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Panel Causality Analysis on FDI — Exports - Economic Growth Nexus in First and Second Generation ANIEs*

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Using panel data from 1981 to 2005, this paper examines the Granger causality relations among GDP, exports and FDI in the three first generation Asian newly industrializing economies (ANIEs): Korea, Taiwan, Singapore, and in the four second generation ANIEs: Malaysia, Philippines and Thailand, in addition to China. After reviewing the current literature, we construct three-variable panel VAR models for the first generation ANIEs, the second generation ANIEs, and finally, all seven economies as a group. We then use the fixed effects model to estimate the panel VAR equations for Granger causality tests. The panel data causality results reveal that there are bidirectional causality relations among all three variables for the three first generation ANIEs, but only statistically weak bidirectional causality between exports and GDP for the four second generation ANIEs. However, when all seven ANIEs are grouped for panel data analysis, we found FDI has unidirectional effects on GDP directly and also indirectly through exports, exports also cause GDP, and there also exists bidirectional causality between exports and GDP for the group. Economic and policy implications of our analyses are then explored in the conclusions.

JEL Classification: C33, C32, F43, F21, O11
Keywords: FDI, Exports, and GDP, panel data causality analysis, granger causality, ANIEs

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1. INTRODUCTION

It is well-known that, since WWII, "economic miracle" took place in Asia (World Bank, 1993), starting from Japan in the 1960s to early 1970s, followed by four Asian Newly Industrializing Economies (ANIEs), Taiwan, Korea, Singapore and Hong Kong, in the 1970s and 1980s. In the latter half of the 1980s, while the ANIEs have continued to grow, the ASEAN-4, Indonesia, Malaysia, Philippines, Thailand, along with China, started rapid growth, and the growth fever spreads to Vietnam and India in this new millennium. The rapid clustered sequential growth of East Asia is unique in the history of economic development not shared by the other regions or areas of the world (World Bank, 1993; UNCTAD, 1995; Fukasaku *et al.*, eds., 2006), and is dubbed as the "flying-geese" model of development (Kojima, 1973, 2000; Ozawa, 2003). While the collapse of the Thai baht in mid-1997 triggered Asian financial crisis, and the economies of most of the Asian countries suffered, especially Korea, Malaysia, Philippines, and Thailand, nevertheless, within a few years, all Asian economies have successfully resumed their rapid growth since then.

Aside from institutional and organizational factors, the most common economic factor mentioned in these studies is openness of the economy, namely, export promotion policy, and active acceptance of inward FDI (with the exception of Japan). The roles of trade and FDI have been extensively discussed in recent years both in theory and in practice (see sections 3 and 4 below). Generally speaking, exports, imports, and inward FDI are sources of new ideas, new goods, new domestic competition, and technology transfer from advanced countries. In addition, to attract FDI, the host governments must maintain stable macroeconomic environment and reduce market distortions. All these enhance economic efficiency and productivity of the economy. The positive relation between openness and economic growth seems overwhelming, at least in theory. However, empirical studies of causalities between openness (trade and FDI) and economic growth are

mixed at best. Their relations are not as obvious and straightforward, as can be seen in the survey of literature in the following section.

The major purpose of this paper follows the current literature and investigates the relation between openness, namely, exports and FDI, and economic growth by using panel data analysis, taking the data from seven rapidly developing countries in East Asia, namely, three first generation ANIEs, consisting of Korea, Taiwan, and Singapore, and the four second generation ANIEs, consisting of Malaysia, Philippines, Thailand, and China. These seven countries are chosen because of their strong openness policy during the past two decades of rapid development, and also due to their clustered sequential growth in East Asia with clearly recognizable different stages of development. This may give us some useful policy implications.

The structure of the paper is as follows. Sections 2 and 3 review some recent theoretical and empirical literature on the causality relations among the three variables in a country or a group of countries. Section 4 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 panel vector autoregression (VAR) analysis in sections 5. In section 5, we construct the panel data from 1981 to 2005 for three groups, the first generation ANIEs, the second generation ANIEs, and all seven ANIEs countries, and then apply the fixed effects model to estimate the panel data VAR and perform the Ganger causality test.[1)] The last section concludes by summarizing our findings and discussing the policy implications.

2. REVIEW OF THEORETICAL LITERATURE

In the neoclassical growth model, technological progress and labor growth

[1)] Note that Granger causality tests focus on time-precedence rather than causality in the usual sense. Therefore, the results of the tests should be interpreted with caution. See Chowdhury and Mavrotas (2006) for the usefulness and the shortcomings of the tests.

are exogenous, and 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 mere US$ 69 billion in 1981 to US$ 202 billion in 1990, and then to almost US$ 1,410 billion in 2000, although it decreased to afterward, but still had 915 billion in 2005 (UNCTAD, 2006; 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, Chakraborty, 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 also 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 exports and imports, and thus promote economic growth (Grossman and Helpman, 1997, Chapter 9; Frankel and Romer, 1999; Frankel, Romer and 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.[2)]

The observations on the FDI-growth nexus and the exports-growth nexus lead us to examine the closely related third side of a triangular relation: the FDI-exports nexus. Perhaps, because the FDI-exports relation affects economic growth indirectly, the FDI-exports nexus has received less attention in academic discussions, and a comprehensive survey of the topic does not seem to exist. Like the other nexuses, the direction whether "FDI causes exports" or "exports cause FDI" is also a matter of dispute (Petri and Plummer, 1998). Trade and FDI are related positively (complement) between asymmetric countries and negatively (substitute) between symmetric countries (Markusen and Venables, 1998). They also depend on whether FDI is market-seeking (substitutes) or efficiency-seeking (complements) (Gray, 1998), "trade-oriented" or "anti-trade-oriented" (Kojima, 1973, 2000), or at the early product life-cycle stage (substitute) or at the mature stage (complement) (Vernon, 1966). Thus, the relation may be positive or negative, if there is a relation at all. On the other hand, exports increase FDI by paving the way for FDI by reducing the investors' transaction costs through the knowledge of host country's market structure. FDI may reduce exports by manufacturing goods directly in the host countries to save transportation costs.

The above three kinds of nexus have been studied separately using methods of correlation, regression, or Granger's bivariate causality tests. Few studies have taken all three variables together, nor have used panel data causality analysis. In terms of econometric methods, this paper finds the causality relations among FDI, exports, and GDP (a proxy for economic growth) in the rapidly growing seven major economies in Asia: the three first generation ANIEs and the four second generation ANIEs. We have excluded

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

Hong Kong and Indonesia since their FDI data contain negative entries for some years. Instead of conventional time-series analysis for individual economy, we propose to use panel data causality analysis, available only in recent years, for group causality test.

3. REVIEW OF RECENT EMPIRICAL LITERATURE

In the current literature, most of the published works examine bivariate relations, either theoretically or empirically, between the pairs of GDP and exports, GDP and FDI, or exports and FDI, as we have reviewed in the previous section. Despite their interrelationships, as we will see in the literature review below, relatively few published empirical works deal with causality relations among these three variables simultaneously in a group of countries, and fewer papers use panel data VAR 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[3] 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[4] from 1970 to 1999; Alici and Ucal (2003) found only unidirectional causality from exports to output[5] 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[6] FDI to real exports, and FDI to real GDP for

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[3] 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 exports are taken from IMF.

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

[5] They use Turkish industrial production index as our GDP, export price index as our exports, along with real FDI.

[6] There is no indication that FDI data were deflated in their paper.

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. 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 of Mexico, Brazil, and Argentina from late 1970s to 2000; Chowdhury and Mavrotas (2006) find unidirectional causality from GDP to FDI for Chile, and bidirectional causality between GDP and FDI in the case of Malaysia and Thailand using data from 1969 to 2000.

For studies of a group of countries, Makki and Somwaru (2004) found a positive impact of exports and FDI on GDP using 66 developing countries data averaged over ten-year periods, 1971-1980, 1981-1990, and 1991-2000 and the instrumental variable method; Wang, Liu and Wei (2004) use panel data analysis on 79 countries from 1970-1998, and find that "FDI is relatively more beneficial to high-income countries, while international trade is more important for low-income countries." But they did not examine the stationarity of the variables to avoid spurious conclusion, and did not apply the panel data causality analysis. Note that, as Basu, Chakraborty and Reagle (2003) have pointed out, the above two papers, and like some other papers not included here, only look at the one-way determinants of FDI in regression analyses rather than at the two-way causality linkages among GDP, exports, and FDI, and so they are not strictly comparable with the causality analysis in this paper.

There are a few examples using causality analysis. Nair-Reichert and Weinhold (2000) found that the Holtz-Eakin causality tests show FDI, not exports, causes GDP using data[7)] from 24 developing countries from 1971 to 1995 applying mixed fixed and random (MFR) effects model; Hansen and Rand (2006), using data for 31 countries from 1970-2000 and the neoclassical growth model, found that there is a strong bidirectional causality

[7)] The paper does not specify the sources of data, whether the data were deflated, and does not check stationarity.

between FDI ratio (FDI/GDP) and GDP. However, they did not take into account of exports. The problem of the above two papers on panel data analysis is that they included too many countries with different stages of development, and thus obscure the results. Recently, Hsiao and Hsiao (2006) have examined the Granger causality relations among GDP, exports, and FDI in eight rapidly developing East and Southeast Asian economies (four ANIEs and three ASEAN plus China) using panel data from 1986 to 2004. For the individual country time series causality tests, they did not find systematic causality among the three variables. However, 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. They find panel data analysis is superior to the time series 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 regression or two-way causality, and the presence of other related variables or inclusion of interaction variables in the estimation equation. The results may be bidirectional, unidirectional, 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 general results appear to show the positive relation from FDI and exports (or trade) to GDP, and that the above brief survey also seems to indicate that there may be some interesting causality relations among exports, FDI and GDP.

4. 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,[8] or expands a production function linearly to make connections. However, here we show that the theoretical underpinning of the econometric model can be derived from the national income model.

For simplicity, we assume equilibrium in the money sector and the government sector. Then, the equilibrium condition[9] of the Keynesian model of aggregate demand and aggregate supply is

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

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 host country.

Since we are interested in the real aspect of the economy, ignoring the financial variables, and writing in more general implicit function form,[10] we have

$$H(Y, X, F) = 0. \tag{2}$$

Thus, the three variables, GDP, exports, and FDI are closely related to each other according to the Keynesian macroeconomic theory. We now examine econometrically the causality relations among the real variables Y, X, and F. If certain regularity conditions are satisfied, the non-linear functions

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[8] An 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).

[9] Not national income identity.

[10] 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.

$C(Y)$, $I(Y, r)$, 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 a vector autoregression (VAR) form for the Granger causality test. Equation (3) in section 5.2 below shows the final form of the panel VAR model, which may be written either in levels or differenced series.

5. PANEL DATA GRANGER CAUSALITY TEST

A 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 unit explicitly into account by allowing for individual-specific effects (Davidson and MacKinnon, 2004), and give "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 of variables like exports, FDI inflows, and GDP.

The seven East Asian economies have more or 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; 2003). Considering the growing interdependence of these seven East Asian economies, we propose to pool their seven cross-sectional data over the 25-year period (1981 to 2005) into a panel data set and then use panel data regressions to examine the causality relations for the group (ANIEs-All). And then, we further divide the seven economies into two groups, the first generation ANIES (ANIEs 1), and the second generation ANIEs (ANIEs 2). We then compare the group Granger causality relations for the three groups.

5.1. 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 notations for real exports, real FDI, and real GDP, respectively). Recent econometric literature has 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) (Maddala and Wu, 1999) to perform the panel data unit root test and compare their results (Christopoulos and Tsionas, 2003).

Table 1 Panel Data Unit Root Tests: ANIEs-All

			ex	fdi	gdp
Panel Level Series	IPS W-stat	Individual Effects	3.741 (0.99)	–1.721** (0.04)	0.565 (0.71)
		Individual Effects & Individual Linear Trends	0.629 (0.74)	–2.155** (0.02)	1.387 (0.92)
	ADF-Fisher Chi-square	Individual Effects	4.013 (0.99)	22.582* (0.07)	12.482 (0.57)
		Individual Effects & Individual Linear Trends	13.535 (0.48)	26.201*** (0.02)	11.794 (0.62)
Panel First-Difference Series	IPS W-stat	Individual Effects	–4.596*** (0.00)	–9.461*** (0.00)	–5.353*** (0.00)
		Individual Effects & Individual Linear Trends	–3.140*** (0.00)	–7.311*** (0.00)	–4.464*** (0.00)
	ADF-Fisher Chi-square	Individual Effects	53.169*** (0.00)	100.232*** (0.00)	53.002*** (0.00)
		Individual Effects & Individual Linear Trends	36.093*** (0.00)	71.160*** (0.00)	42.257*** (0.00)

Notes: a) Panel data include all seven ANIEs. b) The optimal lag length is selected by the minimum AIC with maximum lag 3. c) The numbers in parentheses denote *p*-values. d) *** (**, *) denotes rejection of null hypothesis at the 1% (5%, 10%) level of significance, respectively.

Table 1 presents the panel unit root test results of the three level series and their first-difference series for all seven countries. Both IPS and ADF-Fisher tests indicate that the panel series FDI (fdi) is likely to be a level stationary series, but ex and gdp are not level stationary series. In addition, both tests indicate that the three panel first-difference series dex, dfdi, and dgdp are all stationary series. Therefore, we use the three panel first-difference series in the panel data VAR causality analysis for the group.

Table 2 Panel Data Unit Root Tests: ANIEs 1

			ex	fdi	gdp
Panel Level Series	IPS W-stat	Individual Effects	2.024 (0.98)	–0.793 (0.21)	0.354 (0.64)
		Individual Effects & Individual Linear Trends	–0.917 (0.18)	–2.581*** (0.00)	1.639 (0.95)
	ADF-Fisher Chi-square	Individual Effects	0.810 (0.99)	8.103 (0.23)	3.447 (0.75)
		Individual Effects & Individual Linear Trends	8.192 (0.22)	16.187** (0.01)	1.306 (0.97)
Panel First-Difference Series	IPS W-stat	Individual Effects	–4.427*** (0.00)	–4.461*** (0.00)	–3.718*** (0.00)
		Individual Effects & Individual Linear Trends	–3.348*** (0.00)	–3.943*** (0.00)	–2.984*** (0.00)
	ADF-Fisher Chi-square	Individual Effects	30.149*** (0.00)	30.109*** (0.00)	24.121*** (0.00)
		Individual Effects & Individual Linear Trends	21.610*** (0.00)	24.747*** (0.00)	18.455*** (0.01)

Notes: a) Panel data include the first generation ANIEs (Taiwan, Korea, and Singapore) only. b) The optimal lag length is selected by the minimum AIC with maximum lag 3. c) The numbers in parentheses denote *p*-values. d) *** (**, *) denotes rejection of null hypothesis at the 1% (5%, 10%) level of significance, respectively.

Table 3 Panel Data Unit Root Tests: ANIEs 2

			ex	fdi	gdp
Panel Level Series	IPS W-stat	Individual Effects	3.202 (0.99)	–1.588* (0.06)	0.441 (0.67)
		Individual Effects & Individual Linear Trends	1.675 (0.95)	–0.639 (0.26)	0.420 (0.66)
	ADF-Fisher Chi-square	Individual Effects	3.202 (0.92)	14.479* (0.07)	9.035 (0.34)
		Individual Effects & Individual Linear Trends	5.343 (0.72)	10.264 (0.26)	10.487 (0.23)
Panel First-Difference Series	IPS W-stat	Individual Effects	–2.205** (0.01)	–8.710*** (0.00)	–3.862*** (0.00)
		Individual Effects & Individual Linear Trends	–1.216+ (0.11)	–6.260*** (0.00)	–3.322*** (0.00)
	ADF-Fisher Chi-square	Individual Effects	23.020*** (0.00)	70.123*** (0.00)	28.880*** (0.00)
		Individual Effects & Individual Linear Trends	14.484* (0.07)	46.413*** (0.00)	23.803*** (0.00)

Notes: a) Panel data include the second generation ANIEs (China, Malaysia, Philippines, and Thailand) only. b) The optimal lag length is selected by the minimum AIC with maximum lag 3. c) The numbers in parentheses denote *p*-values. d) *** (**, *) denotes rejection of null hypothesis at the 1% (5%, 10%) level of significance, respectively.

Tables 2 and 3 show the panel unit root test results for the first and the second generation ANIEs countries, respectively. Both IPS and ADF-Fisher tests indicate that the panel level series of the three variables are not stationary, but the three panel first-difference series are all stationary. Thus, we use the first-difference series of the three variables panel to study the Granger causalities for the two groups.

5.2. Panel Data VAR and Granger Causality Test

When we estimate panel data regression models, we 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). Since the random effects model requires the number of cross-section units greater than the number of coefficients, with our seven cross-section units, we can estimate VAR(p) with lag order p = 1 or 2. More importantly, we lose too much information if we have more than 2 lags, for we have data only over 25-year period. The optimal lag lengths are then selected by the minimum AIC method. As will be shown, the random effects model is rejected for all equations, and we explain briefly the estimation of panel VAR in the context of the fixed effects model.

5.2.1. 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

$$y_{it} = \alpha_i + x_{it}\beta + u_{it}, \tag{3}$$

where y_{it} can be one of our three endogenous variables, i is the ith cross-section unit and t is the time of observation. The intercept, α_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 β is a column vector of the common slope coefficients for the group of 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 1981 to 1997 and one for 1998 to 2005, into the model to take into account the effect of the 1997 Asian financial crisis if

significant at 10% level. The FEM is estimated by the method of the least squares dummy variable (LSDV). Note that the Hausman test rejects the null hypothesis of random effect model at 5% level in the estimations of the panel VAR for all seven economies as a group.[11] On the other hand, the first and the second generation models have smaller number of cross section units than the number of the coefficients. Therefore, we can not use the random effects model. Thus, only the fixed effects model is presented in this paper.

5.2.2. Granger Causality Test

Table 4 presents the estimated panel data VAR for all seven economies as a group by FEM, and the Wald test of coefficients for Granger causality directions (for simplicity, subscripts *i* and *t* are omitted, and the cross-section specific constant terms are not presented in the table). The coefficients of dummy variable are all negative, but not significant at the 10% level. Thus, the dummy variable was dropped from the regressions. Figure 1 summarizes the panel data Granger causality results of table 4.

We have found five very interesting causality relations for all seven Asian economies as a group. They are summarized below.

i) From the first equation (dex) of table 4, 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 seven Asian economies as a group.

ii) From the third equation (dgdp), 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 the FDI-led growth in these seven Asian economies as a group.

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[11] For dex, dfdi, and dgdp equations, Hausman test's chi-square statistics (*p*-value) are 14.8 (.02), 20.8 (.00), and 14.4 (.03), respectively, all rejecting random effects model at 5% level of significance.

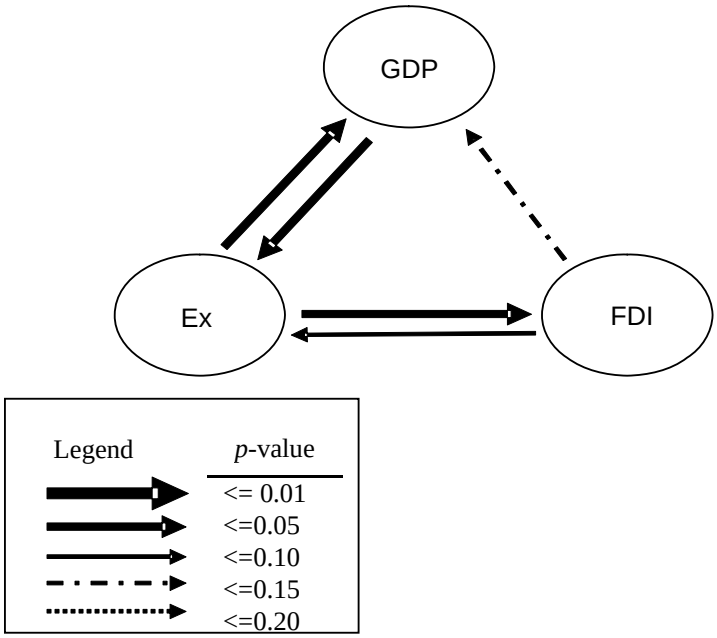
Table 4 Panel Data Granger Causality Tests for ANIEs-ALL

	Dep. var.	dex	dfdi	dgdp
Coefficient Estimates	constant (c1)	0.411 (0.01)	0.719 (0.00)	0.362 (0.03)
	dex (-1) (c2)	0.236 (0.03)	0.131 (0.11)	0.151 (0.17)
	dex (-2) (c3)	0.099 (0.34)	0.138 (0.08)	0.255 (0.02)
	dfdi (-1) (c4)	–0.161 (0.15)	0.415 (0.00)	–0.147 (0.20)
	dfdi (-2) (c5)	–0.012 (0.91)	0.236 (0.00)	–0.021 (0.85)
	dgdp (-1) (c6)	0.109 (0.28)	–0.023 (0.77)	0.179 (0.09)
	dgdp (-2) (c7)	–0.302 (0.00)	–0.144 (0.06)	–0.283 (0.01)
	dummy (c8)			
Wald test of Coefficients Causality Direction (1)	Ho *F*-stat	B 2.458 (0.09) fdi→ex*	A 3.302 (0.04) ex→fdi**	A 4.502 (0.01) ex→gdp***
Wald test of Coefficients Causality Direction (2)	Ho *F*-stat	C 4.846 (0.01) gdp→ex***	C 1.894 (0.15)	B 2.200 (0.11) fdi→gdp

Notes: a) The numbers in parentheses denote p-values. b) *** (**, *, +) denotes rejection of null hypothesis at the 1% (5%, 10%, 15%) level of significance, respectively. c) Ho=null hypothesis, *F*-stat=*F*-statistic. d) In Wald test of coefficients, the null hypothesis A is c2=c3=0, B is c4=c5=0, C is c6=c7=0, respectively.

iii) 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 beneficial to the growth of GDP through increased exports, for example, by opening the export-oriented industrial processing zones for inward FDI in these seven Asian economies.

Figure 1 Panel Data Granger Causality Relations for All Seven ANIEs Countries



iv) From the second equation (dfdi), we have found a unidirectional causality from exports to FDI inflows, but not from GDP to FDI inflows. Apparently, the growth of exports is not the only factors to attract FDI inflows to these seven Asian economies. Other factors, such as the abundant quality labor supply, human capital, low wages, tax holidays, etc. may have to take into considerations if we are interested in the determinations of FDI in regression analysis, as shown in Hsiao and Hsiao (2004).

v) From the first and the second equations together, we have found bidirectional causality between exports and FDI inflows. This shows that exports and FDI inflows have been mutually reinforcing in the process of rapid economic growth of these seven Asian economies.

We have found the evidence that, in general, inward FDI has reinforcing

effects on GDP: FDI not only has strong direct impact on GDP, but also indirectly increases GDP though exports by interactive relations between exports and GDP. This finding is consistent with findings of Hsiao and Hsiao (2006), namely, our results not only support 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," but also provide the possible theoretical underpinning of the hypothesis: It is because of the FDI's reinforcing effects on GDP through exports.

Due to the reinforcing effects of inward FDI, the economic growth policy priority of a developing country, generally speaking, 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. This is a general proposition based on the evidence from the seven rapidly growing East Asian economies as a whole, which can not be captured by the individual country study.

When we divided the seven countries into the first and second generation ANIEs, we have found more interesting results. Table 5 presents the estimated panel data VAR for the first generation ANIEs as a group by FEM, and the Wald test of coefficients for Granger causality directions. The coefficients of dummy variable are all negative and statistically significant at the 5% level. Thus, the dummy variable was included in the regressions. Figure 2 summarizes the panel data Granger causality results of table 5.

Interestingly enough, we have found very strong bidirectional causality relations among GDP, exports, and FDI inflows for the first ANIEs as a group. Not only does the causality from GDP to FDI inflows newly emerge, but each causality relations are much more statistically significant than the previous panel VAR results for all seven Asian economies. This indicates that GDP, exports, and FDI inflows are mutually reinforcing each other, so that any policy aiming to stimulate one of the three variables is likely to have positive impact on the other two variables both directly and indirectly. This virtuous circle running through the three variables may explain the rapid growth of the first generation ANIEs for the past three decades with prudent

Table 5 Panel Data Granger Causality Tests for ANIEs 1

	Dep. var.	dex	dfdi	dgdp
Coefficient Estimates	constant (c1)	0.114 (0.00)	0.307 (0.03)	0.090 (0.00)
	dex (-1) (c2)	0.281 (0.09)	2.683 (0.01)	0.325 (0.06)
	dex (-2) (c3)	0.169 (0.32)	0.831 (0.09)	0.401 (0.02)
	dfdi (-1) (c4)	–0.028 (0.21)	–0.427 (0.00)	–0.032 (0.16)
	dfdi (-2) (c5)	–0.067 (0.00)	–0.335 (0.02)	–0.048 (0.04)
	dgdp (-1) (c6)	–0.076 (0.65)	–2.523 (0.02)	–0.100 (0.56)
	dgdp (-2) (c7)	–0.549 (0.00)	–1.985 (0.07)	–0.475 (0.01)
	dummy (c8)	–0.060 (0.04)	–0.422 (0.02)	–0.089 (0.00)
Wald test of Coefficients Causality Direction (1)	Ho *F*-stat	B 4.764 (0.01) fdi→ex**	A 4.499 (0.02) ex→fdi**	A 4.178 (0.02) ex→gdp**
Wald test of Coefficients Causality Direction (2)	Ho *F*-stat	C 5.373 (0.01) gdp→ex***	C 4.456 (0.02) gdp→fdi**	B 2.568 (0.09) fdi→gdp*

Notes: a) The numbers in parentheses denote p-values. b) *** (**, *, +) denotes rejection of null hypothesis at the 1% (5%, 10%, 15%) level of significance, respectively. c) Ho=null hypothesis, *F*-stat=*F*-statistic. d) In Wald test of coefficients, the null hypothesis A is c2=c3=0, B is c4=c5=0, C is c6=c7=0, respectively.

government policies attracting FDI and promoting exports. Here, again, inward FDI has strong positive effects on GDP: FDI not only has strong direct impact on GDP, but also indirectly increases GDP through exports by interactive relations between exports and GDP.

Figure 2 Panel Data Granger Causality Relations for ANIEs 1 Countries

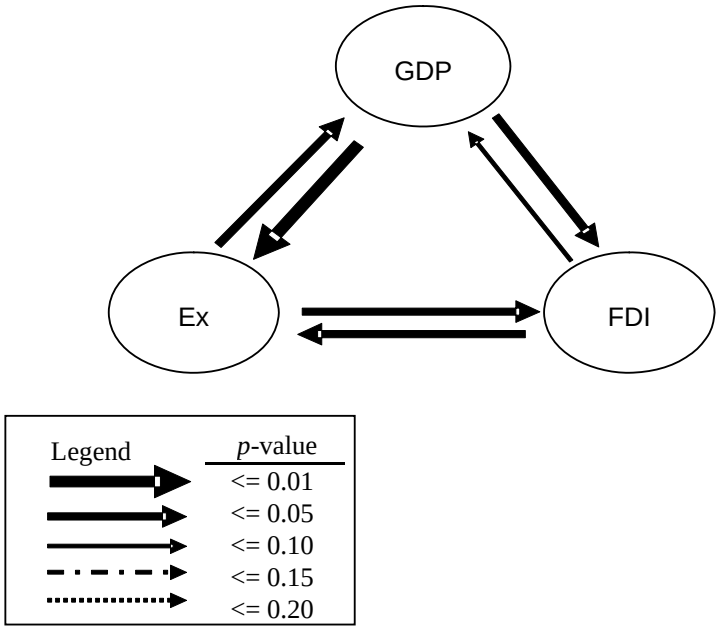


Table 6 presents the estimated panel data VAR for the second generation ANIEs as a group by FEM, and the Wald test of coefficients for Granger causality directions. The coefficients of dummy variable are all negative, but not statistically significant at the 10% level. Thus, the dummy variable was dropped from the regressions. Figure 3 summarizes the panel data Granger causality results of table 6.

Unlike the first generation ANIEs, we have not found many causality relations for the second generation ANIEs, only finding the bidirectional causality between GDP and exports (with statistically weak 15% level of significance). This, of course, coincides with the fact that the second generation ANIEs have promoted the export-led-growth policy during the past two decades. However, it is striking that FDI inflows have no causal effects on either GDP or exports. This result implies that the second generation

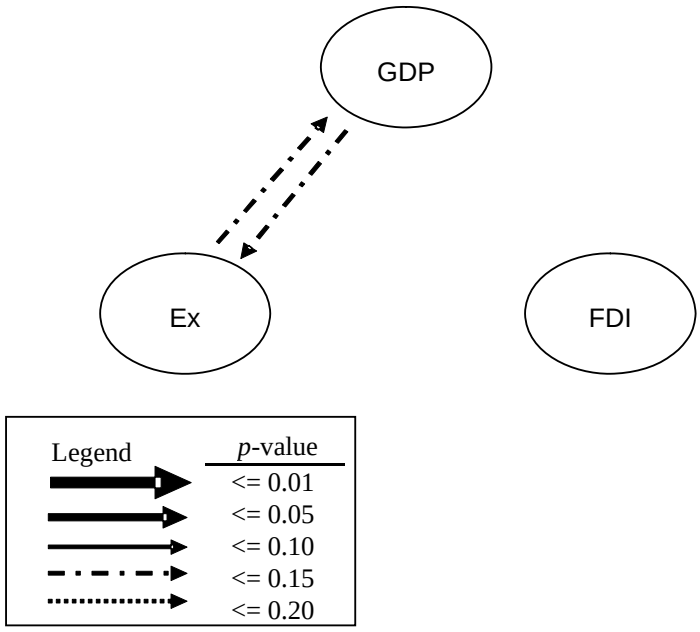
Table 6 Panel Data Granger Causality Tests for ANIEs 2

	Dep. var.	dex	dfdi	dgdp
Coefficient Estimates	constant (c1)	0.047 (0.00)	0.049 (0.55)	–0.003 (0.84)
	dex (-1) (c2)	0.242 (0.09)	0.168 (0.84)	0.127 (0.39)
	dex (-2) (c3)	0.129 (0.34)	0.081 (0.92)	0.227 (0.11)
	dfdi (-1) (c4)	–0.011 (0.59)	–0.349 (0.00)	–0.006 (0.77)
	dfdi (-2) (c5)	0.001 (0.96)	0.098 (0.41)	–0.006 (0.80)
	dgdp (-1) (c6)	0.166 (0.20)	0.714 (0.338)	0.245 (0.07)
	dgdp (-2) (c7)	–0.226 (0.08)	–0.689 (0.349)	–0.277 (0.04)
	dummy (c8)			
Wald test of Coefficients Causality Direction (1)	Ho *F*-stat	B 0.176 (0.84)	A 0.033 (0.97)	A 2.087 (0.13) $ex \rightarrow gdp^{+}$
Wald test of Coefficients Causality Direction (2)	Ho *F*-stat	C 2.185 (0.12) $gdp \rightarrow ex^{+}$	C 0.810 (0.45)	B 0.055 (0.95)

Notes: a) The numbers in parentheses denote p-values. b) *** (**, *, +) denotes rejection of null hypothesis at the 1% (5%, 10%, 15%) level of significance, respectively. c) Ho=null hypothesis, *F*-stat=*F*-statistic. d) In Wald test of coefficients, the null hypothesis A is c2=c3=0, B is c4=c5=0, C is c6=c7=0, respectively.

ANIEs have not fully utilized the beneficial effects of FDI inflows on GDP and exports yet. Therefore, it should be the policy priority for the second generation ANIEs' governments to make sure that FDI inflows exert the reinforcing and beneficial effects on GDP and exports through active acquisition of advanced technology and open trade regime.

Figure 3 Panel Data Granger Causality Relations for ANIEs 2 Countries



A distinctive pattern emerges from the previous panel VAR analyses for the first and the second generation ANIEs, and for all seven ANIES. While we cannot find causality relations running from FDI inflows to GDP or exports in the second generation ANIEs as a group, FDI inflows strongly induce GDP and exports in the first generation ANIEs as a group. In addition, GDP, exports, and FDI inflows are mutually reinforcing each other through a strong virtuous circle in the first generation ANIEs, while only statistically weak bidirectional causalities run between GDP and exports in the second generation ANIEs. It appears that large inflow of FDI can occur and its impact on the economy becomes effective only when the economy has advanced to a certain stage of development and proper institutions are put in place.

6. CONCLUSIONS

We first recognize that the rapid clustered sequential growth of East and Southeast Asia is unique in the modern world economy not shared by the other regions or area. We have called these countries as a whole the Asian Newly Industrializing Economies (ANIEs). The openness of the economy, as manifested by exports and inward FDI, among others, is the most common economic factor attributed to rapid growth of the ANIEs. Thus, the question how the openness variables, exports and FDI, interacted with GDP, the most important economic growth indicator, within each group and among each countries appear to be an important topic to study. Following recent study of panel data analysis of Hsiao and Hsiao (2006), we have applied panel data analysis to the ANIEs and the two generation groups separately. Then, very interesting pattern has emerged. We find statistically strong bidirectional causality among the three variables in the first generation ANIEs countries but only a few statistically weak causalities in the second generation ANIEs countries. More specifically, the contributions of this paper appear in several areas:

i) As in Hsiao and Hsiao (2006), 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 (VAR) procedure.

ii) For empirical studies, we use panel data causality analysis of inward FDI, exports, and GDP simultaneously. Our analysis is different from general conventional time-series analysis or cross-section analysis using bivariate models.

iii) There are many theoretical and empirical studies on the bivariate causality between trade (using exports or 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 natural and worthwhile, as pointed out in Hsiao and Hsiao (2006), to examine multivariate causalities among these three variables.

iv) In terms of the data, our analyses are concentrated on the newly developed East Asian economies, Korea, Taiwan, Singapore, on one hand, and rapidly developing economies in Asia, China, Malaysia, Philippines, and Thailand, on the other hand. We have chosen the data period from 1981 to 2005, the most dynamic phase of their development, as compared with other regions of the world, with active exports and inward foreign direct investment. Our selection of these seven Asian economies and the period, in addition to various panel data analyses, are different from the existing literature, as most of the current publications do the cross-section analysis of a group of either developed countries and/or developing countries, without due considerations of heterogeneous economic characteristics and different stages of development within the group.

v) Unlike Hsiao and Hsiao (2006), we divided the ANIEs in two groups, the first and the second generation countries, and found a prominently distinguished pattern of causality for the first generation countries and less incidence of causality among the second generation countries.

vi) As in Hsiao and Hsiao (2006), we also find in this paper the reinforcing effects of inward FDI through exports, and we also corroborate their policy recommendation of attracting inward FDI, in addition to exports, as an important engine of growth. The reinforcing effects are evident in all seven ANIEs as a whole and are exemplified by the first generation ANIEs as a group (figures 1 and 2).

vii) More generally, the first generation countries show statistically strong bidirectional causality between FDI and exports, between GDP and exports, and between GDP and FDI. When these results are compared with the results of the second generation countries, which have only statistically weak bidirectional causality between exports and GDP, we may conclude that FDI is generally not effective in promoting economic growth at the lower stage of

economic growth, but exports are. It has an important impact and effectiveness only among the newly or already developed countries. This might explain why over 70% of the inward FDI are in the developed countries, and also why most of inward FDI flowing into developing countries are concentrated on those rapidly growing developing countries.

viii) Another implication of our results is that, at the early stage of development, exports, rather than FDI, appear to be more important in promoting economic growth. This interpretation is consistent with the general fear, or Marxists concern, that FDI is the vanguard of imperialistic capitalism and may compete with, or even destroy, the burgeoning domestic infant industries.

ix) In this connection, considering a statistically weak unidirectional causality from FDI to GDP in the general case (figure 1) and stronger unidirectional causality from GDP to FDI in the first generation case (figure 2), FDI is generally attracted to the high income countries. The implication is that economic policy of low income countries to attract FDI may not be effective or even futile. Rather, low income countries should promote exports at the beginning of its development. After export promotion policy has succeeded in lifting the national income, FDI will come and start to have positive reinforcing interrelated impacts on exports and GDP, and enhance further growth.

Lastly, we may point out that recent literature tends to emphasize the contribution of human capital or financial development along with FDI on GDP growth. Human capital, and for that matter, financial development, may be important in a regression estimation or determination of economic growth when the effects of FDI inflows are considered, as shown by Borensztein, *et al*. (1998) and Hermes and Lensink (2003). However, the purpose of this paper is not to estimate such a one-side effect,[12] which inevitably gives rise to the problem of endogeneity of the variables. Rather,

[12] To control endogeneity of FDI, Borensztein, *et al*. (1998) tried several instrumental variables. However, since there is no "ideal" instrument, the endogeneity of FDI and GDP can best be discussed under the causality framework.

our purpose in this paper is to test the causality of FDI and GDP, along with exports. All three variables are endogenous variables simultaneously. As such, we may also point out that our panel data analysis does show the expected results that FDI causes GDP either directly or indirectly through exports, and thus our analysis may suggest that exports may be a good substitute of, if not complementary to, human capital or financial development in its relation with FDI and GDP.

APPENDIX: DATA SOURCES

The data on GDP and merchandise exports from 1981 to 2005, all in current US$ million for the seven Asian economies considered and their GDP deflators(2000=1), except Taiwan's GDP and exports and Singapore's exports, are taken from the World Bank's *World Development Indicators* dataset. The Taiwan's current GDP, merchandise exports and GDP deflator (2000=1) are taken from *MacroEconomic Database*, National Statistics, Republic of China (http://eng.sta.gov.tw). For Singapore, merchandise exports are taken from ICSEAD dataset. The current values of GDP and merchandise exports are deflated by GDP deflator of each country to convert to the real values. The inward FDI data are obtained from UNCTAD's World Investment Report dataset, and deflated by GDP deflator to get real FDI values. Note that all variables are in logarithms, and Indonesia and Hong Kong are not included in the regression analyses due to some negative numbers in FDI data.

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