t = \mu + \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + ... + \Gamma_p y_{t-p} + \varepsilon_t \ , \qquad (3)$$

where $y_t$ is a (3 x 1) vector of the endogenous variables, i.e., $y_t = (dex_t \ dfdi_t \ dgdp_t)'$, μ is a (3 x 1) constant vector, p is the order of lags, each of $\Gamma_1, \Gamma_2, \ldots, \Gamma_p$ is a (3 x 3) coefficient matrix, each of $y_{t-1}, y_{t-2}, \ldots, y_{t-p}$ is a (3 x 1) vector of the lagged endogenous variables, and $\varepsilon_t$ is a (3 x 1) vector of the random error terms in the equation system. In this study, we have eight economies, when we perform the panel VAR causality tests in Section VII, we will be able to estimate up to VAR(2) model, i.e., p = 1 or 2, and we have chosen p = 2. For comparisons, we also use VAR(2) or VECM(2) in the study of individual economy.

In the estimation process of VAR(2) model, first we estimate the equation with the dummy variable, as defined in Section IV above, to take into account the effect of 1997 Asian financial crisis. If the estimated coefficient for the dummy variable is significant at the 10% level, then we use the estimated results to perform the Wald test of coefficients to determine the causality direction. If the estimated coefficient for the dummy variable is not significant, then we delete the dummy variable and re-estimate the equation for the Wald test of coefficients to determine the causality direction. In VECM(2), we include the lag error correction series, but not the dummy variable.

Table 4 presents the estimated VAR(2) models and the results of Granger causality tests for the four East Asian economies, China, Korea, Taiwan, and Hong Kong, respectively. Note, our results here are from the VAR(2) model of dex, dfdi, and dgdp, without including the dummy variable, because it is not significant in any equations in our initial estimations. This may indicate that the four East Asian economies have recovered from the financial crisis in a short time period. The Granger causality relations are examined using the Wald test of coefficients (F-test) and each null hypothesis is stated in the footnote of the table.

<Place Table 4 here>

For China, we have found bidirectional causality between GDP and FDI and a unidirectional causality from exports to GDP. These results indicate that, during the past two decades, China's export-led-growth policy has promoted the rapid GDP growth, and the GDP growth has attracted a large amount of FDI inflows to China, especially from Hong Kong and Taiwan which consist of 40 to 60% of China's inward FDI, taking the advantages of China's low wages and the expanding vast domestic markets (Hsiao & Hsiao, 2004), and in turn this large FDI inflows have also induced the strong growth of GDP. This is consistent with the recent observations of the Chinese economy.

For Taiwan, we have found two unidirectional causalities: FDI causes exports and FDI also causes GDP. These results indicate that the FDI inflows to Taiwan are crucial to Taiwan's GDP growth and exports growth. For Korea, to our surprise, we have not found any causality relation among exports, FDI, and GDP using VAR(2) model and Wald test at the 15% level of significance. For our curiosity, we have estimated VAR(1) and found a unidirectional causality from GDP to FDI at the 15% level of significance. We have also estimated the VAR(3), as in the VAR(2), no causality has been found at the 15% level of significance. Considering the similar development stage, the development policies, and open economy regimes, and industrial productivities between Korea and Taiwan (Hsiao and Hsiao, 2003a; Hsiao and Park, 2002, 2004), this difference is quite surprising. For Hong Kong, we have found bidirectional causality between GDP and exports. This agrees with the fact that Hong Kong is a seaport and city-state (before 1997), the exports are vital to its GDP growth.

Table 5 presents the estimated VAR(2) and VECM(2) and the results of Granger causality tests for the four Southeast Asian economies, Singapore, Malaysia, Philippines, and Thailand, respectively. As we have discussed in the cointegration test above, the VECM(2) is used in Singapore and Thailand, and the VAR(2) model is used in Malaysia and Philippines. Note that, in Malaysia's dfdi equation, the dummy variable has negative coefficient and is significant at the 5% level.

<Place Table 5 here>

For Singapore, we have found bidirectional causality between exports and FDI and a unidirectional causality from GDP to FDI. These relationships have formed the chain effects that, during the past two decades, the rapid GDP growth in Singapore has attracted FDI inflows, and the FDI inflows have promoted the exports growth, and the exports growth has also induced more FDI inflows to Singapore. For Thailand, we have found bidirectional causality between GDP and exports and a unidirectional causality from GDP to FDI. Like other Asian countries, Thailand is also an export-led-growth economy, and its GDP growth also induces more FDI inflows to Thailand. Like Korea, we have not found any significant causality relations among exports, FDI, and GDP in Malaysia and Philippines at the 15% level of significance.

Our causality findings of the eight economies in Tables 4 and 5 are summarized in Figures 4. We have not found any significant causality relations among exports, FDI, and GDP for Korea, Malaysia, and Philippines. This may be due to the shortcomings of using a country's time-series data set with limited number of observations over time.[10] Therefore, we now pool the data of the eight economies into a panel data set to investigate the causality relations.

<Place Figure 4 here>

## VII. Panel Data Granger Causality Tests

Panel data analysis has the merit of using information concerning cross-section and time-series analyses. It can also take heterogeneity of each cross-sectional units explicitly into account by allowing for individual-specific effects (Davidson and MacKinnon, 2004), and give

[10] In an earlier paper, Hsiao (1987) also found in general the "lack of support for the hypothesis of unidirectional causality from exports to GDP" for the Asian NICs from 1960 to 1982 using the Granger's test and Sims' test.

"more variability, less collinearity among variables, more degrees of freedom, and more efficiency" (Baltagi, 2001). Furthermore, the repeated cross-section of observations over time is better suited to study the dynamic of changes like exports, FDI inflows, and GDP.

The eight East and Southeast Asian economies have more of less similarity in culture and geographical proximity, their rapid economic growth during the past two decades, their openness through trade and inward foreign direct investment, especially with the United States and Japan by forming the core of the Pacific trade triangle (Hsiao and Hsiao, 2001; 2003b). Considering the growing interdependence of these eight East and Southeast Asian economies, we propose to pool their eight cross-sectional data over 19 time periods (1986 to 2004) into a panel data set and then use panel data regressions to examine the causality relations for the group. We then compare the group causality relations with the results from individual economy's study above.

### A. Panel Data Unit Root Tests

We first test the stationarity of the three panel level series, ex, fdi, and gdp (for simplicity, we use the same notations as used in the study of individual economies). Recent econometric literatures have proposed several methods for testing the presence of a unit root under panel data setting. Since different panel data unit root tests may yield different testing results, we have chosen Im, Pesaran and Shin (2003) W-test (IPS) and ADF-Fisher Chi-square test (ADF-Fisher) by Maddala and Wu (1999) to perform panel data unit root tests and compare the test results (Christopoulos & Tsionas, 2003). Table 6 presents the test results of the three panel level series and their first-difference series. Both IPS and ADF-Fisher tests indicate that the panel level series exports (ex) is a stationary series, gdp is not a stationary series, and fdi has the mixed results. In addition, both tests indicate that the three panel first-difference series dex, dfdi, and dgdp are all stationary series. Therefore, we have chosen to use the three panel first-difference series in the panel data VAR causality analysis.

<Place Table 6 here>

### B. Panel Data VAR and Granger Causality Tests

When we estimate panel data regression models, we need to consider the assumptions about the intercept, the slope coefficients, and the error term. In practice, the estimation procedure is either the fixed effects model or the random effects model (Greene, 2003). With our eight cross-sectional units, we can estimate VAR(p) with lag order p = 1 or 2 in the random effects model. Therefore, we use panel data VAR with lag order 2 in our causality analysis. In below, we explain briefly the estimation of VAR(2) in the context of the fixed effects model as well as the random effects model.

### a. The Fixed Effects Approach

The fixed effects model (FEM) assumes that the slope coefficients are constant for all cross-section units, and the intercept varies over individual cross-section units but does not vary over time. For our application, the FEM can be written as follows:

$$y_{it} = \alpha_i + x_{it}\beta + u_{it} \tag{4}$$

where $y_{it}$ can be one of our three endogenous variables, i is the *i*th cross-section unit and t is the time of observation. The intercept, $\alpha_i$ , takes into account of the heterogeneity influence from unobserved variables which may differ across the cross-section units. The $x_{it}$ is a row vector of all lag endogenous variables. The $\beta$ is a column vector of the common slope coefficients for the group of eight economies. The error term $u_{it}$ follows the classical assumptions that $u_{it} \sim N(0, \sigma_u^2)$. In addition, we add an ordinary dummy variable, zero for 1986 to 1997 and one for 1998 to 2004, into the model to take into account the effect of the 1997 Asian financial crisis. The FEM is estimated by the method of the least squares dummy variable (LSDV).

### b. The Random Effects Approach and the Hausman Test

The random effects model (REM) also assumes that the slope coefficients are constant for all cross-section units, but the intercept is a random variable, that is, $\alpha_i = \alpha + \varepsilon_i$ , where $\alpha$ is the mean value for the intercept of all cross-section units, and $\varepsilon_i$ is a random error term which reflects the individual differences in the intercept value of each cross-section unit, and $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$. We can modify equation (4) to obtain REM in equation (5) as follows:

$$\begin{aligned} y_{it} &= \alpha + x_{it}\beta + \varepsilon_i + u_{it} \\ &= \alpha + x_{it}\beta + v_{it} \end{aligned} \tag{5}$$

where $v_{it} = \varepsilon_i + u_{it}$. It has been shown that $v_{it}$ and $v_{is}$ (for $t \neq s$) are correlated, so the REM is estimated by the method of generalized least squares.

We have used both FEM and REM to estimate panel data VAR(2) of dex, dfdi, and dgdp for eight economies as a group. We also apply the Hausman test to help in choosing between FEM and REM estimations before implementing the Wald test of coefficients to determine the Granger causality directions. The null hypothesis in the Hausman test is that the correlated REM is appropriate (i.e., the FEM and REM estimators do not differ substantially). It is a Chi-square distribution test. If the null hypothesis is rejected, then we use FEM. Our Hausman test results indicate that we should use the FEM to estimate the first equation $dex_{it}$ and the third equation $dgdp_{it}$ and use the REM to estimate the second equation $dfdi_{it}$ .

**c. Granger Causality Tests**

Table 7 and Figure 5 present the estimated panel data VAR(2) with the dummy variable by FEM and REM, and the Wald test of coefficients for Granger causality directions (for simplicity, subscripts i and t are omitted in Table 7). Note that the cross-section specific constant terms are not presented in the table. In addition, the coefficients of dummy variable are all negative and significant at the 10% level. This agreed with the fact that the 1997 Asian financial crisis did have some negative and significant effects on these eight Asian economies as a group, although we have not found the significant effect on individual economy as in Section VI.

<Place Table 7 here>

<Place Figure 5 here>

We have found four very interesting causality relations for the eight economies as a group. They are summarized below.

1. From the first equation, $dex_{it}$, we have found two unidirectional causalities: GDP causes exports and inward FDI also causes exports. These two causality relations indicate that the growth in domestic products and the large amount of inward FDI are the two vital forces in promoting exports for these eight Asian economies as a group.

2. From the third equation, $dgdp_{it}$, we have also found two unidirectional causalities: exports cause GDP and FDI also causes GDP. These two causality relations indicate that exports and FDI inflows join together to bring up the growth in GDP. These findings support the export-led growth and FDI-led growth in these eight Asian economies as a group.

3. From the first and the third equations together, we have found the bidirectional causality between GDP and exports. In addition, we have found FDI causes exports and GDP. This

finding verifies that inward FDI is crucial and significantly benefits the growth of GDP through increased exports, for example, by opening the export-oriented industrial processing zones for FDI in these eight Asian economies.

4. From the second equation, $dfdi_{it}$, we have not found any significant causality relations at the 15% level. Apparently, the growth of GDP and exports are not the only factors to attract FDI inflows to these eight Asian economies. Other factors, such as the abundant quality labor supply, human capital, low wages, tax holidays, etc. may have to take into considerations.

We have found the evidence that, in general, inward FDI has reinforcing effects on GDP: FDI not only has direct impact on GDP, it also indirectly increase GDP though exports by interactive relations between exports and GDP. Our result not only supports the "Bhagwati Hypothesis" (Kohpaiboon, 2003) that "the gain from FDI are likely far more under an export promotion (EP) regime than an import substitution (IS) regime," it also provides the possible theoretical underpinning of the hypothesis: It is because of FDI's reinforcing effects on GDP through exports.

Due to the reinforcing effects of inward FDI, the policy priority of a developing country appears to be to open the economy for inward FDI under the export promotion regime, and then the interaction between exports and GDP will induce economic development.

## VIII. Conclusions

The uniqueness of this paper appears in several areas. (a) Instead of the supply-side approach or ad hoc relations used in the general literature, we present a Keynesian demand-side model of open economies to explain the interaction between inward FDI, exports, and GDP, and present a model which is the basis of using vector autoregression procedure. (b) For empirical study, we use a panel data causality analysis of inward FDI, exports, and GDP. There are only few articles dealing with causality of FDI and growth, and our analysis is different from other conventional time-series analysis or cross-section analysis. (c) There are many theoretical and empirical studies on the bivariate causality between trade (exports and imports) and growth, openness (as measured by the ratio of exports and imports over GDP) and growth, as well as between trade and FDI, whether FDI is complementary or substitute. However, as these three variables are closely related, instead of studying two variables separately at a time, it is worthwhile to examine multivariate causalities among these three variables. (d) In terms of the data, our analyses are concentrated on the newly developed East Asian economies, Korea, Taiwan, Singapore, Hong Kong and rapidly developing economies in Asia, China, Malaysia, Philippines, and Thailand. We have chosen the period between mie-1980s to 2004, the most dynamic phase of their development, as compared with other regions of the world, with active trade and inward foreign direct investment. Our selection of these eight economies and the period, in addition to panel data analysis, are different from the existing literature, as most of the current publications do the cross-section analysis of either developed countries and/or developing countries, without due consideration of heterogeneous economic characteristics and different stages of development.

The most important implication of the econometric results of this paper for the current literature is our finding of the reinforcing effects of inward FDI, and our policy recommendation of using inward FDI, more than exports, as the main engine of growth. Another important finding is that, so far as the causality relations between exports, FDI, and GDP are concerned, our illustration in Figure 4 shows that the time-series analysis of causality among these three variables for individual country alone may not yield useful information for a general rule. Since even the widely recognized fast growing export-oriented countries like Taiwan, Korea and China with relative large amount of FDI inflows cannot show strong causality between the three variables. This is the same as we have found in the literature survey. Only when we pooled the data for the eight economies together, we found in Figure 5 very interesting and meaningful causality relations among these variables and the results are consistent with our intuitive observations, with added advantage of being able to ascertain different degrees of importance on the relationship.

Comparing the individual country results and the panel data results, our causality analysis seem to indicate that, in this interdependence world, an individual country performance may not reveal the true effects of the open economic policy on economic growth. Only when the data of similarly developing countries are pooled together and the interaction among countries and heterogeneity are considered in a panel data setting, we can find the general pattern of causality relations among exports, FDI, and GDP. In conclusion, it appears that the panel data analysis is the direction of the future: it enhances the results of the traditional time-series or cross-section analysis.

**Appendix: Data Sources**

The inward FDI data from 1986 to 2004 for China, Korea, Taiwan, Hong Kong, Malaysia, Philippines, Singapore, and Thailand, all in current US$ million, are obtained from the UNCTAD (2006) and the website of the UNCTAD Secretariat (http://stats.unctad.org/fdi/ReportFolders/ReprtFolders.aspx?CS_referer=&CS_ChosenLang=en) as of May 2006. Data on Indonesia are not included in this study due to some negative numbers in FDI data. The data on GDP and total merchandize exports, all in current US$ million for all eight economies are taken from the ICSEAD (2006) and its website.

The current values of FDI are deflated by the GDP deflator of trade of each country; and denoted as rFDI. The current values of GDP of the eight economies have been deflated by their GDP deflators, respectively, and denoted as rGDP. Current values of exports are deflated by each economy's export price index, and denoted as rEX. All these deflators are taken from the ICSEAD (2006), and the base year for all deflators has been converted to 2000 = 1.

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**Figure 1. Real GDP Per Capita**
**East and Southeast Asia and the World**

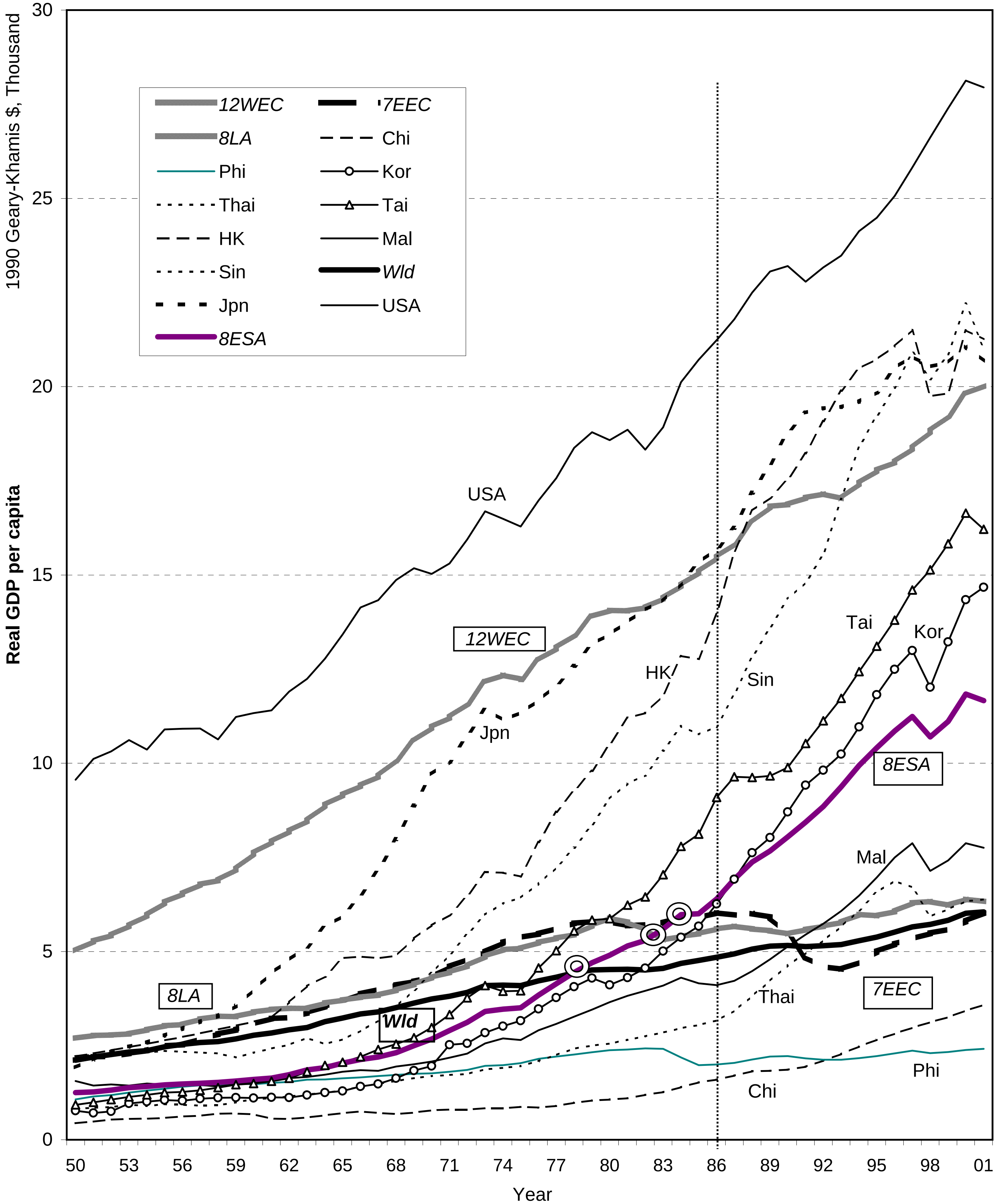

**Figure 2. Real GDP, Real FDI, and Real Exports of Four East Asian Economies**

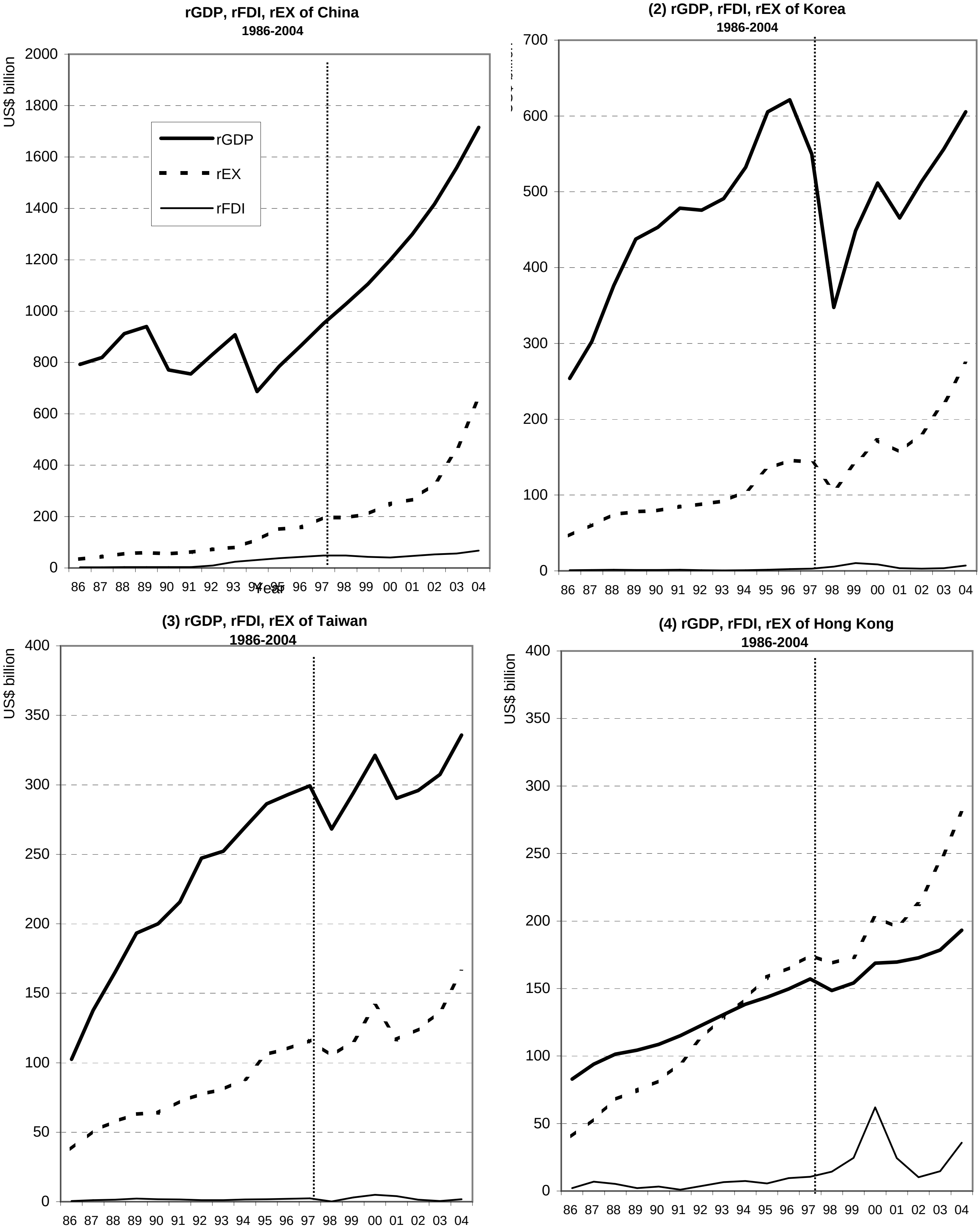

**Figure 3. Real GDP, Real FDI, and Real Exports of Four Southeast Asian Economies**

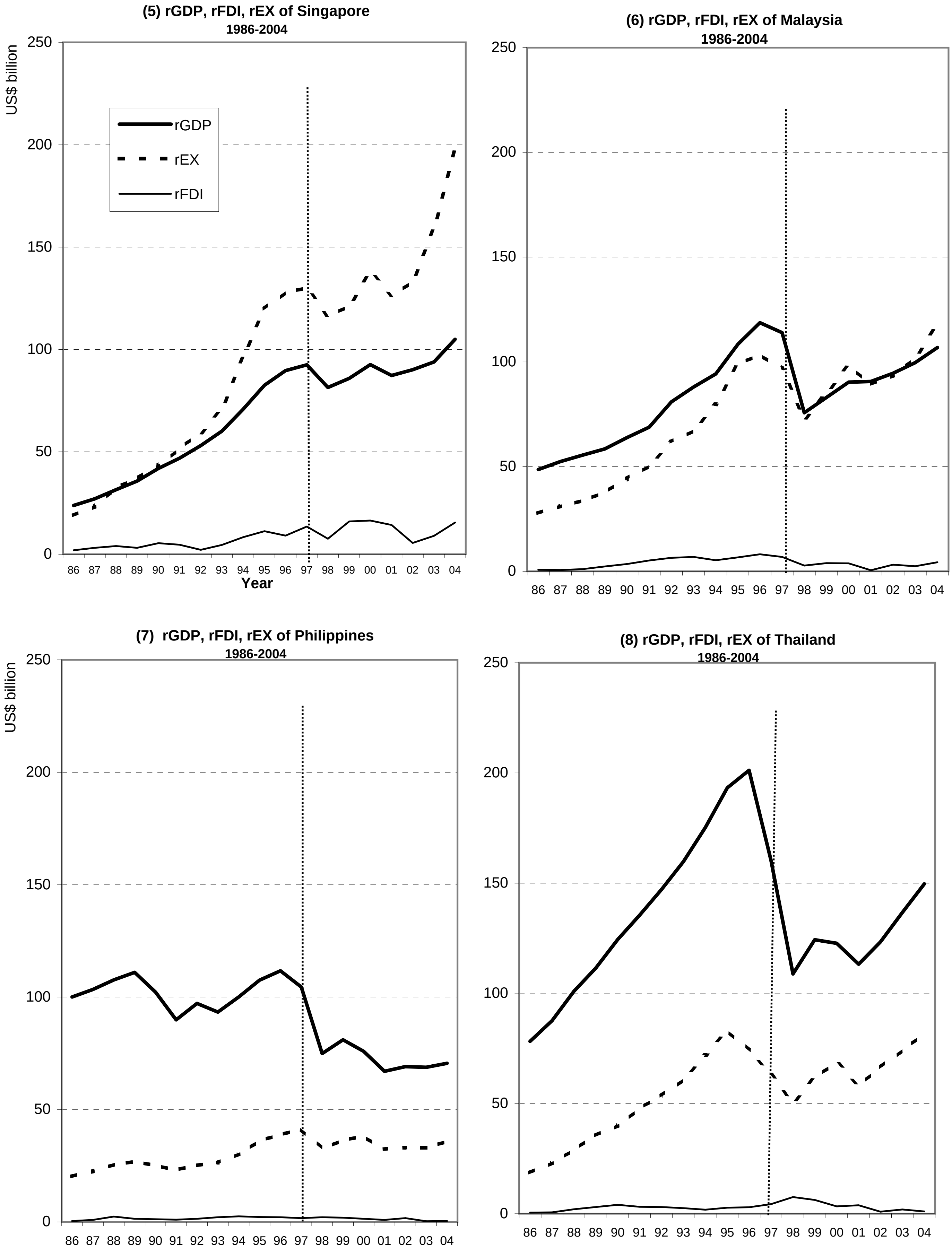

**Figure 4. Granger Causality Relations of Eight Economies**

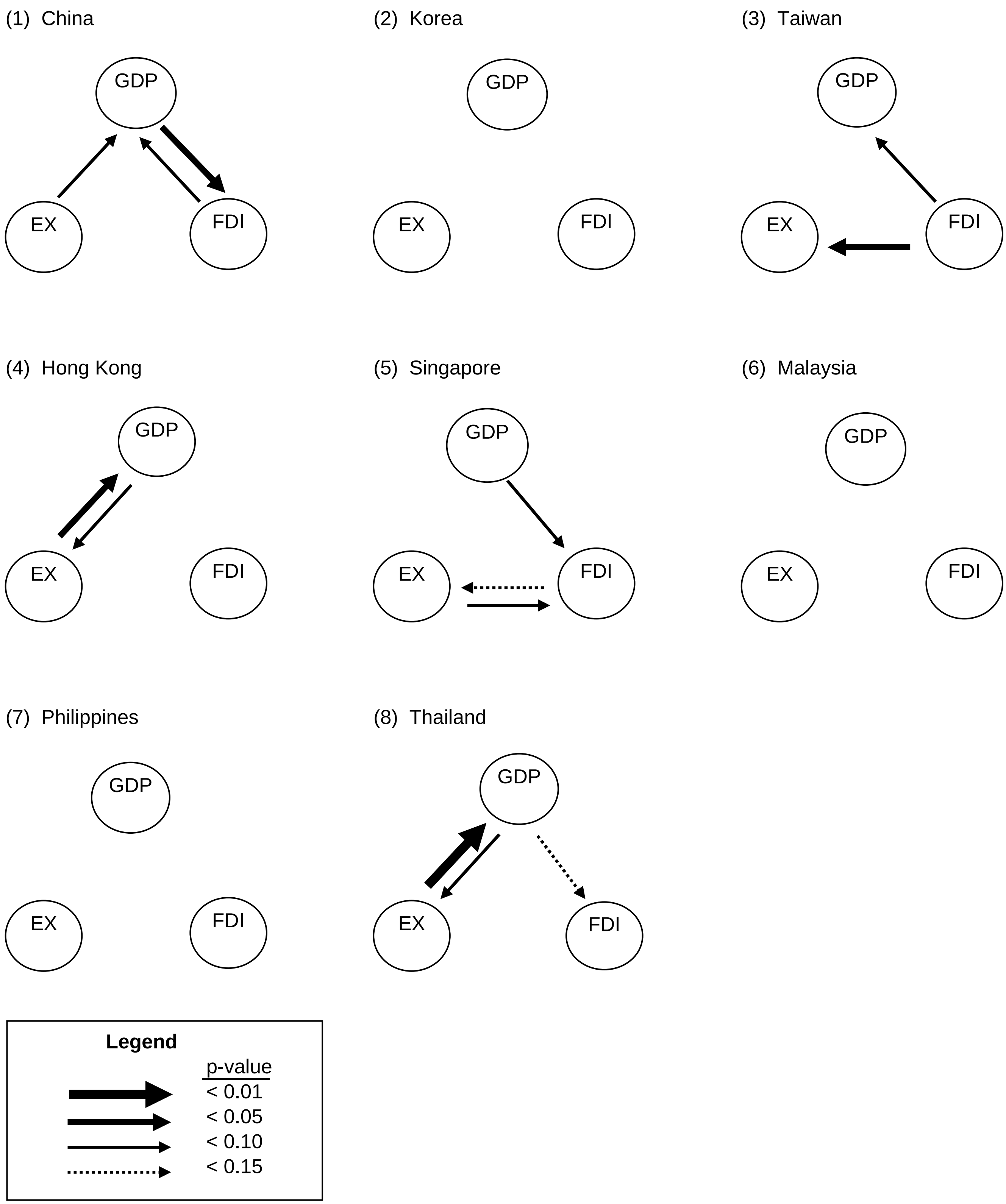

**Figure 5. Panel Data Granger Causality Relations for 8 Economies**

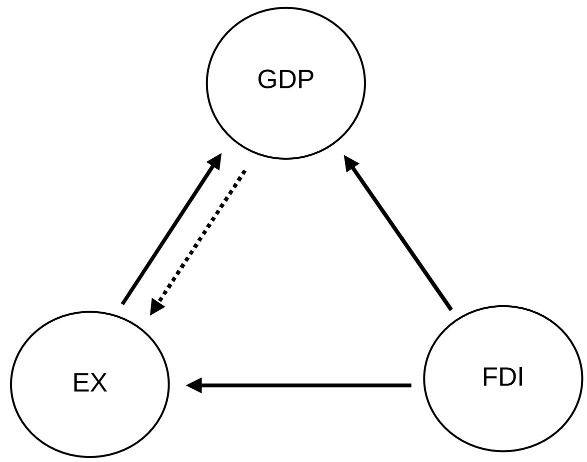

**Table 1. ADF Unit Root Test: Eight Individual Economies, 1986-2004**

| | Level series k | Level series Test-statistic (p-value) | | First-difference series k | First-difference series Test-statistic (p-value) | | Level series k | Level series Test-statistic (p-value) | | First-difference series k | First-difference series Test-statistic (p-value) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 China | | | China | | | 5 Singapore | | | Singapore | | |
| ex | 3 | -4.097 ** | dex | 3 | -2.495 w | ex | 1 | -2.213 | dex | 0 | -2.274 w2 |
| | | (0.03) | | | (0.14) | | | (0.45) | | | (0.19) |
| fdi | 3 | -2.298 | dfdi | 1 | -3.124 ** | fdi | 0 | -3.099 | dfdi | 2 | -3.469 ** |
| | | (0.41) | | | (0.05) | | | (0.14) | | | (0.02) |
| gdp | 3 | -1.130 | dgdp | 0 | -4.004 *** | gdp | 0 | -1.137 | dgdp | 0 | -2.281 w2 |
| | | (0.89) | | | (0.01) | | | (0.89) | | | (0.19) |
| 2 Korea | | | Korea | | | 6 Malaysia | | | Malaysia | | |
| ex | 1 | -3.467 | dex | 1 | -4.209 *** | ex | 0 | -1.455 | dex | 0 | -3.148 ** |
| | | (0.08) | | | (0.01) | | | (0.81) | | | (0.04) |
| fdi | 1 | -2.982 | dfdi | 0 | -2.599 w | fdi | 0 | -2.240 | dfdi | 0 | -5.670 *** |
| | | (0.16) | | | (0.11) | | | (0.44) | | | (0.00) |
| gdp | 0 | -2.694 | dgdp | 0 | -3.727 *** | gdp | 0 | -1.630 | dgdp | 0 | -3.411 ** |
| | | (0.25) | | | (0.01) | | | (0.74) | | | (0.03) |
| 3 Taiwan | | | Taiwan | | | 7 Philippines | | | Philippines | | |
| ex | 0 | -3.742 ** | dex | 1 | -3.872 *** | ex | 0 | -1.912 | dex | 0 | -3.787 *** |
| | | (0.05) | | | (0.01) | | | (0.61) | | | (0.01) |
| fdi | 3 | -4.605 *** | dfdi | 3 | -4.942 *** | fdi | 3 | 0.956 | dfdi | 0 | -5.094 *** |
| | | (0.01) | | | (0.00) | | | (0.99) | | | (0.00) |
| gdp | 3 | -2.622 | dgdp | 0 | -3.765 *** | gdp | 0 | -2.285 | dgdp | 0 | -4.189 *** |
| | | (0.28) | | | (0.01) | | | (0.42) | | | (0.01) |
| 4 Hong Kong | | | Hong Kong | | | 8 Thailand | | | Thailand | | |
| ex | 0 | -3.188 | dex | 0 | -3.216 ** | ex | 0 | -2.115 | dex | 0 | -2.795 * |
| | | (0.12) | | | (0.04) | | | (0.50) | | | (0.07) |
| fdi | 0 | -2.747 | dfdi | 0 | -4.654 *** | fdi | 2 | -2.522 | dfdi | 3 | -3.072 ** |
| | | (0.23) | | | (0.00) | | | (0.31) | | | (0.05) |
| gdp | 0 | -3.057 | dgdp | 1 | -4.082 *** | gdp | 1 | -2.169 | dgdp | 0 | -2.774 * |
| | | (0.15) | | | (0.00) | | | (0.48) | | | (0.08) |

Notes:
1. In level series, the test equation includes constant and linear trend. Reject null hypothesis: Series has a unit root at the 5% (or less) level.
2. In the first-difference series, the test equation includes constant. Reject null hypothesis: Series has a unit root at the 15% (or less) level, except for Singapore, the 20% level is used.
3. Lag length (k) is selected by the minimum AIC with maximum lag = 3. The p-value is in the parenthesis.
4. *** (**, *, w, w2) denotes rejection of null hypothesis at the 1% (5%, 10%, 15%, 20%) level of significance, respectively.

**Table 2. Johansen Cointegration Test Summary**

| | Number of Cointegrating Relations in Level Series: ex, fdi, and gdp | | | | | |
|---|---|---|---|---|---|---|
| | Korea | Hong Kong | Singapore | Maylaysia | Philippines | Thailand |
| Trace test | 2 | 2 | 1 | 2 | 0 | 2 |
| Max-eigenvalue test | 2 | 0 | 1 | 1 | 0 | 2 |

Notes:
Note: Test equation includes intercept and linear deterministic trend, and reject the null hypothesis: Number of CE(s) = r (0, 1, 2, respectively) at the 5% level of significance.

**Table 3. Descriptive Statistics of the Growth Rates of Real Export, FDI, and GDP, 1987-2004**

| | Statistics | Export | FDI | GDP | | Statistics | Export | FDI | GDP |
|---|---|---|---|---|---|---|---|---|---|
| 1 China | Mean | 0.164 | 0.183 | 0.043 | 5 Singapore | Mean | 0.130 | 0.115 | 0.082 |
| | Maximum | 0.358 | 0.936 | 0.135 | | Maximum | 0.331 | 0.759 | 0.164 |
| | Minimum | -0.074 | -0.213 | -0.280 | | Minimum | -0.111 | -0.950 | -0.127 |
| 2 Korea | Mean | 0.098 | 0.119 | 0.048 | 6 Malaysia | Mean | 0.080 | 0.094 | 0.044 |
| | Maximum | 0.292 | 0.672 | 0.255 | | Maximum | 0.216 | 1.736 | 0.162 |
| | Minimum | -0.301 | -0.863 | -0.458 | | Minimum | -0.288 | -1.915 | -0.409 |
| 3 Taiwan | Mean | 0.082 | 0.074 | 0.066 | 7 Philippines | Mean | 0.032 | 0.003 | -0.019 |
| | Maximum | 0.298 | 2.559 | 0.296 | | Maximum | 0.181 | 1.003 | 0.079 |
| | Minimum | -0.188 | -2.351 | -0.110 | | Minimum | -0.237 | -1.667 | -0.333 |
| 4 Hong Kong | Mean | 0.107 | 0.156 | 0.047 | 8 Thailand | Mean | 0.082 | 0.038 | 0.036 |
| | Maximum | 0.276 | 1.328 | 0.126 | | Maximum | 0.230 | 1.109 | 0.142 |
| | Minimum | -0.035 | -1.191 | -0.057 | | Minimum | -0.224 | -1.402 | -0.388 |

| | Statistics | Export | FDI | GDP |
|---|---|---|---|---|
| Panel data | Mean | 0.097 | 0.098 | 0.043 |
| | Maximum | 0.358 | 2.559 | 0.296 |
| | Minimum | -0.301 | -2.351 | -0.458 |

Note: The annual growth rates of a variable are calculated by the first-differences of the logarithmic values of the real export series, real FDI series, and real GDP series, respectively.

**Table 4. Granger Causality Test: Four East Asian Economies, 1986-2004**

| | **Vector Autoregression** | | | | | | | | **Wald test of coefficients (1)** | | **Causality direction** | | **Wald test of coefficients (2)** | | **Causality direction** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dep. var. | constant c1 | dex(-1) c2 | dex(-2) c3 | dfdi(-1) c4 | dfdi(-2) c5 | dgdp(-1) c6 | dgdp(-2) c7 | Ho: | F-stat | | | Ho: | F-stat | | |
| 1 China VAR(2) | dex | 0.111 | 0.322 | -0.232 | 0.057 | 0.059 | -0.122 | 0.310 | B | 0.318 | | | C | 0.320 | | |
| | | (0.19) | (0.38) | (0.59) | (0.75) | (0.79) | (0.81) | (0.44) | | (0.74) | | | | (0.73) | | |
| | dfdi | 0.251 | 0.178 | -0.514 | 0.952 | -0.666 | -1.420 | -0.659 | A | 0.731 | | | C | 5.992 | gdp--->fdi | ** |
| | | (0.02) | (0.66) | (0.31) | (0.00) | (0.02) | (0.03) | (0.16) | | (0.51) | | | | (0.02) | | |
| | dgdp | 0.008 | 0.576 | 0.095 | 0.008 | -0.283 | -0.404 | 0.086 | A | 2.907 | ex--->gdp | w | B | 3.676 | fdi--->gdp | * |
| | | (0.89) | (0.04) | (0.75) | (0.95) | (0.08) | (0.27) | (0.75) | | (0.11) | | | | (0.07) | | |
| 2 Korea VAR(2) | dex | 0.095 | -0.103 | 0.406 | 0.025 | -0.175 | 0.035 | -0.671 | B | 1.523 | | | C | 0.427 | | |
| | | (0.15) | (0.90) | (0.63) | (0.82) | (0.12) | (0.96) | (0.39) | | (0.27) | | | | (0.67) | | |
| | dfdi | 0.029 | 2.196 | -0.119 | 0.350 | -0.386 | -2.846 | 0.321 | A | 0.410 | | | C | 0.913 | | |
| | | (0.88) | (0.40) | (0.96) | (0.32) | (0.25) | (0.22) | (0.89) | | (0.68) | | | | (0.43) | | |
| | dgdp | 0.058 | -0.680 | 0.527 | 0.025 | -0.137 | 0.590 | -0.711 | A | 0.310 | | | B | 0.595 | | |
| | | (0.46) | (0.51) | (0.62) | (0.86) | (0.30) | (0.51) | (0.46) | | (0.74) | | | | (0.57) | | |
| 3 Taiwan VAR(2) | dex | 0.058 | -0.045 | -0.044 | -0.019 | -0.093 | -0.027 | 0.313 | B | 5.803 | fdi--->ex | ** | C | 0.280 | | |
| | | (0.10) | (0.91) | (0.90) | (0.45) | (0.01) | (0.96) | (0.52) | | (0.02) | | | | (0.76) | | |
| | dfdi | -0.495 | 6.266 | 4.034 | -0.488 | -0.682 | -5.347 | 1.695 | A | 0.740 | | | C | 0.209 | | |
| | | (0.31) | (0.32) | (0.46) | (0.21) | (0.13) | (0.54) | (0.81) | | (0.50) | | | | (0.82) | | |
| | dgdp | 0.015 | 0.055 | -0.099 | -0.023 | -0.061 | 0.023 | 0.523 | A | 0.079 | | | B | 3.891 | fdi--->gdp | * |
| | | (0.56) | (0.87) | (0.75) | (0.30) | (0.02) | (0.96) | (0.21) | | (0.92) | | | | (0.06) | | |
| 4 Hong Kong VAR(2) | dex | 0.090 | 0.375 | 0.792 | -0.035 | -0.010 | -0.491 | -2.099 | B | 1.512 | | | C | 4.071 | gdp--->ex | * |
| | | (0.01) | (0.33) | (0.04) | (0.12) | (0.66) | (0.54) | (0.02) | | (0.27) | | | | (0.06) | | |
| | dfdi | 0.612 | 6.727 | 3.072 | -0.204 | 0.137 | -15.071 | -18.444 | A | 1.198 | | | C | 2.062 | | |
| | | (0.13) | (0.22) | (0.52) | (0.49) | (0.67) | (0.20) | (0.11) | | (0.35) | | | | (0.18) | | |
| | dgdp | 0.049 | 0.272 | 0.482 | 0.001 | 0.003 | -0.623 | -1.302 | A | 6.141 | ex--->gdp | ** | B | 0.044 | | |
| | | (0.00) | (0.17) | (0.02) | (0.89) | (0.78) | (0.14) | (0.01) | | (0.02) | | | | (0.95) | | |

Notes:
1. The p-value is in the parenthesis.
2. ** (*, w) denotes rejection of hull hypothesis at the 5%(10%, 15%) level of significance, respectively.
3. In Wald test of coefficients, the null hypothesis A is c2 = c3 = 0, B is c4 = c5 = 0, and C is c6 = c7 = 0, respectively.

**Table 5. Granger Causality Test: Four Southeast Asian Economies, 1986-2004**

| | **Vector Autoregressions** | | | | | | | | | | **Wald test of coefficients (1)** | | **Causality direction** | | **Wald test of coefficients (2)** | | **Causality direction** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dep. var. | constant c1 | dex(-1) c2 | dex(-2) c3 | dfdi(-1) c4 | dfdi(-2) c5 | dgdp(-1) c6 | dgdp(-2) c7 | dummy c8 | err. cor.(-1) c9 | Ho: | F-stat | | | Ho: | F-stat | | |
| 5 Singapore | dex | 4.279 | -0.604 | -0.037 | 0.207 | 0.057 | 0.800 | -0.379 | | 1.080 | B | 2.841 | fdi--->ex | w | C | 0.711 | | |
| VECM(2) | | (0.06) | (0.43) | (0.94) | (0.15) | (0.59) | (0.32) | (0.57) | | (0.06) | | (0.12) | | | | (0.52) | | |
| | dfdi | 34.418 | -8.538 | -0.204 | 1.662 | 1.103 | 6.802 | -4.039 | | 8.787 | A | 3.827 | ex--->fdi | * | C | 3.094 | gdp--->fdi | * |
| | | (0.00) | (0.03) | (0.92) | (0.02) | (0.03) | (0.07) | (0.18) | | (0.00) | | (0.07) | | | | (0.10) | | |
| | dgdp | 3.107 | -0.493 | 0.297 | 0.163 | 0.082 | 0.522 | -0.525 | | 0.789 | A | 0.961 | | | B | 1.523 | | |
| | | (0.08) | (0.42) | (0.43) | (0.16) | (0.33) | (0.41) | (0.33) | | (0.08) | | (0.42) | | | | (0.28) | | |
| 6 Malaysia | dex | 0.035 | 1.174 | 0.059 | -0.014 | -0.007 | -1.047 | -0.110 | | | B | 0.016 | | | C | 0.941 | | |
| VAR(2) | | (0.56) | (0.21) | (0.95) | (0.86) | (0.92) | (0.21) | (0.91) | | | | (0.98) | | | | (0.43) | | |
| | dfdi | 1.561 | -6.221 | -8.144 | -0.721 | 0.118 | 6.041 | 2.837 | -1.612 | | A | 1.764 | | | C | 1.107 | | |
| | | (0.04) | (0.23) | (0.21) | (0.13) | (0.73) | (0.19) | (0.58) | (0.04) | | | (0.23) | | | | (0.38) | | |
| | dgdp | -0.034 | 1.310 | 0.653 | -0.023 | -0.042 | -1.134 | -0.502 | | | A | 2.093 | | | B | 0.247 | | |
| | | (0.54) | (0.13) | (0.49) | (0.75) | (0.50) | (0.14) | (0.57) | | | | (0.18) | | | | (0.79) | | |
| 7 Philippines | dex | 0.029 | -0.685 | 0.283 | 0.057 | 0.091 | 0.538 | -0.399 | | | B | 0.730 | | | C | 0.417 | | |
| VAR(2) | | (0.65) | (0.41) | (0.70) | (0.38) | (0.33) | (0.50) | (0.59) | | | | (0.51) | | | | (0.67) | | |
| | dfdi | -0.338 | 0.315 | 3.393 | -0.431 | -0.043 | -0.938 | -2.957 | | | A | 0.586 | | | C | 0.452 | | |
| | | (0.24) | (0.93) | (0.31) | (0.15) | (0.92) | (0.79) | (0.38) | | | | (0.58) | | | | (0.65) | | |
| | dgdp | 0.004 | -0.947 | 0.003 | 0.071 | 0.113 | 0.554 | -0.027 | | | A | 0.794 | | | B | 1.237 | | |
| | | (0.95) | (0.24) | (0.99) | (0.26) | (0.21) | (0.47) | (0.97) | | | | (0.48) | | | | (0.34) | | |
| 8 Thailand | dex | 1.371 | 0.551 | 1.540 | -0.011 | -0.037 | -1.072 | -2.115 | | -0.368 | B | 0.181 | | | C | 4.102 | gdp--->ex | * |
| VECM(2) | | (0.04) | (0.26) | (0.05) | (0.87) | (0.57) | (0.12) | (0.02) | | (0.04) | | (0.84) | | | | (0.06) | | |
| | dfdi | 2.168 | 1.407 | -3.012 | -0.020 | 0.393 | -1.604 | 3.277 | | -0.572 | A | 1.823 | | | C | 2.971 | gdp--->fdi | w |
| | | (0.24) | (0.32) | (0.17) | (0.92) | (0.07) | (0.40) | (0.18) | | (0.25) | | (0.22) | | | | (0.11) | | |
| | dgdp | 1.215 | 0.825 | 1.934 | -0.068 | -0.082 | -1.363 | -2.223 | | -0.347 | A | 8.242 | ex--->gdp | *** | B | 1.955 | | |
| | | (0.03) | (0.05) | (0.01) | (0.25) | (0.14) | (0.02) | (0.01) | | (0.02) | | (0.01) | | | | (0.20) | | |

Notes:
1 VECM is vector error correction model and err. cor.(-1) is one lag of estimated error correction series.
1. The p-value is in the parenthesis.
2. ** (*, w) denotes rejection of hull hypothesis at the 5% (10%, 15%) level of significance, respectively.
3. In Wald test of coefficients, the null hypotheses A, B, and C are the same as in note 3 of Table 4.
4. The regression equation includes dummy variable when it is significant at the 10% level.

**Table 6. Panel Data Unit Root Tests, 1986-2004**

| | | Panel Level series | | | | | Panel First-difference series | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | IPS W-stat | | ADF-Fisher Chi-square | | | IPS W-stat | | ADF-Fisher Chi-square | |
| 1 | ex | -1.891 | ** | 27.095 | ** | dex | -4.973 | *** | 53.456 | *** |
| | | (0.03) | | (0.04) | | | (0.00) | | (0.00) | |
| 2 | fdi | -1.035 | | 25.051 | * | dfdi | -7.300 | *** | 78.703 | *** |
| | | (0.15) | | (0.07) | | | (0.00) | | (0.00) | |
| 3 | gdp | 0.088 | | 13.494 | | dgdp | -5.981 | *** | 62.889 | *** |
| | | (0.54) | | (0.64) | | | (0.00) | | (0.00) | |

Notes:

1. In level series, the test equation includes individual effects and individual linear trends.
   In the first-difference series, the test equation includes individual effects.
   Automatic selection of lags based on minimum AIC: 0 to 3.
   The p-value is in the parenthesis.

2. *** (**, *) denotes rejection of null hypothesis: Panel series has a unit root.
   at the 1% (5%, 10%) level of significance, respectively.

**Table 7. Panel Data Granger Causality Test, 1986-2004**

| | **VAR(2, dummy)** | | | | | | | | | **Wald test of coefficients (1)** | | **Causality direction** | | **Wald test of coefficients (2)** | | **Causality direction** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Model | DepVar | constant c1 | dex(-1) c2 | dex(-2) c3 | dfdi(-1) c4 | dfdi(-2) c5 | dgdp(-1 c6 | dgdp(-2 c7 | dummy c8 | Ho: | F-stat | | | Ho: | F-stat | | |
| 1 Fixed effects | dex | 0.116 | 0.296 | -0.095 | -0.011 | -0.038 | -0.250 | -0.160 | -0.068 | B | 2.420 | fdi--->ex | * | C | 2.168 | gdp-->ex | w |
| | | (0.00) | (0.04) | (0.52) | (0.50) | (0.03) | (0.09) | (0.27) | (0.01) | | (0.09) | | | | (0.12) | | |
| 2 Random effects | dfdi | 0.173 | 1.005 | -0.085 | -0.283 | -0.173 | -1.309 | -0.111 | -0.261 | A | 0.874 | | | C | 1.409 | | |
| | | (0.15) | (0.19) | (0.92) | (0.00) | (0.08) | (0.10) | (0.89) | (0.06) | | (0.42) | | | | (0.25) | | |
| 3 Fixed effects | dgdp | 0.040 | 0.268 | 0.125 | -0.019 | -0.037 | -0.153 | -0.252 | -0.047 | A | 2.442 | ex--->gdp | * | B | 2.870 | fdi--->gdp | * |
| | | (0.06) | (0.05) | (0.37) | (0.22) | (0.03) | (0.27) | (0.07) | (0.05) | | (0.09) | | | | (0.06) | | |

Notes:
1. Hausman test is used in the selection of fixed effects or random effects model.
VAR(2, dummy) equation includes a dummy variable when it is significant at the 10% (or less) level.
Cross-section's constants are not shown here. The p-value is in the parenthesis.
2. * (w) denotes rejection of hull hypothesis at the 10% (15%) level of significance, respectively.
3. In Wald test of coefficients, the null hypotheses are the same as in note 3 of Table 4.