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FDI Inflows, Exports and Economic Growth in First and Second Generation ANIEs: Panel Data Causality Analyses

Yongkul Won, Frank S.T. Hsiao, and Doo Yong Yang

KIEP Korea Institute for International Economic Policy

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Executive Summary

Using time-series and panel data from 1981 to 2005, this paper examines the Granger causality relations between GDP, exports, and FDI among the three first generation Asian newly industrializing economies (ANIEs): Korea, Taiwan, Singapore, and the four second generation Asian newly industrializing economies (ANIEs): Malaysia, the Philippines, and Thailand, in addition to China. We first show the difference between the first and second generation ANIEs in terms of real GDP per capita, trade structure, and inward FDI, and find some individual characters of each economy. After reviewing the current literature and testing the properties of individual time-series data, we estimate the VAR of the three variables to find various Granger causal relations for each of the seven economies.

We found each country has different causality relations and does not yield general rules. We then construct the panel data of the three variables for the first generation ANIEs, the second generation ANIEs, and finally, all seven economies as a group. We 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 there are bidirectional causality relations among all three variables for the three first generation ANIEs, but only a weak bidirectional causality between real 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 causes GDP, and there also exists bidirectional causality between exports and GDP for the group. Our results indicate that the panel data causality analysis has superior results over the time series causality analysis. Economic and policy implications of our analyses are then explored in the conclusions.

Keywords: FDI, Exports, GDP, Panel Data Causality Analysis, Granger Causality, VAR, Flying Geese Models, East Asia.

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1960년대 이후 진행되어 온 동아시아 국가들의 중층적 경제성장은 다른 지역에서는 예를 찾아보기 힘든 경우로서 이들의 경제적 성공요인에 대한 다양한 연구가 개발경제학 및 성장정책적 측면에서 활발히 이루어져 왔다. 본 연구는 이런 연구들의 연장선상에서 동아시아 국가들의 수출, 외국인직접투자 유입 및 경제성장 간 상호 인과관계에 대해 일관된 데이터 구득이 가능한 1981~2005년의 기간을 대상으로 시계열 및 패널 데이터 분석을 실시한다. 특히 본 연구는 동아시아 국가들을 제1세대 신흥공업국(한국, 싱가포르 및 대만)과 제2세대 신흥공업국(말레이시아, 필리핀, 태국 및 중국)으로 나누어 각 그룹별 차이점을 살펴본다는 데 그 특징이 있다.

본 연구는 먼저 일인당 GDP, 무역구조, 그리고 외국인직접투자 유입에 대한 개별 동아시아 국가들의 특성 및 제1세대 및 제2세대 신흥공업국들 간 차이를 살펴본 후, 최근의 실증분석 관련문헌들을 검토하였다. 그리고 동아시아 7개국을 대상으로 1981~2005년의 데이터를 이용하여 GDP, 수출, 외국인직접투자 유입 등 세 변수간 상호 인과관계를 확인하기 위해 벡터자기회귀(VAR)모형을 추정하였다. 개별국가에 대한 분석결과, 국가별로 서로 상이한 인과관계를 보여 일반화된 결론을 제시할 수 없었다.

이에 본 연구는 제1세대, 제2세대 신흥공업국, 그리고 동아시아 전체를 대상으로 하여 각각 패널데이터를 구성한 후 각 그룹에서의 세 변수간 인과관계를 분석하기 위해 고정효과 및 임의효과 모형을 이용하여 패널 VAR 추정을 실시하였다. 패널인과관계 분석결과 제1세대 신흥공업국 그룹에서는 세 변수간 강한 양방향의 인과관계를 발견할 수 있었다. 반면 제2세대 신흥공업국 그룹에서는 단지 수출과 GDP 간에서만 약한 양방향의 인과관계를 찾을 수 있었다. 한편 동아시아 전체 그룹에서는 외국인직접투자가 일방향으로 GDP에 영향을 미치는 동시에 수출을 통해 간접적으로 GDP에 영향을 미치는 것으로 나타났고, 수출과 GDP, 수출과 외국인직접투자 간에는 강한 양방향의 인과관계가 존재함을 발견하였다. 본 연구의 결과는 정책적으로 매우 흥미있는 시사점을 제시함과 동시에 패널데이터 분석이 개별국 시계열데이터 분석보다 우월함을 보여주고 있다.

Yongkul Won is an associate professor of economics at the University of Seoul. He has been teaching and working in fields of international economics, macroeconomics, and development economics. He was a Research Fellow at the Korea Institute for International Economic Policy (KIEP) from 1995 to 1998. He was also a visiting scholar at the University of Colorado-Boulder. He has written many articles and books on international economics, economic development and East Asian economies. His publications appeared in *European Economic Review*, *Korean Economic Review*, *Seoul Journal of Economics*, and *Journal of East Asian Affairs*.

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FDI Inflows, Exports and Economic Growth in First and Second Generation ANIEs: Panel Data Causality Analyses

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I. 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 NIEs, Taiwan, Korea, Singapore and Hong Kong, in the 1970s and 1980s. In the latter half of the 1980s, while the Asian NIEs have continued to grow, the ASEAN-4, Indonesia, Malaysia, Philippines, Thailand, along with China, started rapid growth, and the growth fever spread to Vietnam and India in this new millennium. The rapid clustered sequential growth of 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 2006), and is dubbed as the "flying-geese" model of

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development (Kojima 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 (ADO 1999), especially Korea, Malaysia, Philippines, and Thailand, nevertheless, within a few years, all Asian economies have successfully resumed their rapid growth since then.

Many factors have contributed to rapid sequential growth in Asia. According to the World Bank (1993), the major factors are, among others, open economy in the sense of export oriented policy and foreign direct investment (FDI)-led growth, market friendly government, high levels of domestic saving and accumulation of human capital. UNCTAD (1995) points to the importance of "mutual interactions between countries through demonstration effects, learning and emulation, with the transmission mechanism being flows of people, trade in goods and services, flows of FDI, technology and other TNC-related assets. A characteristic feature of the 'flying-geese' pattern in Asia has been the increasing role of TNC, initially through non-equity arrangements and joint ventures and more recently through FDI." Hsiao and Hsiao (2003a) explain Korea and Taiwan's postwar rapid growth by emphasizing the continuity and impact of economic and social infrastructure built before WWII and external international economic environment after WWII. More, specifically, OECD (2005) find six external factors: the US-centered, bilateral security treaties and the regional forums, multilateral trade liberalization under the GATT/WTO, massive increase in Japanese outward FDI due to yen's real appreciation in the 1970s and market fragmentation due to "microelectronic revolution, emergence of trade nexus among Japan-ANIEs/ASEAN-US and the role of FDI from OECD countries, free labor migration, and finally, the role of international aid or official development assistance (ODA) programs. In general, OECD (2005) observed that Asian Miracle is achieved through coherent international economic environment created by OECD countries and the adoption of openness policies of trade-FDI nexus in Asia. (Chapter 1 in Fukasaku 2006; Hsiao 2007). Elsewhere, Hsiao and Hsiao (2001, 2003b) also emphasized the imprtant role of trade-FDI nexus of the pacific trade triangle among Japan, the rest of Asia, especially ANIEs, and the United States.

Thus, institutional and organizational factors aside, the most common economic factor mentioned in these studies is openness of the economy, namely, export promotion policy, and acceptance of inward FDI (with the exception of Japan, the first geese). The role of trade and FDI have been extensively discussed in recent years both in theory and in practice, (see Sections 4 and 5 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–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 time series and panel data analyses, taking the data from seven rapidly developing countries in 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 Asia with clearly recognizable different stages of development. This may give us some useful policy implications.

The structure of the paper is as follows. In Section 2, we explain and justify the choice of the seven economies by examining their historical performance of real GDP per capita from the global economic perspectives. We also study in details the trade and FDI structures of the first and second generation ANIEs. The East and Southeast Asian (EASEA) economies are known for their rapid 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 3 examines the statistical characteristics of the data in each economy and also among the EASEA economies. In Sections 4 and 5 we review some recent theoretical and empirical literature on the causality relations among the three variables in a country or a group of countries. Section 6 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 (VAR) and error correction models (ECM) in Sections 7 and 8. In Section 7, we first assess the Granger causality relations of each economy using time-series data from 1981 to 2005.

In Section 8, we construct the panel data for three groups, the first generation ANIEs, the second generation ANIEs, and all seven EASEA economies, and then apply the fixed or random effects model to estimate the panel data VAR and perform the Ganger causality test. The last section concludes by summarizing our findings and discusses the policy implications.

II. East and Southeast Asia in the World Economy

As noted in Introduction, instead of lumping countries with different backgrounds and stages of development in cross-section analysis, this paper deals only with seven Asian economies. We have excluded Hong Kong from the four NIEs and Indonesia from ASEAN-4 because their FDI data contain negative entries which we can not take logarithm in the following econometric analysis. Thus, in our analysis, the first generation Asian newly developing countries (ANIEs) consist of Korea, Taiwan, and Singapore (3EA), and the second generation Asian newly developing countries (ANIEs) consist of three ASEANs, Malaysia, Philippines, and Thailand (3SEA), plus another newly developing country, China. Thus, we have chosen seven first and second generation rapidly developing countries in Asia.

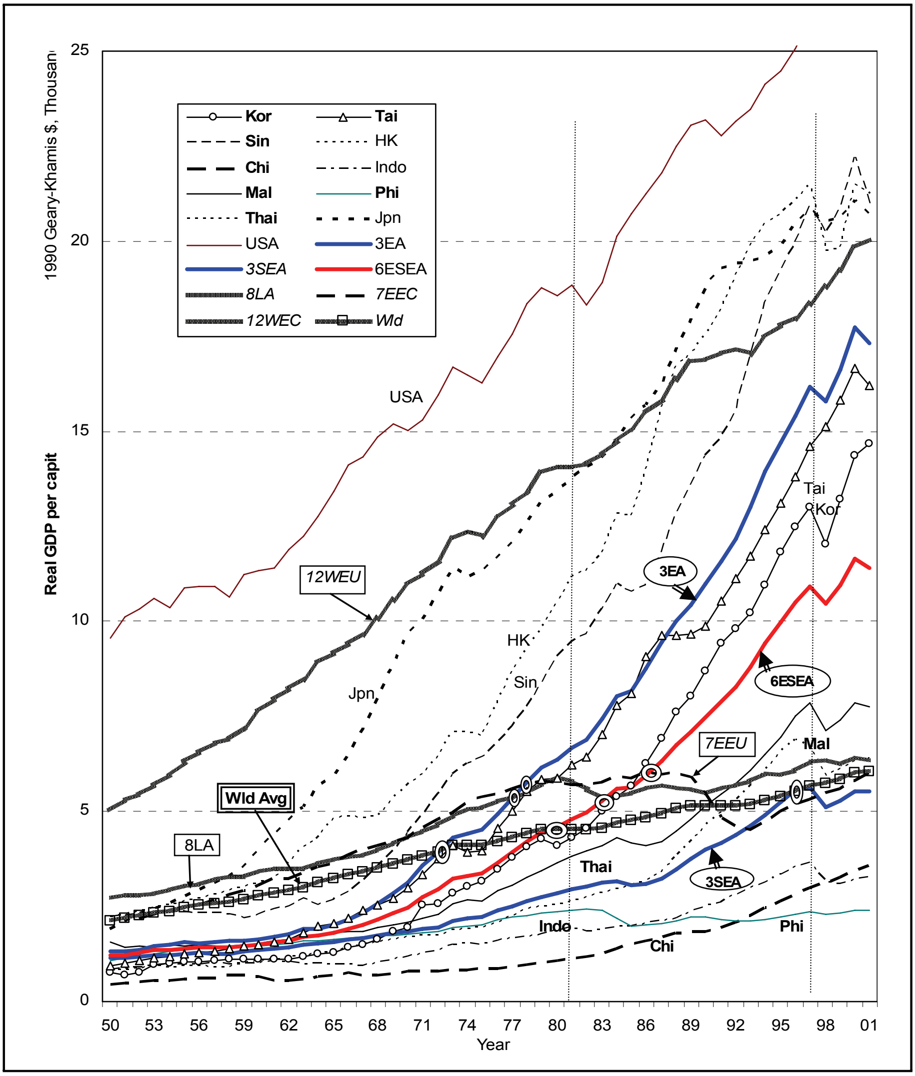
1. Real GDP Per Capita of the ANIEs

To show the unique development position of the seven economies in the world economy, Figure 1 presents real GDP per capita of the EASEA economies and other world geographic regions[1] compiled by

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

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 seven Asian economies, namely 3EA,

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



3SEA, and China, have grown and stand out in the world economy. Japan, the “leading geese” in Asia, and the USA are included in the figure just for comparisons.

Indeed, the diagram shows vividly that the average real GDP per capita of the East Asia and South East Asia, denoted as 6EASEA in the chart, surpassed, as shown by double circles, the world average real GDP per capita (Wld Avg, the solid line with squares) in 1980, that of the eight Latin American countries (8LA) in 1984 and also that of the seven East European Union countries (7EEU) in the 1987, after which it grew rapidly and led these three regions far and far away. The chart shows the dynamism of the East and Southeast Asia in the world economy, as compared stagnating growth of average eight Latin American countries (8LA) and average 7 East European countries (7EEU).

The dynamism is, as we will show below, brought about by the increased exports and investment in the region. It should be noted, however, among these six East and Southeast Asian countries, we may divide into two quite different groups. The first group is Asian Newly Industrializing Economies (ANIEs), Taiwan, Korea, and Singapore (3EA). They grew much faster than the other three (3SEA). The average real GDP per capita of the NIES surpassed the average real GDP per capita of the world average (Wld) in 1972, the eight Latin American countries (8LA) in 1977, the seven East European countries (7EEC) in 1978, and accelerated far faster after 1978. While the small city-state economy, Singapore (Sin) (and Hong Kong (HK)), had already caught up with the average of the 12 Western European countries (12WEC) in 1993 and with Japan (Jpn) in 1997, Taiwan (Tai) and Korea (Kor) are growing closely to each other and are also poised to catch up with the average real GDP per capita levels of the Western European countries (Hsiao and Hsiao 2003a).

The second generation group, Malaysia, Philippines, and Thailand, grew much slower (see 3SEA). The average GDP per capita of these three counties even did not surpass the World Average by 2001, the closest they can go is in 1996, and then it decreased after 1997 due to the Asian Financial Crisis. China is not included in 3SEA. While China's economic growth in recent years has been eye-opening, it has never caught up even with the average of 3SEA, and still much less than the World Average. Thus, up to 2001, China's real GDP per capita level is clearly in the same group as Indonesia and Philippines. On the other hand, Malaysia and Thailand are only slightly above the world average by 2001, but still far below the average of NIEs.

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 Average. In 1950, the average real GDP per capita of the seven Asian economies (7EASEA) was only about 60% of the world average or only 50% of the average of the eight-Latin American economies (8LA). However, after 50 years of development, they exceeded the average of the 12 Western European countries between late 1980s and early 1990s. Taiwan and Korea started well below the world average in 1950, grew side by side (Hsiao and Hsiao 2003a), and accelerated considerably in the 1980s.

Figure 1 shows clearly that the seven East and Southeast Asian economies as a whole really took off relative to other world regions after the early 1980s. For our time series and panel data analysis, we would like to take the data as long as possible. However, monthly and quarterly data are not available for all variables, and annual data before 1980 are also not readily available. Thus, we take the annual data from 1981 to 2005. Figure 1 shows the period after 1981 can be a starting point that the seven Asian economies forked out from the other regions, and, as a group, 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 EASEA economies. By examining their dynamic phase, instead of prolonged period, we wish to reduce the possible heterogeneity problem among the countries in the process of estimation: this heterogeneity problem has been pointed out by Nair-Reichert & Weinhold (2000). Thus, we have chosen the data from 1981 to 2005 for our study.

To find the characteristics of the time trend, we fit a polynomial equation of degree 4 to the data, as shown in Figure 2. The fitted trend lines are as follows:

3EA $y = -0.0024x^4 + 0.2509x^3 - 0.7351x^2 + 11.708x + 1345.2$
$R^2 = 0.9976$

3SEA $y = -0.0012x^4 + 0.1304x^3 - 2.6836x^2 + 48.055x + 1041$
$R^2 = 0.9855$

6EASEA $y = -0.0018x^4 + 0.1906x^3 - 1.7094x^2 + 29.882x + 1193.1$
$R^2 = 0.9964$

China $y = -0.0005x^4 + 0.0896x^3 - 3.0564x^2 + 44.593x + 411.89$
$R^2 = 0.9968$

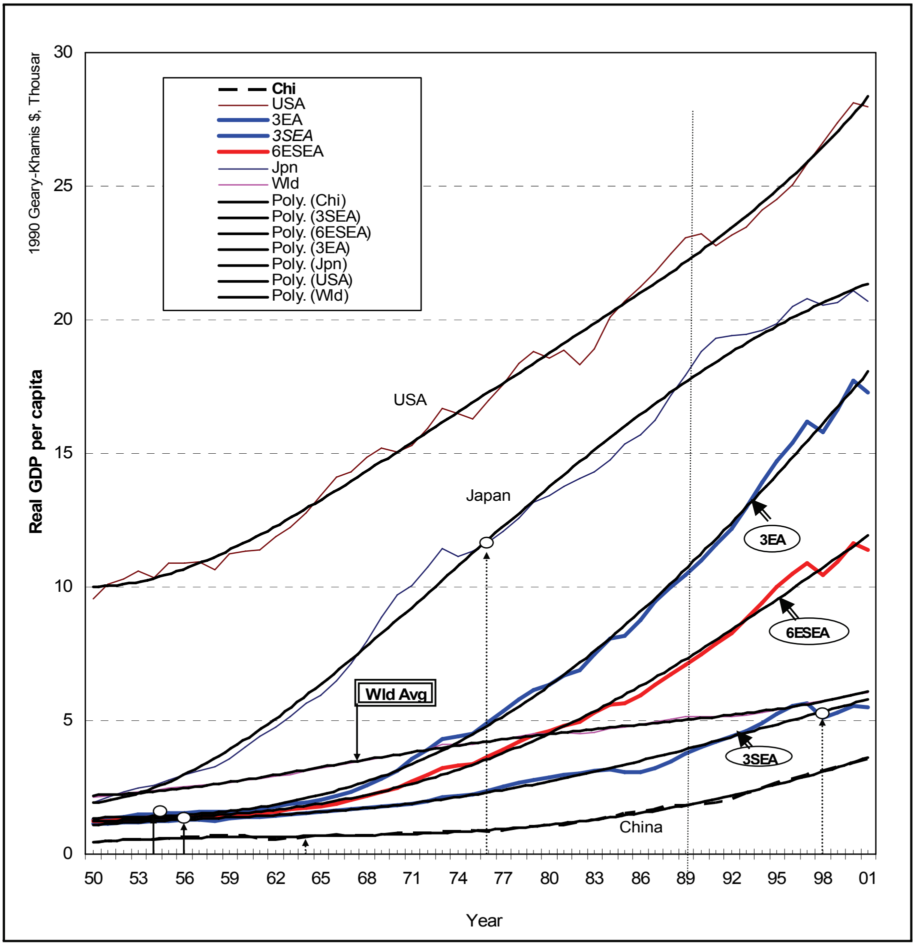
Japan $y = 0.0021x^4 - 0.407x^3 + 22.291x^2 + 19.655x + 1873.4$, US
$R^2 = 0.9945$

USA $y = 0.0053x^4 - 0.5823x^3 + 23.51x^2 - 48.031x + 10047$
$R^2 = 0.9942$

World $y = 0.0021x^4 - 0.2189x^3 + 7.2872x^2 - 3.0269x + 2196.4$
$R^2 = 0.9977$

where x denotes time ranging from 0 to 52. All the trend lines have almost perfect fit. Using these trend lines, we took the first, the second and the third difference of the consecutive years. We found that the first generation 3EA has a point of inflection at 1953, that is, its real GDP per capita increases at a decreasing rate (concave from

Figure 2. Polynomial Trend Lines of Real GDP Per Capita East and Southeast Asia and the World



below, or decelerate) up to 1952, and then increases at an increasing rate (convex from below, accelerate) after 1953. The second generation 3SEA growth decelerated up to 1959, and then accelerated up to 1997, but started deceleration again after 1998. On average, the six Asian countries (6EASEA) growth decelerated (concave) before 1953, accelerated (convex) from 1954 to 2001, and started decelerating (concave) in 2002. This is in contrast with the case of Japan, which accelerated up to 1975 and started decelerating after 1976. The United States growth has been accelerating all the way from 1950 to 2002. If the trend of 3EA persists, we may expect the average real GDP per capita growth of the first generation NIEs to catch up with that of Japan in near future (Hsiao and Hsiao 2004a). Note that China's growth has decelerated until 1963, but started accelerating after 1964. For China, there is no indication that the acceleration may cease like 3SEA.

2. The Trade Structure of the First and Second Generation ANIEs

To show the general dynamism of East and Southeast Asian economies, we present the trade structure of the four NIEs, Korea, Taiwan, Singapore, and Hong Kong, the first generation Asian countries, denoted as NIE4, and five ASEAN countries, namely, Indonesia, Malaysia, Philippines, Thailand, and Vietnam, denoted as ASEAN5 (AS5), along with China. Thus, in this and the next subsection, we consider the six second generation Asian countries. As usual, Japan, the first geese in the hierarchy of the flying geese model, is included for reference. All together, we have 11 major Asian countries in this group. Following Asian Development Bank, we call them "EASEA"

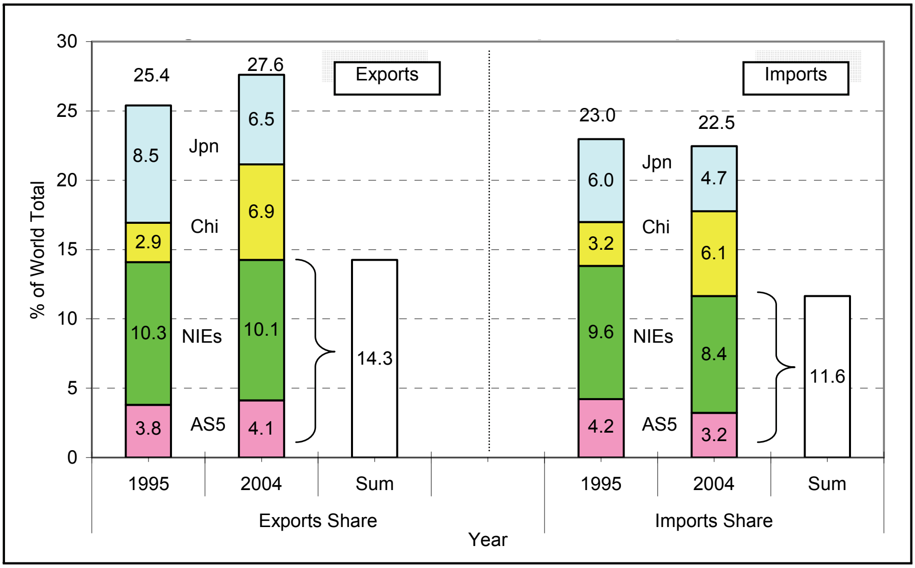
(ADO 2007). Thus, our discussions in this and the next subsections present general view of the economy in East and Southeast Asia as a whole.

Figure 3 shows the EASEA share of world exports and imports of 1995 and 2004. The exports of the 11 economies of EASEA alone consist of 25% of world total exports in 1995 and it even increased to 28% in 2004. Similarly, the imports of EASEA consist of 23% of the world total imports in 1995 and maintain almost the same level in 2004. Considering that the world trading volume and value are increasing every year, this EASEA trade performance indicates unprecedented vigorous production and trading activities in this part of the world. The difference in exports and imports shares also indicates that the region accumulated huge trade surpluses *vis-à-vis* the rest of the world, mainly with the United States.

The number in each compartment of the stacked column in Figure 3 shows the world share (in percentage of world total exports or imports) of exports and imports in four areas: from below, AS5 (in pink), NIE4 (in green), China (in yellow), and Japan (in blue). About half of the EASEA share comes from NIE4 and AS5, and the share of NIE4 is twice as much as the AS5 share. The rests are divided between Japan and China. Note that China's exports share increased more than twice and imports share almost twice in nine years from 1995 to 2004, eroding the Japanese share. With its enormous area and population, China becomes the single factory of the world, if the four tiny NIEs are excluded.

What are they trading? The analyses of exports and imports structure of EASEA are much more revealing and relate trade directly with economic development. The stacked columns of Figures 4 and 5

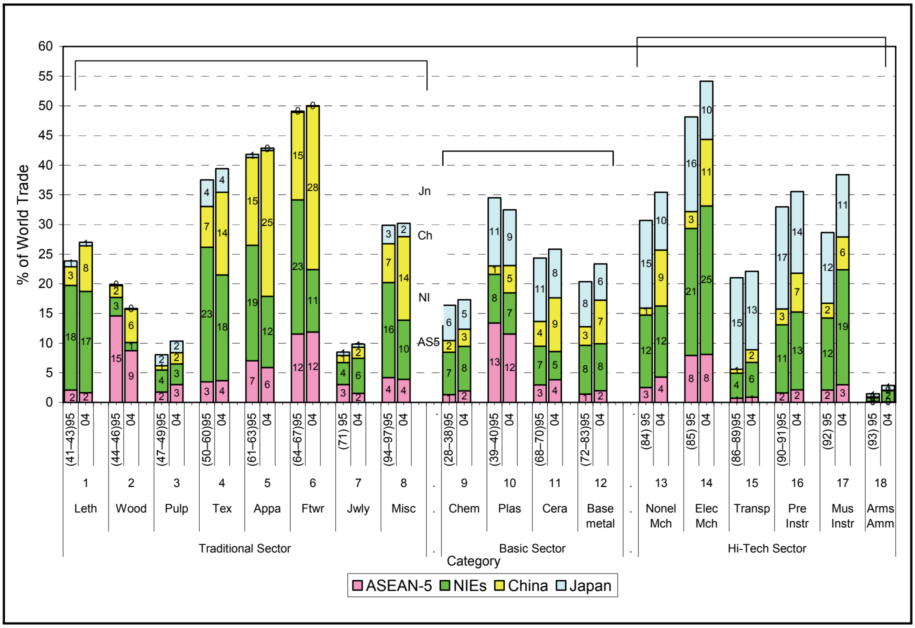
Figure 3. Asian Share of World Exports and Imports



show the world exports and imports shares of 18 manufacturing industries in EASEA in 1995 and also in 2004, expressed as the percentage of the world total of each industry. The classification of the industrial category is based on Harmonized System (ADO 2007, p. 83), and is listed in detail in the Appendix B of this paper. For easier reading, we have reclassified the 18 industries in three sectors: Traditional sector, consisting of eight industries, leather, wood, textile, apparel, footwear, jewelry, and miscellaneous industries; Basic sector, consisting of four industries, chemicals, plastic, ceramic, and base metal industries; and Hi-Tech sector, consisting of six industries, non-electronic machinery, electronic machinery, transportation, precision instruments, music instruments, and arms and ammunition industries.[2)]

2) This classification roughly follows that of Hsiao and Park (2002, 2005).

Figure 4. Structure of Exports (% Share of World Trade) 1995 and 2004



Same as Figure 3, the number in each compartment of the stacked column in Figures 3 and 4 shows the world share (in percentage of world total exports or imports) of each industry in four areas: from below, AS5 (in pink), NIE4 (in green), China (in yellow), and Japan (in blue).

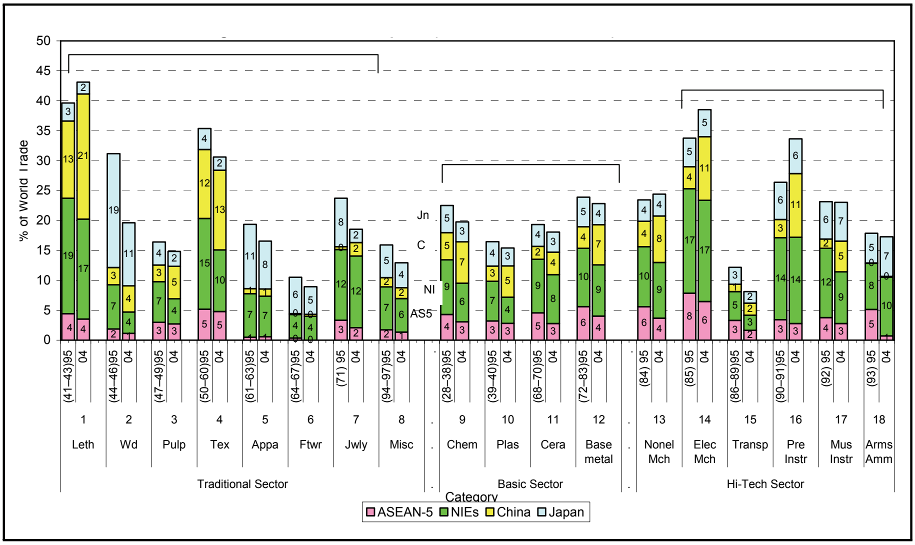
Overall, Figure 4 shows that among the 18 industries, between 1995 and 2004, EASEA exported more than 50% of electric machinery of the world electric machinery exports, almost 50% of world footwear exports, more than 40% of world apparel exports, and more than 30% of world miscellaneous (furniture, toys, sports equipment and art) plastic, precision instruments, and music instruments exports. From 1995 to 2004, the exports of eight industries in traditional and basic industries either decreased or most of them increased slightly, while all six hi-tech industries increased considerably, indicating that the ASEAN manufacturing industries upgrading its industrial structure from traditional industry to hi-tech industry.

The change of exports shares of individual areas reveals the flying geese pattern of industrialization over the nine years. By mid-1990s, Japan is almost completely out of the business of the traditional sector (this was not the case in the 1970s, see Hsiao 1990; Hsiao and Hsiao 1995), reduced its already small world shares slightly in the basic sector industries, and lost considerably in hi-tech sector industries to China and the NIEs. For NIEs, they are generally more active exporters among the four areas. However, their exports shares of eight traditional sector industries are uniformly decreasing, while those of the hi-tech sector industries are either stay at the same, or expanded greatly, like non-electric and electric machinery (#13, from 1% to whopping 9%; and #14, from 3% to 11%) and music (#17, from 12% to 19%), indicating their rapid expansion of industrial structure from the traditional sector to the hi-tech sector.

On the other hand, China expanded considerably its shares in all 18 industries in nine year in recent years. The expansions are especially prominent in traditional and, in a lesser degree, in hi-tech industries. Apparently, in view of its size of population and area, China can afford to promote traditional and hi-tech sectors simultaneously through vigorous inward direct investment (Hsiao and Hsiao 2004b; also see the next section). The exports shares of the AS5 also increased slightly or stay the same at low levels in most of the 18 industries. The increases are mostly small, about 1%, indicating that, like their average real GDP per capita growth, they still have a long way to catch up with the NIEs.

Figure 5 presents the world imports share structure of EASEA. The height of the columns is generally lower than those of exports in Figure 4, except the first six industries in the traditional sector. Clearly, EASEA countries imports leather and fur products (#1, over 40% of the world share) and wood and cork (#2, about 25% of the world share), and exports in the form of apparel (over 40% of the world share) and footwear, including headgear and umbrellas (#6, about 50% of the world share). Note that, in contrast with exports structure, Japan is a large importer of traditional sector products, especially wood, apparel, and footwear. Like the exports structure, NIEs generally have large import shares, especially in hi-tech sector industries, indicating vigorous trading activities of the four economies. Note NIEs imported whopping 17% of electric machinery (#14), 14% of precision instruments, and 10% of non-electric machinery (#16), while their exports of these products consisted of 25%, 13%, and 12% in 2005, indicating intra-industrial trading structure in the hi-tech sector industries in the resources poor NIEs. Note also that, like its exports share structure, China's imports of hi-tech products, although the shares are smaller than those of NIEs, also increased considerably, indicating rapid catch up of Chinese hi-tech sector with that of the NIEs. Similar to the export share structure, ASEAN5's import shares of 18 industries are small, except electric machinery (#14, 6% to 8%), and between 1995 and 2004, all 18 industries show the tendency of either remaining the same or decreasing, especially in the hi-tech sector industries, apparently squeezed by NIEs and China. In view of the lower exports share in hi-tech sector and large population, ASEAN countries appear to import hi-tech products for domestic

Figure 5. Structure of Imports (% Share of World Trade) 1995 and 2004



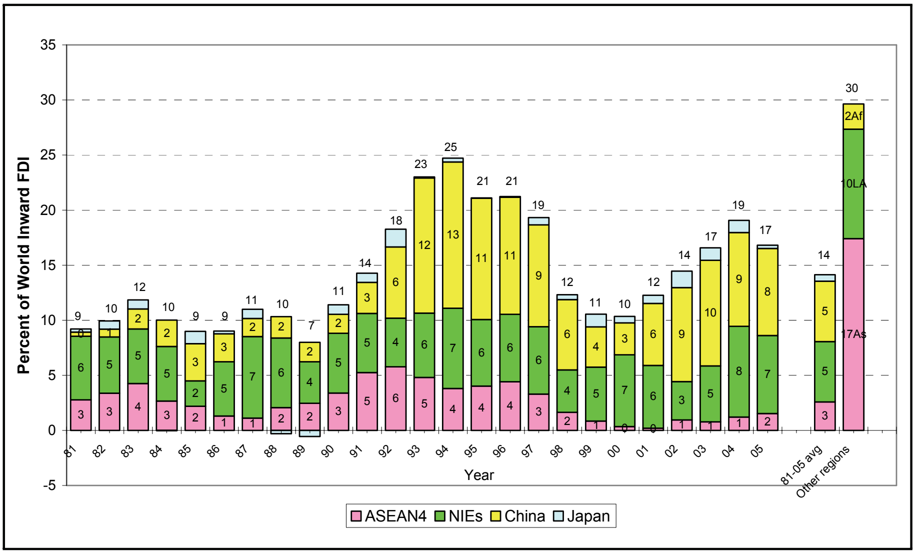
market, rather than processing for exports like NIEs.

In addition to extra-regional trade, intra-regional trade also increased enormously among EASEA countries (ADO 2007). Elsewhere, Hsiao and Hsiao (2003b, 2007) examined how the recent information technology (IT) revolution has increased interdependence through two channels: in terms of the real linkage through trade and investment, and the financial linkage through stock markets, among these seven economies along with the United States and Japan. Recently, based on the Flying Geese Model, Kojima (2000) and Ozawa (2003) show the sequential development of these countries in details. Applying a gravity-coefficient index to East Asia and Southeast Asia, Petri (2006) also shows that the regional interdependence of these seven Asian economies has increased since the mid-1980s, as compared with other periods.

3. The FDI Structure of the First and Second Generation ANIEs

In addition to vigorous trading activities, EASEA counties can equally be characterized as the most active inward FDI (or simply, FDI) region among the developing countries. The last two stacked columns of Figure 5 attest to this. Since FDI in Vietnam only started in 1990 and very small, ranging from US$ 0.1 to 0.5 million, we have excluded Vietnam from EASEA. Thus, in this subsection we have four ASEAN countries, denoted as ASEAN4. According to UNCTAD (2006), from 1981 to 2005, the average FDI to EASEA was 14% of the world total FDI, shared equally among NIEs and China at 5%, AS5 at 3%, and Japan less than 1%. Compared with over 25% world export share, 14% world share appears to be small. However, the bulk of world FDI, average 70% from 1981 to 2005, went to the

Figure 6. East and Southeast Asia Share of World Inward FDI



developed countries like the United States (24%) and European Union (36%), the rest, 30% goes to the developing countries. The last column of Figure 5 shows the distribution of FDI among developing countries: 17% went to Asia and Oceania, 10% to Latin American and Caribbean, and mere 2% went to Africa. Thus, the 11 economies of EASEA are the largest receiving region of world FDI among the developing countries.

As might be expected, the amount of FDI to EASEA fluctuated considerably. After a long stagnation during the 1980s at around 10% of the world share, FDI to EASEA increased rapidly from 1990 up to 1994, and then decreased precipitously after the Asia financial crisis of 1997. It recovered quickly after 2001, although, by 2005, it has not been fully recovered to the pre-crisis peak of 25% in 1994. The recovery was mainly due to expansion of China's FDI after 1999, while recovery of FDI to NIEs has been slow. Japan's inward FDI has been almost negligible, and FDI to AS5 after crisis is still depressed, far from recovery. In general, in terms of world share, we may state that the bulk of FDI to EASEA went to NIEs and China, but not so much to ASEAN4.

Although the world share of FDI into ASEAN4 is rather small, the impact of FDI depends on sectors to which FDI occurred. In many cases, FDI went to key industries in hi-tech sector and lead the trade of that sector. The host economy grows through technology transfer from the foreign firms.[3] As the inward FDI increases, their intra-regional exports and inter-regional exports to other regions also grew considerably (Hsiao and Hsiao, 2003b). Thus, it is also of great

3) For a theoretical inquiry, see Cho and Hsiao (2007).

interest theoretically and empirically to examine the interdependence and the role of the three important variables, FDI, exports, and GDP, in the development process of these ANIEs countries during the period from 1981 to 2005.[4)]

4) Note that, including other countries, especially, stagnant, non-export promoting, low growth, or low FDI countries, into our sample will worsen the heterogeneity problems.

III. Characteristics of the Individual ANIEs Country Data

Since Maddison's data consist of only GDP per capita, for our purposes, we use the data from the WDI dataset (2007), as explained in the Appendix A on the data sources. To examine the data, we graphed the time-series of real GDP, real merchandize exports, and real inward foreign direct investment for each of the nine Asian economies from 1981 to 2005 in the nine charts of Figure 7 (see the explanation of construction of real variables in the Appendix A). Since the magnitude of FDI is generally very small as compared with GDP and exports, we gave drawn real FDI on the secondary Y-axis in all the charts in Figure 7. From Figure 7, we found some interesting characteristics from the country data. Like Figure 6, we have deleted the chart for Vietnam since we consider Vietnam, along with Cambodia, etc. belongs to the third generation NIEs.

In Figure 7, except Philippines, the real GDP levels of all other economies have increased overtime, and except China, all 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, Hong Kong and Singapore. Exports play a vital important role in all nine economies. By 1997, the real exports have exceeded real GDP in Hong Kong and Singapore, almost the same in Malaysia. In other countries, the amount of real 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

Figure 7. Real GDP, Exports, and FDI

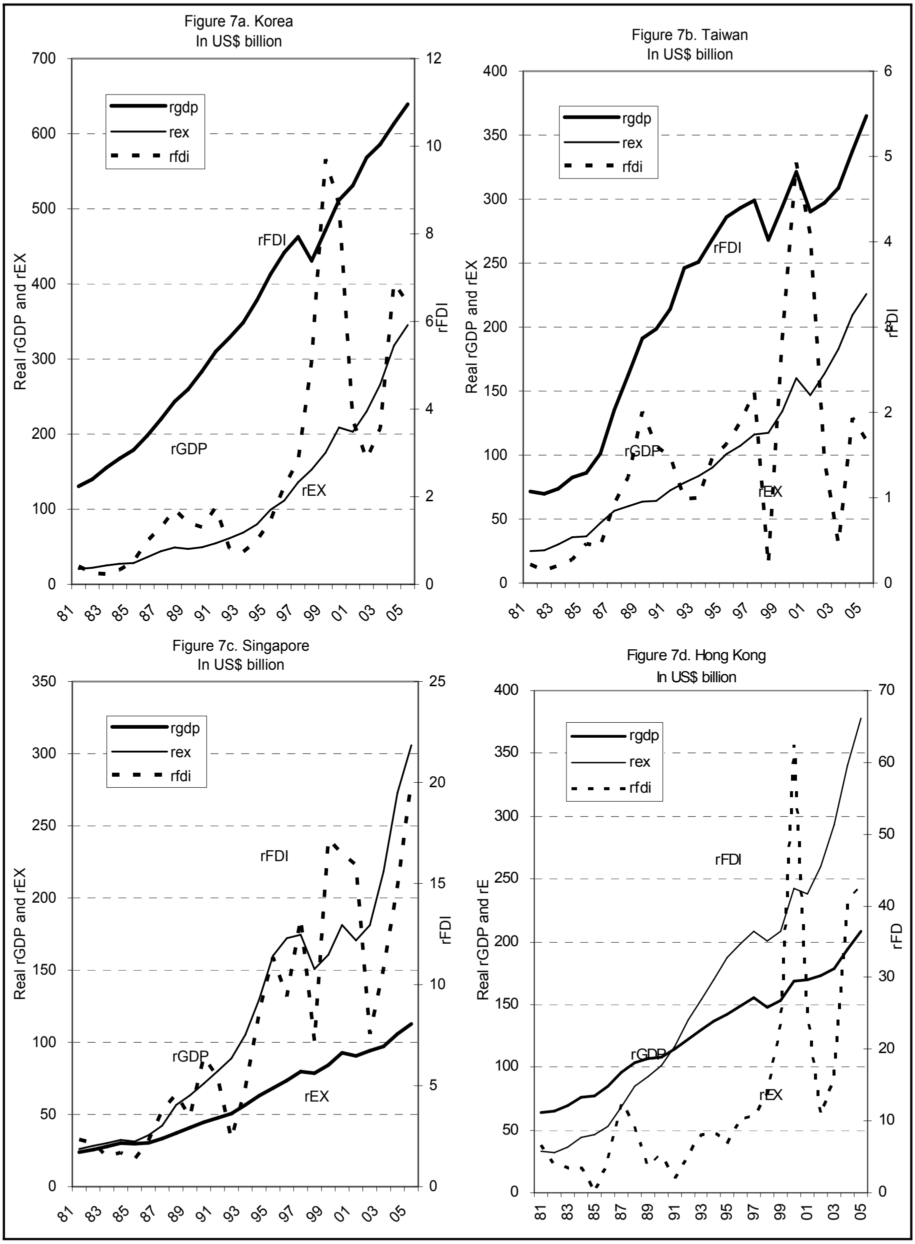


Figure 7. Continue

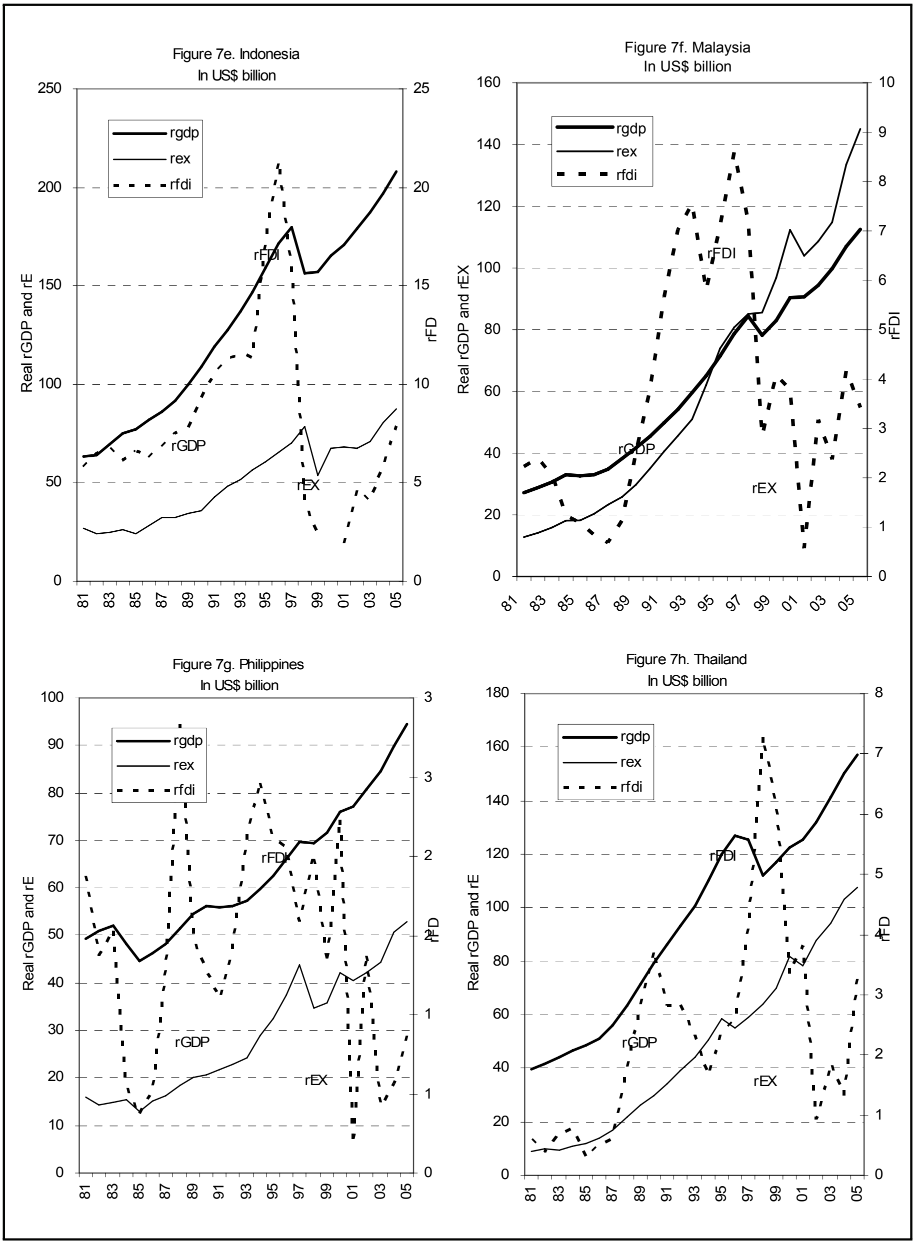
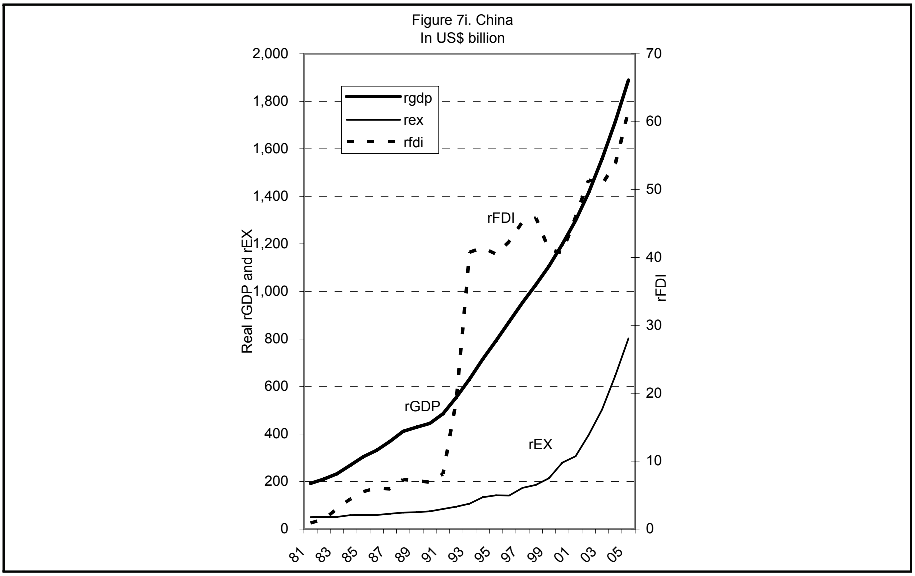


Figure 7. Continue



Asian financial crisis of 1997 also exerted impact on 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 real GDP and real exports shows that they appear to be strongly correlated.[5)]

Compared with real GDP and real export activities, real FDI in each economy fluctuates considerably, and has much lesser weight, almost negligible, in terms of its amount, as indicated by the large difference in scale of main (left-hand) Y-axis and that of the

5) The simple correlation coefficients between these two variables for the seven economies for 1981-2005 range from 0.17 (for Philippines) to 0.89 (for Singapore). The correlation coefficients for China, Korea, Taiwan, Malaysia, and Thailand are 0.75, 0.48, 0.61, 0.66, and 0.35, respectively.

secondary (right-hand) Y-axis. China and Hong Kong, and possibly in Singapore are exception. Thus, one may doubt the importance of FDI on an economy. Furthermore, except China and, to a lesser degree, Hong Kong, real FDI tends to decrease after the 1997 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,[6] 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 technology transfer and exports in these sectors. Thus, FDI may have a strong influence on the growth of GDP in a country.

We have seen that 1997 Asian financial crisis exert influence on the time-series of real GDP, real FDI, and real exports. All these three variables, except those in China, 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 1997 Asian financial crisis, we introduce a dummy variable with the value equals to zero for 1981 to 1997 and the value equals to one for 1998 to 2005 in Granger causality test equations in Sections 7 and 8 below. We also note that FDI inflows in Hong Kong in 1985 and in Indonesia around 2000 have negative values.

6) Statistically, this problem is mitigated by taking the variables in logarithmic form, as we do in later sections.

IV. Review of Theoretical Literature

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 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.[7)]

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

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

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 between FDI, exports and GDP (a proxy for economic growth) among the rapidly growing seven major economies in Asia: the three first generation Asian NIEs, Korea, Taiwan and Singapore and the four second generation Asian NIEs, the three Southeast Asian countries, Malaysia, the Philippines and Thailand, plus China. We have excluded Hong Kong and Indonesia since their FDI data contain negative entries. 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.

V. 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[8] 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[9] from 1970 to 1999; Alici and Ucal (2003) found only unidirectional causality from exports to output[10] for Turkey using seasonally unadjusted quarterly data from 1987.1 to 2002.4; Dritsaki, Dritsaki and

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8) 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.

9) There is no indication that the data were deflated.

10) They use Turkish industrial production index as our GDP, export price index as our exports, along with real FDI.

Adamopoulos (2004) found a bidirectional causality between real GDP and real exports, unidirectional causalities from[11] 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. 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

11) There is no indication that FDI data were deflated in their paper.

here, only look at the one-way determinants of FDI in regression analyses rather than at the two-way causality linkages between 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[12)] 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 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) has examined the Granger causality relations between GDP, exports, and FDI among 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. Based on the method used in Hsiao and

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

Hsiao (2006), Cho (2005) applied the panel data causality analysis and found only a strong unidirectional causality from FDI to exports among the three variables, using annual data of nine economies (the same economies as in this paper plus Indonesia) from 1970 to 2001. In Cho's model, however, GDP growth is taken as the Malmquist productivity index. This paper follows closely the methods used in Hsiao and Hsiao (2006), but, as we have explored in the first part of this paper, we divide the Asian Newly Developing countries further into two groups, the first and second generation countries, and compare the performance of the three variables in individual country, within each group, and among the two groups together.

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. Our econometric study follows.

VI. 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,[13)] 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[14)] of the Keynesian model of aggregate demand and aggregate supply is

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

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

13) 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).

14) Not national income identity.

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,[15] 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 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 7.2 below shows the final form of the VAR model, which may be written either in levels or differenced series.

15) 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.

VII. Individual Economy's Granger Causality Test

The econometric technique requires transforming the values of all real variables into their logarithmic values. The transformed level series are denoted by the 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 the same as the continuous growth rates, or percentage changes, of the variables, and are denoted by dgdp, dex, and dfdi in this paper.

In this section, we explain the procedures of 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, we then use the cointegration test among the three series. If the series are cointegrated, then we use error correction models (ECM) to estimate the coefficients. Based on the characteristics of the time-series data for each economy, we select either the level series or the first-difference series in the estimation of a vector autoregression (VAR) model for Granger causality test.

Since Indonesia and Hong Kong have negative values of FDI on which logarithm does not exist, we have seven countries in our causality analysis: three ANIEs, namely, Korea, Taiwan and Singapore, and three ASEANs, namely, Malaysia, the Philippines, and Thailand, in addition to China. The data ranges for 25 years, from 1981 to 2005. The sources of data are explained in Appendix A.

1. Unit Root and Cointegration Tests

The most commonly used tests of the unit root in time-series are the Dickey-Fuller (DF) test and the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1979, 1981; Said and Dickey 1984). However, their test critical values (or p-values) for different small sample size has to be approximated asymptotically by simulation methods. MacKinnon (1996), applying response surface analysis to annual data, calculated the test p-values (and critical values) for 20 observations, which are available in an econometric software package.[16] Since our sample has 25 observations for each country from 1981 to 2005, it has more than 20 observations. Thus, this paper uses MacKinnon's p-values (or critical values) in the DF or ADF unit root test.[17].

While the DF or ADF unit root test has been the most commonly used test, there are some other tests which have higher power in the sense that the tests are more likely to reject the null hypothesis H_0 of a unit root and accept the alternate hypothesis H_1 of no unit root. Following the suggestions of Maddala and Kim (1998) and Stock and Watson (2003), we also apply two other unit root tests, the DF-GLS test (Elliott, Rothenberg, and Stock 1996) and the KPSS test (Kwiatowski, Phillips, Schmidt and Shin 1992) for comparison. However, the test critical values available for application in the DF-GLS test are calculated for 50 observations. Therefore, we need to be cautious when we

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16) See EViews 6.0 (2007).

17) MacKinnon (1996, p. 613, p. 615) pointed out the advantage of using annual data vs. quarterly or monthly data under i.i.d. error terms. We use annual data, because quarterly or monthly data are not available for FDI.

interpret the test results. On the other hand, the hypothesis testing of the KPSS test is opposite to the ADF test: the null hypothesis of KPSS is that the series is stationary and its alternate hypothesis is nonstationary. It appears that the test results for the ADF test and the KPSS test are often contrary, and require careful examination.

Tables 1 and 2 present the results from the ADF, DF-GLS, KPSS unit root tests for the level series and the first-difference series, respectively, for each country. In Table 1, for the level series, the three tests yield very similar results for China Thailand, and Malaysia, being level nonstationary, except fdi and gdp for Malaysia that have contradictory results. For Korea and Singapore, fdi is level stationary, but gdp is not, and ex has contradictory results. For Taiwan, ex and gdp are level nonstationary, but the test results for fdi are contradictory. For Philippines, all variables have mixed results. Therefore, at least for the latter four countries, we cannot use the level series in the estimation of regressions for causality analysis.

In Table 2, for these seven countries, the ADF, DF-GLS, and KPSS tests show that all the first-difference series are difference stationary series.[18] Since Table 1 shows all the three variables of Thailand, China, and Malaysia are level nonstationary, we may consider that all their level series are I(1) and we continue to test the cointegration among the three level series for each of these three countries using

18) China's dgdp as well as Korea's ex and Philippines' ex (in ADF test) reject the null hypothesis of a unit root at a weak 15% significant level. According to Maddala and Kim (1998), it is acceptable to set the level of significance around the 20% level in a unit root test. In addition, Phillips-Perron test for China's ex confirms that it is and I(1) series.

Table 1. ADF, DF-GLS and KPSS Unit Root Tests: Level Series

	ADF	DF-GLS	KPSS		ADF	DF-GLS	KPSS
1. Korea				**5. Philippines**			
ex	-3.086[1]$^{+}$ *(0.13)*	-3.154[1]	0.102	ex	-3.206[1]$^{+}$ *(0.11)*	-2.323[1]	0.129*
fdi	-3.477[1]* *(0.07)*	-3.691[1]**	0.085	fdi	-3.514[0]* *(0.06)*	-3.652[0]**	0.129*
gdp	-1.735[0] *(0.7)*	-1.785[0]	0.123*	gdp	-4.347[1]** *(0.01)*	-3.056[1]*	0.128*
2. Taiwan				**6. Thailand**			
ex	-1.902[0] *(0.62)*	-1.926[0]	0.131*	ex	-1.367[0] *(0.84)*	-1.832[1]	0.155**
fdi	-3.293[0]* *(0.09)*	-3.431[0]	0.139*	fdi	-2.633[2] *(0.27)*	-2.773[2]	0.136*
gdp	-0.743[0] *(0.96)*	-2.215[3]	0.381***	gdp	-1.836[1] *(0.65)*	-1.904[1]	0.155**
3. Singapore				**7. China**			
ex	-2.834[3] *(0.2)*	-2.873[3]	0.102	ex	0.420[0] *(0.99)*	-1.927[3]	0.535***
fdi	-3.606[0]* *(0.05)*	-3.682[0]**	0.077	fdi	-1.234[2] *(0.88)*	-1.258[2]	0.152**
gdp	-1.572[1] *(0.77)*	-1.752[1]	0.323***	gdp	-0.025[2] *(0.99)*	-1.30[1]	0.711***
4. Malaysia							
ex	-1.603[1] *(0.76)*	-1.795[1]	0.165**				
fdi	-2.201[0] *(0.47)*	-2.299[0]	0.1				
gdp	-1.736[0] *(0.7)*	-1.823[0]	0.117				

Notes: 1. The test equations include constant and linear trend.
2. The numbers in brackets and parentheses denote optimal lag lengths selected by minimum AIC with maximum lag=3 and p-values, respectively.
3. ***(**, *, +) denotes rejection of null hypothesis at the 1%(5%, 10%, 15%) level of significance, respectively.
4. For ADF and DF GLS tests, null hypothesis is that series has a unit root, while KPSS tests stationarity of a series.
5. In DF GLS tests, the critical values for the 1%, 5%, and 10% level, are -3.770, -3.190, and -2.890, respectively.
6. In KPSS test, the critical values for the 1%, 5%, and 10% level, are 0.737, 0.463, and 0.347, respectively.

Table 2. ADF, DF-GLS and KPSS Unit Root Tests: First-Difference Series

	ADF	DF-GLS	KPSS		ADF	DF-GLS	KPSS
1. Korea				**5. Philippines**			
dex	-4.007[1]*** *(0.01)*	-3.916[1]***	0.078	dex	-2.677[0]* *(0.09)*	-2.413[0]**	0.275
dfdi	-3.716[1]** *(0.01)*	-3.094[0]***	0.051	dfdi	-8.224[0]*** *(0.00)*	-8.388[0]***	0.11
dgdp	-4.213[0]*** *(0.00)*	-4.306[0]***	0.097	dgdp	-3.163[0]** *(0.04)*	-3.232[0]***	0.253
2. Taiwan				**6. Thailand**			
dex	-4.817[0]*** *(0.00)*	-4.442[0]***	0.098	dex	-3.698[0]** *(0.01)*	-3.426[0]***	0.104
dfdi	-3.954[3]*** *(0.01)*	-6.125[0]***	0.093	dfdi	-3.712[3]** *(0.01)*	-3.363[3]***	0.085
dgdp	-3.249[0]** *(0.03)*	-3.076[0]***	0.285	dgdp	-3.361[0]** *(0.02)*	-3.426[0]***	0.129
3. Singapore				**7. China**			
dex	-2.974[3]** *(0.05)*	-3.701[1]***	0.105	dex	0.050[2] *(0.95)*	0.030[2]	0.593***
dfdi	-4.268[2]*** *(0.02)*	-4.281[2]***	0.064	dfdi	-4.195[1]*** *(0.00)*	-3.612[1]***	0.308
dgdp	-2.952[0]** *(0.05)*	-3.010[0]***	0.151	dgdp	-2.563[0]$^{+}$ *(0.11)*	-2.629[0]**	0.311
4. Malaysia							
dex	-3.753[0]*** *(0.01)*	-3.654[0]***	0.126				
dfdi	-6.317[0]*** *(0.00)*	-6.466[0]***	0.092				
dgdp	-4.015[0]*** *(0.01)*	-4.107[0]***	0.077				

Notes: 1. The test equations include constant.

2. The numbers in brackets and parentheses denote optimal lag lengths selected by minimum AIC with maximum lag=3 and p-values, respectively.
3. ***(**, *, +) denotes rejection of null hypothesis at the 1%(5%, 10%, 15%) level of significance, respectively.
4. For ADF and DF-GLS tests, null hypothesis is that series has a unit root, while KPSS tests stationarity of a series.
5. In DF-GLS tests, the critical values for the 1%, 5%, and 10% level, are -2.686, -1.959, and -1.607, respectively. 6. In KPSS test, the critical values for the 1%, 5%, and 10% level, are 0.216, 0.146, and 0.119, respectively.
6. For China's real exports (ex) series, an additional Phillips-Perron test confirms that it's an I(1) series.

Table 3. Johansen Cointegration Test Results

Cointegrating rank(r)	China	Thailand	Malaysia	
	Trace statistics	Trace statistics	Trace statistics	C(5%)
$r = 0$	61.562**	51.348**	24.376	42.915
$r \leq 1$	19.086	19.529	11.553	25.872
$r \leq 2$	8.171	8.787	2.613	12.518
	λ -max statistics	λ -max statistics	λ -max statistics	
$r = 0$	42.475**	31.819**	12.822	25.823
$r \leq 1$	10.915	10.742	8.940	19.387
$r \leq 2$	8.171	8.787	2.613	12.518

Notes. 1. Intercept and trend in the cointegration equations are allowed.
2. The critical values, (C(5%)), for the tests are taken from MHM with size 0.05.
3. ** denotes rejection of null hypothesis at 5% level of significance.

Johansen cointegration test[19] (Johansen 1991; Greene 2003). Table 3 summaries the results from Johansen cointegration test. The trace and maximum-eigenvalue tests indicate that the level series, ex, fdi, and gdp, are cointegrated for Thailand and China, but not for Malaysia. For Thailand and China, therefore, we use the error correction models (ECM) to estimate the coefficients for causality tests. Based on these results, we have chosen to use the first-difference series, dex, dfdi, and dgdp, in the estimation of the VAR model for causality test for the remaining five countries – Korea, Taiwan, Singapore, Malaysia, and the Philippines.

19) It should be noted that Toda (1994) has shown that the LR tests need a very large sample size, 300 or more observations, to ensure good performance and to detect the true cointegrating rank. In applications, it is seldom to have very large sample size.

2. The VAR Model and Granger Causality Test

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

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

where y_t is a (3 x 1) column vector of the endogenous variables, i.e., y_t = (dex_t $dfdi_t$ $dgdp_t$)′ or (ex_t fdi_t $gdp_{t)}$′, μ is a (3 x 1) constant vector, p is the order of lags, each of Γ_1, Γ_2, …, Γ_p is a (3 x 3) coefficient matrix, each of y_{t-1}, y_{t-2}, …, y_{t-p} is a (3 x 1) vector of the lag endogenous variables, and ε_t is a (3 x 1) vector of the random error terms in the system. The lag length p in level series VAR is then selected by the minimum Akaike Information Criterion (AIC) with maximum lag equals to 3.[20)]

The results show that the optimal lag length in level series VAR for Taiwan is 3, 2 for the Philippines, and 1 for Korea, Singapore, and Malaysia. Following the suggestion of Toda and Yamamoto (1995), we added an additional one-lag if the optimal lag is 1. Since we have limited number of observations, we have not added an extra lag when the optimal lag is 3, as lag of 3 is sufficient and exceeds the order of integration and cointegration noted in Toda and Yamamot o.[21)] Our method is similar to Hansen and Rand (2006) and

20) The maximum lag is, therefore, 2 in the first-differenced series VAR.

21) Toda and Yamamoto (1995) proposed a method to over-fit VAR to

Chowdhury and Mavrotas (2006), but we have applied the new method to three variable-panel data causality analysis.

In the estimation process of VAR, we first estimate the regression equation with a dummy variable, as defined in Section 3 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 keep the dummy variable in the model and 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 from the model specification and re-estimate the equation for the Wald test of coefficients to determine the causality direction.

Table 4 presents the estimated VAR models and the results of Granger causality test for, Korea, Taiwan, Singapore, Malaysia, and the Philippines. Note that, the results here are from using the first-difference series, dex, dfdi, and dgdp. Only in Singapore's dgdp equation, the coefficient of the dummy variable is negative and marginally significant, and the other countries' coefficients of the dummy variable are negative but not significant at 10%, which indicates that unlike what is expected, 1997 Asian financial crisis had

supplement pretests for a unit root and cointegration, as these pretests may have low power. However, their method does not mean to substitute the pretests. In this paper, we have used the pretests and also integrated their suggestions in selecting the lag length of VARs. In an over-fit VAR model, we may use the modified Wald test for the determination of causality directions. Our causality results in Tables 4 and 5 with VAR are the same as the results when we used the modified Wald test.

Table 4. VAR Granger Causality Tests: Individual Countries

Dep. var.	Constant (c1)	dex(-1) (c2)	dex(-2) (c3)	dfdi(-1) (c4)	dfdi(-2) (c5)	dgdp(-1) (c6)	dgdp(-2) (c7)	dummy (c8)	Wald test of coefficients Causality direction (1) Ho F-stat	Wald test of coefficients Causality direction (2) Ho F-stat
1. Korea										
dex	0.051	-0.022		0.074		0.061			B 1.262	C 0.075
	(0.07)	*(0.95)*		*(0.28)*		*(0.79)*			*(0.28)*	*(0.79)*
dfdi	0.142	0.314		0.298		-1.229			A 0.079	C 2.606
	(0.13)	*(0.78)*		*(0.21)*		*(0.12)*			*(0.78)*	*(0.12)* gdp→fdi^{+}
dgdp	0.04	0.143		0.03		0.002			A 0.102	B 0.114
	(0.27)	*(0.75)*		*(0.74)*		*(0.12)*			*(0.75)*	*(0.74)*
2. Taiwan										
dex	-0.078	-0.047	0.105	-0.031	-0.076	0.257	-0.194		B 2.457	C 0.087
	(0.05)	*(0.92)*	*(0.78)*	*(0.34)*	*(0.04)*	*(0.69)*	*(0.75)*		*(0.12)* fdi→ex^{+}	*(0.92)*
dfdi	-0.268	4.764	2.241	-0.582	-0.548	-3.236	2.065		A 1.813	C 0.180
	(0.4)	*(0.22)*	*(0.49)*	*(0.05)*	*(0.08)*	*(0.56)*	*(0.69)*		*(0.33)*	*(0.84)*
dgdp	0.029	0.071	0.011	-0.032	-0.047	0.388	0.219		A 0.023	B 1.811
	(0.33)	*(0.84)*	*(0.97)*	*(0.21)*	*(0.11)*	*(0.45)*	*(0.65)*		*(0.98)*	*(0.2)* fdi→gdp^{w}
3. Singapore										
dex	0.073	0.368		0.007		-0.167			B 0.015	C 0.120
	(0.04)	*(0.32)*		*(0.9)*		*(0.73)*			*(0.9)*	*(0.73)*
dfdi	0.117	1.926		-0.345		-2.061			A 1.554	C 0.980
	(0.41)	*(0.23)*		*(0.18)*		*(0.33)*			*(0.23)*	*(0.33)*
dgdp	0.087	0.259		-0.002		-0.107		-0.07	A 1.050	B 0.002
	(0.01)	*(0.32)*		*(0.96)*		*(0.79)*		*(0.09)*	*(0.32)*	*(0.96)*
4. Malaysia										
dex	0.051	0.564		0.009		-0.418			B 0.082	C 2.151
	(0.07)	*(0.11)*		*(0.78)*		*(0.16)*			*(0.78)*	*(0.16)* gdp→ex^{w}
dfdi	-0.048	1.22		-0.357		-0.46			A 0.241	C 0.049
	(0.81)	*(0.63)*		*(0.16)*		*(0.83)*			*(0.63)*	*(0.83)*
dgdp	0.01	0.656		0.002		-0.309			A 2.644	B 0.831
	(0.97)	*(0.12)*		*(0.96)*		*(0.37)*			*(0.12)* ex→gdp^{+}	*(0.37)*
5. Philippines										
dex	-0.005	0.724	-0.062	-0.053	-0.005	0.187	-0.277		B 0.492	C 0.676
	(0.89)	*(0.13)*	*(0.86)*	*(0.4)*	*(0.92)*	*(0.52)*	*(0.33)*		*(0.62)*	*(0.52)*
dfdi	-0.073	3.482	-3.188	-0.979	-0.03	1.375	-0.841		A 1.524	C 0.515
	(0.71)	*(0.18)*	*(0.12)*	*(0.01)*	*(0.91)*	*(0.19)*	*(0.58)*		*(0.25)*	*(0.61)*
dgdp	-0.035	-0.111	0.237	0.028	0.019	0.367	-0.264		A 0.175	B 0.840
	(0.42)	*(0.84)*	*(0.58)*	*(0.71)*	*(0.74)*	*(0.3)*	*(0.44)*		*(0.84)*	*(0.45)*

Notes: 1. The numbers in parentheses denote p-values.
2. ***(**, *, +) denotes rejection of null hypothesis at the 1%(5%, 10%, 15%) level of significance, respectively.
3. In Wald test of coefficients for VAR (2), the null hypothesis A is c2=c3=0, B is c4=c5=0, C is c6=c7=0, respectively. For VAR(1), the null hypothesis A is c2=0, B is c4=0, C is c6=0, respectively.
4. The optimal lag length is selected by the minimum AIC with maximum lag 3.

not have harmful effect on these countries in general. This may also indicate that these countries have recovered from the 1997 financial crisis in a short time period. The dummy variable was then dropped in other equations because it is not significant in the initial estimations. The Granger causality relations are examined using the Wald test of coefficients (F-test), and each null hypothesis is indicated in the footnote of the table.

For Korea, to our surprise, we have found only a weak causality relation running from GDP to FDI at the 15% level of significance. For Taiwan, we have found two unidirectional causalities: FDI causes exports at the 15% level of significance and FDI causes GDP at the 20% level of significance. These results indicate that the FDI inflows to Taiwan are important for her GDP and exports growth. Considering the similar development stage, the development policies, open economy regimes, and industrial productivities between Korea and Taiwan (Hsiao and Hsiao 2003a; Hsiao and Park 2002, 2005), the different results from causality analysis of the two countries are quite intriguing. Surprisingly enough, we have found no causality relations for Singapore. For Malaysia, we have found bidirectional causality between GDP and exports. This agrees with the fact that Malaysia has promoted the export-led-growth policy during the past two decades. Like Singapore, we have found no causality relation for the Philippines.

Table 5 presents the estimated error correction models (ECM) and the results of Granger causality tests for China and Thailand. Note that, the results here are based on the first-differenced series[22], dex,

22) The results can be easily converted to the level series ECM.

Table 5. ECM Granger Causality Tests

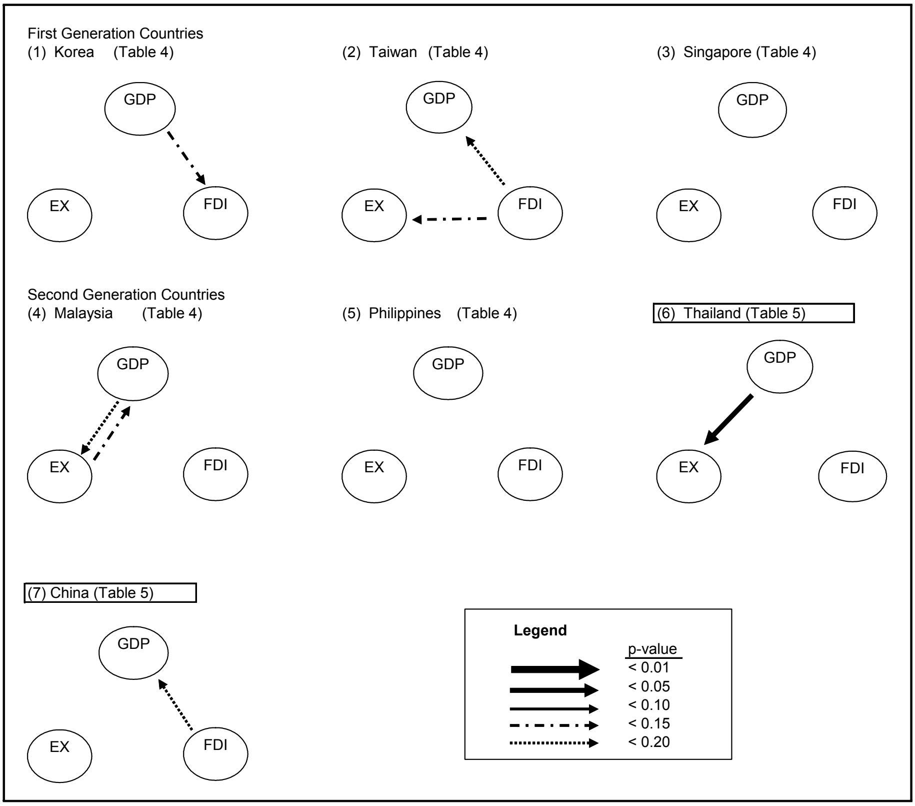
Dep. var.	Constant (c1)	dex(-1) (c2)	dex(-2) (c3)	dfdi(-1) (c4)	dfdi(-2) (c5)	dgdp(-1) (c6)	dgdp(-2) (c7)	ect(-1) (c8)	Wald test of coefficients Causality direction (1) Ho F-stat	Wald test of coefficients Causality direction (2) Ho F-stat
1. China										
dex	0.094	0.164		-0.067		-0.121		-0.310^{w}	B 0.490	C 0.162
	(0.04)	*(0.54)*		*(0.49)*		*(0.69)*		*(0.2)*	*(0.49)*	*(0.69)*
dfdi	-0.01	0.509		0.803		-0.091		-0.482***	A 1.104	C 0.024
	(0.86)	*(0.31)*		*(0.00)*		*(0.88)*		*(0.01)*	*(0.31)*	*(0.88)*
dgdp	-0.00	0.146		-0.093	0.13	0.649		-0.173*	A 0.941	B 2.029
	(0.98)	*(0.35)*		*(0.13)*	*(0.09)*	*(0.00)*		*(0.1)*	*(0.35)*	*(0.16)*
										fdi→gdp^{w}
2. Thailand										
dex	0.009	0.443	0.765	-0.453	-0.051	0.117	-0.67	-0.925^{+}	B 1.071	C 4.620
	(0.84)	*(0.26)*	*(0.03)*	*(0.31)*	*(0.21)*	*(0.67)*	*(0.01)*	*(0.13)*	*(0.37)*	*(0.03)*
										gdp→ex**
dfdi	0.188	-0.759		0.416	0.551	-0.537	-0.374	-1.133***	A 0.290	C 0.205
	(0.22)	*(0.49)*		*(0.12)*	*(0.02)*	*(0.65)*	*(0.7)*	*(0.00)*	*(0.6)*	*(0.82)*
dgdp	0.043	-0.237		0.014		0.491		-0.691*	A 0.493	B 0.093
	(0.21)	*(0.49)*		*(0.76)*		*(0.12)*		*(0.05)*	*(0.49)*	*(0.76)*

Notes: 1. The numbers in parentheses denote p-values.
2. ***(**, *, +) denotes rejection of null hypothesis at the 1%(5%, 10%, 15%) level of significance, respectively.
3. The optimal lag length is selected by the minimum AIC with maximum lag 3.

dfdi, and dgdp, with (or without) including the dummy variable depending on its significance, and are noted in Table 5. The optimal lag lengths for the three endogenous variables are selected by the minimum AIC method.

The signs of error correction term, ect(-1), are all negative and significant at least at the 20% level. The dummy variable was dropped in all equations because it was not significant for both countries, which implies that the 1997 Asian Crisis had no significant effect on both countries. For China, we have found a weak (at the 20% level of significance) unidirectional causality from FDI to GDP. This unidirectional causality indicates that, during the past two decades, China attracted a large amount of FDI because of its low wage, the expectation of its high income growth, and the potentially vast domestic market, and thus, the FDI-led-growth hypothesis seems to be applicable for China. For Thailand, we have found a strong

Figure 8. Granger Causality Relations of Seven Countries



unidirectional causality relation: GDP causes exports at the 5% level of significance. Unlike what is perceived, the 1997 Asian financial crisis turned out to have no significant effect on Thailand. Our causality findings in Tables 4 and 5 are summarized in Figure 8.

While each country has a different story to tell, there are some reservations in the interpretations of the above causality relations using individual country's time-series data.

- First, each country has only 25 observations of annual data. As we have mentioned above, the available critical values (or p-values) for the ADF and DF-GLS unit root tests were calculated for 20 observations and 50 observations, respectively. Therefore, these critical values (or p-values) can only be used as the approximations (or proxies) for our unit root tests in the small sample size.
- Second, we have not found any causality relations for the Philippines and Singapore. This may be also due to the limited observations in a country's time-series data set.
- Third, for the other countries, except Taiwan and Malaysia, we have found only one causality relations among the three variables, and even the causality directions between GDP and FDI in Taiwan on the one hand and Korea on the other, are not consistent and the relations are very weak.
- Fourth, there is a weak unidirectional causality from GDP to exports for Malaysia and Thailand. This result is consistent with the finding of Ahmad and Harnhirun (1996), in which they found that there is only a unidirectional causality from real GNP per capita and real exports per capita in their bivariate system for Malaysia and Thailand from 1966 to 1988, although they also

found the same unidirectional causality for the Philippines.

- Fifth, since the causality differs from country to country, the time-series analysis based on a single country cannot yield a general rule for development policy. However, when the seven countries are grouped into the first generation countries and the second generation countries, a systematic pattern emerges. While we cannot find causality relations between GDP and FDI in the second generation countries except for China, GDP induces FDI in the first generation countries, and in the case of Taiwan, FDI causes GDP (that is, economic growth) and exports. 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. This motivates our next analysis of using panel data.

As the time period is generally limited for a time-series analysis,[23] and, on the other hand, a cross-section analysis is criticized for assuming similar economic structure for vastly diverse countries (Giles and Williams 2000). A solution to these problems is to pool the data of the seven Asian countries into a panel dataset to investigate Granger causality relations for the group.

23) 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.

VIII. 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 and Southeast 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, 2003b). Considering the growing interdependence of these seven East and Southeast 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) including Korea, Taiwan, and Singapore, and the second generation ANIEs (ANIEs 2) including Malaysia, the Philippines, Thailand, and China. We then compare the group causality relations with the results from individual economy's study in Section 7.

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 same notations as used in the study of individual economies). 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 6 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 a level stationary series, but ex and gdp are not level stationary series. In addition,

Table 6. Panel Data Unit Root Tests: ANIEs-All

	Panel level series				Panel first-difference series			
	IPS W-stat		ADF-Fisher Chi-square		IPS W-stat		ADF-Fisher Chi-square	
	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends
ex	3.741 (0.99)	0.629 (0.74)	4.013 (0.99)	13.535 (0.48)	-4.596*** (0.00)	-3.140*** (0.00)	53.169*** (0.00)	36.093*** (0.00)
fdi	-1.721** (0.04)	-2.155** (0.02)	22.582* (0.07)	26.201*** (0.02)	-9.461*** (0.00)	-7.311*** (0.00)	100.232*** (0.00)	71.160*** (0.00)
gdp	0.565 (0.71)	1.387 (0.92)	12.482 (0.57)	11.794 (0.62)	-5.353*** (0.00)	-4.464*** (0.00)	53.002*** (0.00)	42.257*** (0.00)

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

Table 7. Panel Data Unit Root Tests: ANIEs 1

	Panel level series				Panel first-difference series			
	IPS W-stat		ADF-Fisher Chi-square		IPS W-stat		ADF-Fisher Chi-square	
	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends
ex	2.024 (0.98)	-0.917 (0.18)	0.810 (0.99)	8.192 (0.22)	-4.427*** (0.00)	-3.348*** (0.00)	30.149*** (0.00)	21.610*** (0.00)
fdi	-0.793 (0.21)	-2.581*** (0.00)	8.103 (0.23)	16.187** (0.01)	-4.461*** (0.00)	-3.943*** (0.00)	30.109*** (0.00)	24.747*** (0.00)
gdp	0.354 (0.64)	1.639 (0.95)	3.447 (0.75)	1.306 (0.97)	-3.718*** (0.00)	-2.984*** (0.00)	24.121*** (0.00)	18.455*** (0.01)

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

Table 8. Panel Data Unit Root Tests: ANIEs 2

	Panel level series				Panel first-difference series			
	IPS W-stat		ADF-Fisher Chi-square		IPS W-stat		ADF-Fisher Chi-square	
	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends	Individual effects	Individual effects & Individual linear trends
ex	3.202 (0.99)	1.675 (0.95)	3.202 (0.92)	5.343 (0.72)	-2.205** (0.01)	-1.216+ (0.11)	23.020*** (0.00)	14.484* (0.07)
fdi	-1.588* (0.06)	-0.639 (0.26)	14.479* (0.07)	10.264 (0.26)	-8.710*** (0.00)	-6.260*** (0.00)	70.123*** (0.00)	46.413*** (0.00)
gdp	0.441 (0.67)	0.420 (0.66)	9.035 (0.34)	10.487 (0.23)	-3.862*** (0.00)	-3.322*** (0.00)	28.880*** (0.00)	23.803*** (0.00)

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

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.

Tables 7 and 8 show the panel unit root test results for first and second generation countries, respectively. The test results are the same as Table 6. 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.

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. Since as a general principle, it is desirable to have a longer lag length, we have chosen to estimate the panel data VAR (2) in our causality analysis. We explain briefly the estimation of VAR (2) in the context of the fixed effects model.

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:

$$y_{it} = \alpha_i + x_{it}\beta + u_{it} , \qquad (4)$$

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, 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 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 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. 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.

2) Granger Causality Test

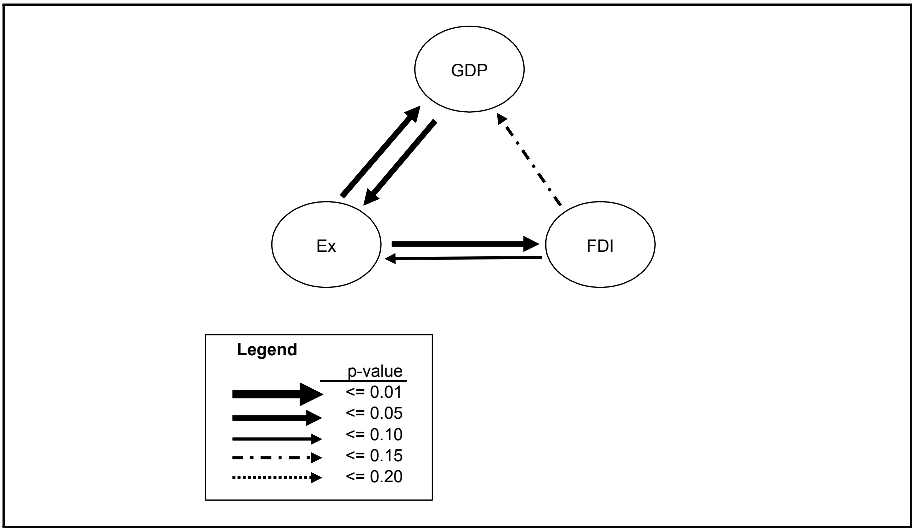
Table 9 presents the estimated panel data VAR for all seven economies as a group by FEM, and the Wald test of coefficients for Granger

Table 9. PANEL Data Granger Causality Tests for ANIEs-ALL

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

Notes: 1. The numbers in parentheses denote p-values.
2. ***(**, *, +) denotes rejection of null hypothesis at the 1%(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, C is c6=c7=0, respectively.

Figure 9. Panel Data Granger Causality Relations for All Seven ANIEs Countries



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 9 summarizes the panel data Granger causality results of Table 9.

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

(1) From the first equation (dex_{it}) of Table 9, 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.

(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 the FDI-led growth in these seven 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 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.

(4) From the second equation ($dfdi_{it}$), 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 (2004b).

(5) 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 also 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.

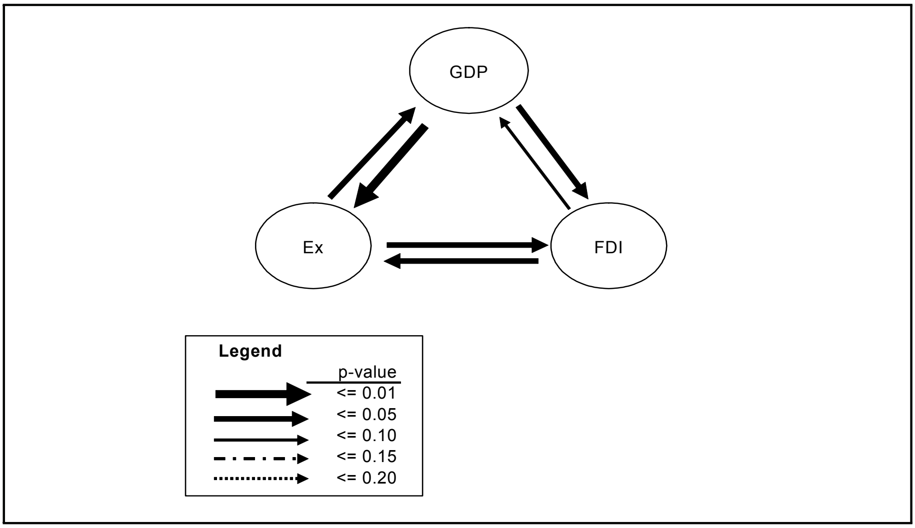
Due to the reinforcing effects of inward FDI, the economic growth policy priority of a developing country, generally speaking, appears to be to open the economy for inward FDI under the export promotion regime, and then the interaction between exports and GDP will induce economic development. This is a general proposition based on the evidence from the seven rapidly growing East and Southeast Asian economies as a whole, which was not captured by the individual

Table 10. PANEL Data Granger Causality Tests for ANIEs 1

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

Note: The footnotes of the table 9 apply.

Figure 10. Panel Data Granger Causality Relations for ANIEs 1 Countries



country study in Section 7.

When we divided the seven countries into the first and second generation ANIEs, we have found more interesting results. Table 10 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 10 summarizes the panel data Granger causality results of Table 10.

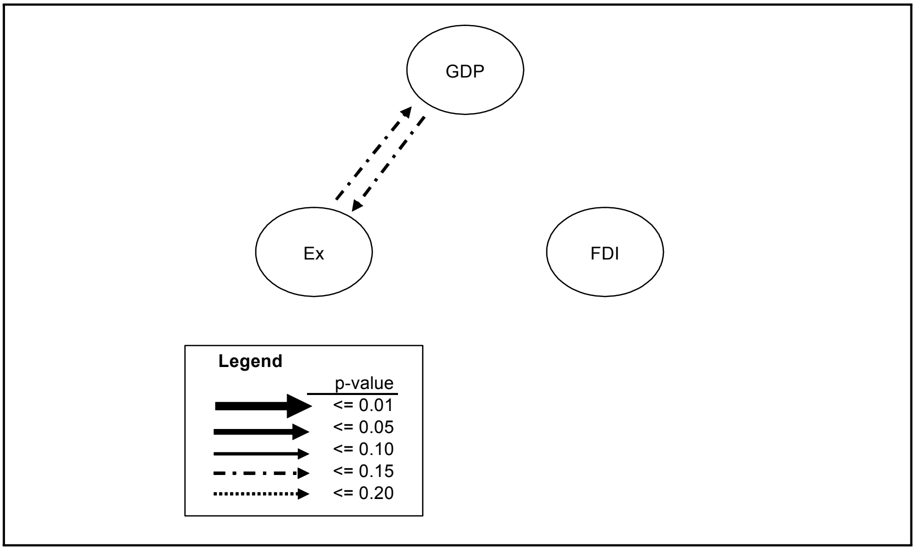
Interestingly enough, we have found very strong bidirectional causality relations among GDP, exports, and FDI inflows for the first ANIEs as a group. Not only does the causality from GDP to FDI inflows newly emerge, but each causality relations are much more statistically significant than the previous 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

Table 11. PANEL Data Granger Causality Tests for ANIEs 2

									Wald test of coefficients Causality direction (1)	Wald test of coefficients Causality direction (2)
Dep. var.	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
dex	0.047 (0.00)	0.242 (0.09)	0.129 (0.34)	-0.011 (0.59)	0.001 (0.96)	0.166 (0.20)	-0.226 (0.08)		B 0.176 (0.84)	C 2.185 (0.12) gdp→ex+
dfdi	0.049 (0.55)	0.168 (0.84)	0.081 (0.92)	-0.349 (0.00)	0.098 (0.41)	0.714 (0.338)	-0.689 (0.349)		A 0.033 (0.97)	C 0.810 (0.45)
dgdp	-0.003 (0.84)	0.127 (0.39)	0.227 (0.11)	-0.006 (0.77)	-0.006 (0.80)	0.245 (0.07)	-0.277 (0.04)		A 2.087 (0.13) ex→gdp+	B 0.055 (0.95)

Note: The footnotes of the table 9 apply.

Figure 11. Panel Data Granger Causality Relations for ANIEs 2 Countries



virtuous circle running through the three variables may explain the rapid growth of the first generation ANIEs for the past three decades with prudent 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 though exports by interactive relations between exports and GDP.

Table 11 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 11 summarizes the panel data Granger causality results of Table 11.

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 a 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 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.

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 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.

IX. 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). In the first part of this paper, we have traced and characterized their rapid growth by comparing diagrammatically their real GDP per capita growth with that of other regions and areas of the world. The ANIEs' rapid growth clearly started in the early 1980s. When ANIEs are grouped into first generation and the second generation countries, the evidence of rapid growth of the first generation countries is quite clear as compared with that of the second generation countries. This leads to our inquiry of the sources of the growth differences among the rapidly growing countries.

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. Indeed, our study shows that the trade structure and inward FDI structure of the two generation countries are quite different, and present a clear sequential pattern of "flying geese." Thus, the question how the open 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 time series analysis and panel data analysis of Hsiao and Hsiao (2006), we have analyzed first the time series causality of the three variables for each country, but, as in the previous paper, we have not found any systematic pattern of causality. However, when we apply panel data analysis to the ANIEs and the two generation groups separately, very interesting pattern has emerged. We find a strong bidirectional causality among the three variables in the first generation countries but only a few weak causalities among the second generation countries. More specifically, the contributions of this paper appear in several areas:

(1) 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.

(2) 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.

(3) 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.

(4) 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, longer than Hsiao and Hsiao (2006),

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.

(5) 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.

(6) Considering the low power in the pretests of a unit root and cointegration in small sample, we also followed Hsiao and Hsiao (2006) and adopted the method suggested by Toda and Yamamoto to over-fit VAR in selecting the lag length for time-series analysis in the country study.

(7) 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 seven ANIEs as a whole and are exemplified by the first generation ANIEs as a group (Figure 10).

(8) More generally, the first generation countries show a very 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 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.

(9) 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.

(10) In this connection, considering a weak unidirectional causality from FDI to GDP in the general case (Figure 9) and stronger unidirectional causality from GDP to FDI in the first generation case (Figure 10) as exemplified by individual case of Korea (Figure 8), FDI is generally attracted to the high income countries. This 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.

Another important finding in the area of methodology is that, as in Hsiao and Hsiao (2006), so far as the causality relations between exports, FDI, and GDP are concerned, our illustration in Figure 8 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 for economic policy. Even the widely recognized fast growing export-oriented countries like Singapore and Korea with relatively large amount of FDI inflows cannot show any causality among the three variables, although Korea shows a very weak unidirectional causality (at 15% level of significance) from GDP to FDI. We submit that some of the inconclusive results of the causality tests between GDP and FDI in the literature surveys in our Introduction section and Section 5 are at least due to the shortcoming of time series analysis.

Only when we pooled the data either for the seven, or the three (the first generation ANIEs) similarly developing Asian economies together, and the interaction among countries and heterogeneity are considered in the panel data causality analysis, we found in Figure 9 and Figure 10 very interesting and meaningful causality relations among FDI, exports, and GDP, with added advantage of being able to ascertain different degrees of importance on the relationships. In conclusion, it appears that the panel data analysis is superior and the direction of the future: It supplements and enhances the results of the traditional time-series or cross-section analysis.

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, De Gregorio, and Lee (1998) and Hermes and Lensink (2003). However, the purpose of this paper is not to estimate such a one-side effect,[24] which inevitably gives rise to the problem of endogeneity of the variables. Rather, 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.

24) To control endogeneity of FDI, Borensztein, De Gregorio, and Lee (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.

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Appendix

Appendix A. Data sources

The data on GDP and merchandise exports from 1981 to 2005, all in current US$ million for the nine 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, 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 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 Indonesia and Hong Kong are not included in the regression analyses due to some negative numbers in FDI data.

Appendix B. Harmonized System Categories

Cat	Ppr	HS	HS	Explanation
			HS 01 - 05	Live animals (meat, fish, poultry, livestock)
			HS 06 - 10	Unprocessed fruit and vegetable products
			HS 11 - 24	Processed agricultural products (food, beverages and tobacco)
			HS 25 - 26	Mineral products (including cement)
			HS 27	Mineral fuels (including petroleum and coal)
T	1	3	HS 41 - 43	Leather products (articles of leather, manufactures of fur)
T	2	4	HS 44 - 46	Wood and cork (articles of wood, cork and straw)
T	3	5	HS 47 - 49	Pulp and paper (including printed matter of paper)
T	4	6	HS 50 - 60	Textiles (natural and manmade fiber yarn and fabric, carpets)
T	5	7	HS 61 - 63	Apparel (including other made up textile articles)
T	6	8	HS 64 - 67	Footwear, headgear and umbrellas (including articles of human hair)
T	7	10	HS 71	Gems and jewelry (including precious stones and precious metals, and coin)
T	8	18	HS 94 - 97	Miscellaneous manufactures (furniture, toys, sports equipment and art)
B	9	1	HS 28 - 38	Chemicals and allied industries (organic and inorganic chemicals)
B	10	2	HS 39 - 40	Plastic and rubber products (articles of plastic, articles of rubber)
B	11	9	HS 68 - 70	Articles of stone, glass and ceramic products
B	12	11	HS 72 - 83	Base metals (articles of base metal)
H	13	12	HS 84	Nonelectrical machinery (including plant and capital equipment, office machinery and computers)
H	14	13	HS 85	Electrical machinery (including television receivers, sound recorders and reproducers, and telecommunications equipment)
H	15	14	HS 86 - 89	Transportation machinery (vehicles and parts)
H	16	15	HS 90 - 91	Precision instruments (optical, medical, measuring equipment)
H	17	16	HS 92	Musical instruments (parts and accessories)
H	18	17	HS 93	Arms and ammunition (parts and accessories)

Sources: Asian Development Outlook, 2007. p. 83. Cat = Category of industries; Ppr = industry sequence of this paper; HS = the sequence of industry given in ADO (2007).

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