Role of Exports and FDI in Economic Growth:

Comparative Study of Three Northeast Asian Economies

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Summary

The thesis is about the relationships among economic growth, exports, and inward FDI. Traditionally, many studies are based on the assumption that the causality runs from either exports or FDI exports to economic growth. Recently, the relevant studies by some scholars have cast doubts on the assumption (Chow, 1987; Jung and Marshall, 1985; Shan, 2002). In addition, the traditional theories of FDI and international trade have been developed separately. The relationship between exports and FDI has been rarely studied. In this study, we hypothesize the existence of bi-directional causality between any two time series of economic growth, exports and inward FDI. We also build up a simultaneous equation model to examine the inter-relations among economic growth, exports, and inward FDI, in order to avoid the simultaneity bias.

The econometric results show that almost all the hypothesized bidirectional causalities are supported in Korea, Taiwan and China. The hypothesized bi-directional causality between economic growth and inward FDI is not supported only in Korea. The results also support the presence of a positive relationship between exports and economic growth in all three cases, and a positive relationship between inward FDI and economic growth in the cases of China and Taiwan. However, the relationship between exports and inward FDI is complex.

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Chapter 1: Introduction

1.1 Background of this study

The topic of economic growth has been discussed for a long time. However, the arguments for the engines of economic growth have not been unanimous until recently.

Exports have been regarded as an engine of economic growth. However, some causality studies showed that there is no causal relationship between exports and economic growth (Jung and Marshall, 1985) while some studies showed that there is bi-direction causality between them (Chow, 1987). These studies cast doubt on the export-led growth theory, which assumes one-way causality from exports to economic growth.

The effect of Foreign Direct Investment (FDI) on economic growth has also been debated. Most studies focus on the impact of FDI on economic growth through either direct or indirect effect (Todaro, 1982; Dunning, 1970; Bende-Nabende, 1999; and Krueger, 1987). These studies assume that there is unidirectional causality running from FDI to economic growth. However, this assumption has been noted and criticized in recent years. Theoretically, the causality between FDI and economic growth could run in either direction, that is, not only can FDI 'Granger-cause' economic growth but economic growth can also cause the inflow of FDI. The two-way causality relationship was supported by the results of some empirical studies (Toda and Yamamoto, 1995).

By comparison, the interdependence between the international trade and FDI has been a less-explored issue to date. The traditional theories of FDI and international trade were developed separately. Recently, some international trade theorists have attempted to integrate the theories of FDI and trade (Vernon, 1966; Kojima, 1973, 1975 and 1982). However, most of these studies assume that causality runs from FDI to trade. Actually, it is also reasonably possible to find that FDI is causally affected by trade (Kreinin, Plummer and ABE, 1998). Even though some studies mentioned above used exports as a proxy to foreign trade, the study on the causality between exports and FDI is rare.

1.2 Purpose of this study

Since the role of exports and FDI in economic growth is debatable, it may be safe to conclude that a single "engine" of economic growth cannot absolutely propel the economic growth process. Hence, we combine the two so-called engines of economic growth in the study on economic growth and hope to determine the triangular relationship among them.

In some empirical studies, the data set covered a period in which the host country took a closed-door policy. For example, the period of 1952-78 is regarded as a closed-door period for China. In the closed-door period, economic growth is mainly due to domestic market demand and domestic production. Exports and FDI, which were strictly controlled, even prohibited, logically have no important effect on economic growth. Therefore, the data set of each country in our study covers an open-door period.

In order to add to the rare study on exports and FDI, this study purports to give a special focus on the relationship between exports and FDI. Some researchers found that exports and FDI were highly correlated, but the correlations are not statistically meaningful. In this study, we hypothesize that the causality between exports and FDI is bi-directional and employ the Granger causality test to examine the relationship. In addition, we also hope to find the evidence of bi-directional causality between the two engines and economic growth.

Based on earlier studies on economic growth, exports and FDI, we set up a simultaneous-equation model to assess the effects of the economic variables. Due to the existence of simultaneity, a single equation will cause a simultaneity bias. In this study, we purport to find positive inter-relations among economic growth, exports and FDI.

1.3 Structure of this study

Following the introduction, Chapter 2 will first introduce the theories and previous studies on economic growth, exports and FDI. After that, our hypotheses will be presented. This chapter will focus on the relationships among economic growth, exports and FDI. As mentioned before, the studies have not been conclusive. We hypothesize that the causality between any two series of economic growth, exports and FDI is bi-directional. We also hypothesize that each series is positively related to one another.

In Chapter 3, we will discuss the history of economic growth, export growth and inward FDI in the three Northeast economies, namely, South Korea, Taiwan, and Mainland China. These economies have impressed the world with their economic performance. This chapter will provide an overview of the role of exports and FDI in these countries.

The methodology and data of this study will be presented in Chapter 4. In this chapter, the traditional Granger causality test will be employed to determine the direction of causality among the variables, namely, FDI, exports and economic growth. In this process, the unit root test will be performed. Subsequently, a simultaneous equation model is developed to investigate the relationship among FDI, exports and economic growth.

Chapter 5 will discuss and analyze the results from the models specified and estimated in Chapter 4. In this chapter, the empirical results will provide interesting and illuminating statistical evidence to support or refute the hypotheses stated in this study.

The main findings will be summarized in the final chapter and some policy strategies that may help to sustain economic growth will be considered. Some suggested areas for further studies will also be included.

Chapter 2: Literature Review and Hypotheses

2.1 Overview

Economic growth involves many interrelated economic, political and social factors such as investment, labor, expanded international trade, new technology transfer, traditional culture, religions, government stability and government policy. The studies on these factors have resulted in the development of economic theories.

In general, economic theories can be classified into three types, that is, the classical theory, the neo-classical theory and the new growth theory. The earlier classical economists believe that economic growth is caused by increasing the input quantities in the production, that is, capital, labor and land. The neo-classical economists emphasize the importance of technical advancement and technological innovation to economic growth. The recently developed new growth theory focuses on the multiple effects of human resources, labor skills, foreign capital flow, and international trade, and so on.

In economic theories, exports and Foreign Direct Investment (FDI) have already become two of the most interesting research topics. Export-led growth theory has won the respect not only in the academic circles but also in the governments. It provides the theoretical reasoning why many governments in the world encourage exports. FDI has also been playing an increasingly important role in economic growth such that every country is trying to implement incentive measures to attract more inward FDI.

At the same time when the debates occurred in the economic theories, the empirical studies on these topics have showed not only different results but also different methodologies employed. In some earlier studies, many researchers used correlation to measure the relationship between the variables studied. As criticized, the correlation does not provide any insights about the causal relationship. Recent researchers have employed the causality tests in their empirical investigation on the causal relationship.

The earliest prevalent causality approach is Granger's work (1969). Based on Granger's causality approach, many other scholars developed some more complex econometric models to examine the causality, such as the Granger-Sim causality test, the vector autoregressive (VAR) model, the vector error correction model (VECM) and so on.

However, the causality test has also been criticized. In their papers, Giles and Williams (2000b) noticed the problems of the causality test models in the definition of the information set, the selection of lag number, nonstationarity, cointegration and deterministic terms. Giles and Williams (2000a) pointed out that Granger's approach makes no attempt to incorporate economic theory to impose some restrictions upon the relationships between the variables studied. Ahmad (2001) summarized the previous empirical causality studies and found that a wide spectrum of results suggested sharply divergent conclusions on the causal relationships. "It is not clear, however, as to why these differences arise, and it does not seem possible to reconcile them". Hence, we should permit the existence of different findings and the employment of different econometric models in the previous empirical studies.

2.2 Linkage between exports and economic growth

On the one hand, the international exchange of goods, services, capital, technologies and ideas has developed strong interdependence among countries and led to the globalization trend. On the other hand, international trade has benefited economic growth.

The role of international trade in economic growth has been debated among trade optimists and trade pessimists. The trade optimists regard international trade as an engine of economic growth, while the pessimists think that it retards economic growth. As Hogendorn (1992) said, the pessimists believe that trade risks “backwash effects,” with exports growing slowly if at all, with inelastic demands moving prices against poor countries, and with those prices (as well as quantities and earnings) being unstable, thus making development more difficult.

Although the export-led theory is not supported by all theorists, it is widely supported by the undeniable evidence that many governments have succeeded in economic growth by encouraging exports. In the economic development history, the import-substituting policy was once adopted by some developing countries and had little success. However, after countries such as South Korea, Taiwan, Hong Kong and Singapore succeeded in radical economic growth under export-promotion policies, export-led growth theory appears to be well justified and tested.

The expansion of exports has many positive effects on economic growth. An immediate consequence is job creation. Export growth usually creates more job opportunities. Secondly, export expansion increases national savings. Thirdly, export expansion can enlarge the market size, and consequently may facilitate economies of scale and lead to specialization. Fourth, exports can promote economic growth by increasing efficiency in the allocation of production factors. Fifth, exporters may learn something new about technology, design, quality control, organization, and management, which will benefit the national economy.

Park and Prime (1998) summarized four linkages between exports and economic growth. First, the growth of exports can lead to the enhancement of productivity due to the results of economies of scale. Second, export earnings are the major source of foreign exchange to import items important for the national economy. Third, exports have a positive effect on productivity through better allocation of resources and specialization based on comparative advantage. Fourth, increased competition encountered in international markets will provide greater incentives for technological improvements and better management, the effects of which will spill over into the non-export sector and thereby help to raise the overall productivity.

In fact, the export promotion hypothesis is supported by many empirical studies based on either cross-country or time-series data. The relationship between exports and economic growth was found to be significantly positive by some earlier researchers using the method of correlation. Later, researchers have shifted their attention to the direction of causality since the causality test was developed. Many researchers employed the Granger causality test to determine the direction of causality between exports and growth. Some of them studied the developed countries like U.S. and Canada, and others focused on the developing countries such as Korea, Taiwan, Hong Kong, Singapore and Brazil. Thornton (1996) applied the cointegration test and the Granger-causality test to the study on exports and GDP in Mexico in the period of 1895-1992. He found that exports and GDP were cointegrated and there was a significant and positive Granger-causal relationship running from exports to economic growth. Some cross-country studies investigating the relationship between exports and economic growth also support export-promotion strategy (Feder, 1983; Fosu, 1990; Balassa, 1978).

Many researchers noticed the one-way causality from exports to economic growth. Nevertheless, the effect of economic growth on export expansion cannot be neglected. Firstly, economic growth means an increase in supply capability. Economic growth induces the increase in the productivity and consequently leads to the increase in the possibility of production, which indicates an increase in supply capability. The increase in supply capability makes it physically possible for the home countries to export more. Secondly, economic growth also leads to the change of comparative advantages. Many original agrarian economies such as Korea and Taiwan have been successfully transformed to industrialized ones after a period of high-speed economic growth. When such a transformation occurred, comparative advantages in agriculture disappeared gradually and the new advantages in the industries were obtained. In addition, economic growth also caused other changes, such as technological advances, increase in human capital, and increase in capital formation, which would probably change the original set of comparative advantages. The newly obtained comparative advantages facilitate the expansion of exports.

The growth-driven export argument is supported by some scholars. Jung and Marshall (1985) pointed out that output growth might cause export growth if the growth of domestic demand lags behind the growth of output. They concluded that, if domestic consumption was not able to absorb all the increased output, exports would grow. Helpman and Krugman (1985) argued that the increase in productivity made it possible that economies of scale can lead to the expansion of exports.

Therefore, theoretically, the causality relationship between exports and economic growth could be bi-directional. Ghirmay, T., Grabowski, R. and Sharma, S.C. (2001) examined the relationship between exports and growth for 19 less developed countries by using the multivariate causality analysis based on an error correction model. The results indicated that increase in output and capital accumulation in an economy would have as much an influence on exports as exports would have on output and capital accumulation.

Chow's study (1987) showed bi-directional causalities between exports and manufacturing output for six out of eight NICs. The bi-directional causality means that "export growth and industrial development are mutually beneficial and reinforce each other" (Chow, 1987).

However, export-led growth hypothesis and growth-driven export hypothesis are not always supported by empirical evidence. Jung and Marshall (1985) applied the Granger causality test to the time series data for 37 LDCs. Only in four countries did they find evidence of unidirectional causality from exports to growth. They found little evidence in support of the causality hypothesis from exports to growth even in those newly industrialized countries (NICs) that have experienced both rapid export growth and economic growth, such as South Korea and Taiwan. Park and Prime (1998) found that, in the case of China, the results of the Granger causality tests for data from 1953 to 1988 did not support the argument that exports cause economic growth, nor did they support the alternate argument that economic growth causes export growth. In Chow's study (1987), the results did not support bi-directional causalities between exports and manufacturing output for two out of eight NICs.

We believe that the bi-directional causalities exist only under some conditions. We believe that some other factors which were omitted by many scholars influence economic growth progress, and consequently influence the causality results. Hogendorn (1992) summarized a group of five important factors that propel the economic growth process: (1) increased savings and investment and acquisition of appropriate technology, (2) agriculture improvement, (3) a growing foreign trade with close attention to comparative advantage, (4) an economic system that allows for efficient allocation, and (5) human resource development. When we study the relationship between exports and economic growth, we should also consider these factors.

Hence, we develop the following hypotheses for the causality in the three Northeast Asian economies.

Hypothesis 1a: the causality between exports and economic growth is bi-directional.

Hypothesis 1b: economic growth has a positive effect on export expansion, and export expansion also has a positive effect on economic growth.

2.3 Linkage between Economic Growth and FDI

International trade has grown radically in the past fifty years. However, in the past twenty years, FDI has increased enormously, with a faster growth than international trade. Kreinin, Plummer and ABE (1998) found that, in recent decades, international trade has increased at a percentage of GDP in most major economies, but FDI and other financial flows have been growing exponentially. The total value of inward FDI in the world increased from about US$ 200 billion in 1993 to US$ 1.3 trillion in 2000 (UNCTAD, 2000). FDI with a rapid growth has interested researchers and government policy makers.

Foreign Direct Investment (FDI) is one form of capital flows which have a particular impact on economic growth in developing countries and multinational enterprises (MNEs) are the main drivers of FDI (Fortanier, F. and Maher, M., 2002). OECD (1978) defined the main forms of FDI as follows:

- Outlays for the establishment of a new enterprise or for the expansion of an existing enterprise whose operation is controlled by the foreign investor.
- Financial outlays for the acquisition of an existing enterprise (or part of it) either through direct purchase or through purchases of equity, with a controlling interest by the foreign investor. The notion of control is not defined, but control is assumed when the foreign investor owns at least between 10 and 51 percent of

the enterprise's value according to different definitions used by different governments.

- Intra-corporate long-term loans.

The linkage between FDI and economic growth has been studied in past twenty years. Most of the studies focus on the impact of inward FDI on economic growth through either direct or indirect effect. Generally speaking, inward foreign direct investment (FDI) can lead to job creation, increase tax revenue, introduce advanced management skills and technologies, benefit the insufficient domestic capital formation, and increase foreign exchange reserves. It provides a unique combination of long-term finance, technology, training, know-how, managerial expertise and marketing experience (Bende-Nabende, 1999).

One of the most direct effects of inward FDI on economic development is that inward FDI is an important financing source of domestic capital. It can increase the production of the host country by adding to the country's savings and investment, and it is more stable than other forms of private capital inflows, e.g. portfolio equity and debt flows (Fortanier, F. and Maher, M., 2002).

However, inward FDI is more than a form of capital flow. Todaro (1982), Dunning (1970) and Krueger (1987) argued that through the capital accumulation in the host country, inward FDI was expected to generate non-convex growth by encouraging the incorporation of new inputs and foreign technologies in the production function of the host country. The more important effect of FDI is to increase the productivity of the host country through technology transfer. Although technology can also be transferred through foreign trade, as argued earlier, inward FDI has a unique impact on the transfer.

Fortanier, F. and Maher, M. (2002) summarized four channels through which inward FDI may lead to technology transfer, namely, vertical linkages, horizontal linkages, labour migration and the internationalisation of R&D activities. Vertical linkage indicates backward linkages with suppliers and forward linkages with buyers (either individual consumers or other firms). These business partners of the host country may be able to partly or entirely absorb some explicit and implicit technology. Horizontal linkages refer to relations with the competitors of the MNEs' subsidiaries. The diffusion of technology takes place through the competitors in two ways: demonstration and competition. The MNEs expose the superior technology to the local firms and lead them to update their technology. The entrance of foreign firms also strengthens the competition in the host countries and forces the local firms to improve the production technology. These two effects are difficult to disentangle and may reinforce each other. Labour migration is another way through which technology may be transferred and disseminated. Employers by the MNEs acquire superior technology and management skills. When they switch to work for local firms or start their own business, their acquired advanced technology and management skills spread. The MNEs will also bring some R&D activities to the host country, which may also lead to the improvement of technology.

However, economic growth can also benefit inward FDI. Economic growth induces the increase in domestic market size which is a determinant of inward FDI. Meyer (1999) argued that output growth was an important reflection of market size in one host country, and 'penetration of foreign market is a major motive for FDI'. Rapid economic growth, accompanied by an increasing per capita income, will create huge opportunities by expanding the domestic consumption demand (for both industrial and consumer goods) in the host country. Output growth is considered as one important determinant for FDI inflows to a host country and this argument is often called a "market size hypothesis" (OECD, 1983; Moore, 1993; Shan, 2002). More importantly, rapid economic growth in the host country will build the confidence of overseas investors for investing in the host country (Shan, 2002). According to the static investment theory, a risk is always associated with an investment and investors always try to reduce the risk in pursuing a high return. A high-speed growth which indicates a low risk in the investment is undoubtedly attractive for the investors. Thirdly, economic growth is associated with an increase in capital demand. The increase in capital demand pushes the governments to embark on incentive policies towards attracting FDI inflow in the case of shortage of domestic capital. The increasing capital demand also raises the price of capital, indicating an increase in the return of capital, and consequently induces inward FDI. Finally, economic growth is also accompanied by an improvement in investment environment, such as the infrastructure, energy supply, legal system, human capital, education, and R&D level. A good investment environment can induce foreign investment.

Hence, in empirical studies, it is shown that the causality between inward FDI and economic growth can run in either direction, that is, not only can inward FDI 'Granger-cause' economic growth but also economic growth can cause FDI. Toda and Yamamoto (1995) found that there was indeed a two-way causality between FDI and output in China. Shan (2002) also found the evidence of bi-directional causalities between inward FDI and output growth in the case of China. However, the studies on the causality between inward FDI and economic growth are rare as compared to the studies on exports and economic growth.

In addition, the bi-directional causal effects are positive. That is, inward FDI and economic growth reinforce each other. We hope to find some evidence of positive effects between them in our study. The hypotheses are given as follows.

Hypothesis 2a: the causality between inward FDI and economic growth is bi-directional.

Hypothesis 2b: economic growth has a positive effect on inward FDI, and inward FDI also has a positive effect on economic growth.

2.4 Linkage between FDI and Exports

The traditional theories of FDI and international trade have been developed separately. FDI theories explain why foreign firms invest in the host countries and what the determinants of FDI decision are. Trade theories explore why countries need international trade and what the determinants of trade patterns are. However, unfortunately, the interdependence between the international trade and FDI has been a less-explored issue to date. The key issues are how FDI affects trade and trade affects FDI. These issues can be studied at both the macro and micro levels. This study focuses on the macro level relationship between FDI and trade.

The linkage between FDI and international trade is complex, and not completely known. To some degree, it depends on a nation's stage in the investment development cycle (Dunning and Narula, 1994). It is also related to the industries we are studying, manufactures or services (WTO, 1996). Furthermore, the linkage is influenced by whether the main products in a nation's trade are in the early or mature stage of the product cycle.

Many researchers began to notice the linkage between international trade and FDI. International trade theorists have attempted to integrate the theories of FDI and trade.

Vernon (1966) developed the Product Life Cycle (PLC) theory of investment to explain the sequence from domestic production of a new product to its export and then the production in the host countries. He believed that foreign investment was essentially a defensive investment designed to preserve profit margins in both export and home markets. In the product-cycle-life theory, FDI is viewed as substituting trade.

The view that FDI is substituting for international trade has been debated recently. Many theorists think that FDI is complementary for international trade. The first important reason is that inward FDI brings advanced technologies and management skills which will benefit the local exporters. The second reason is that some inward FDIs lead to re-export. According to the product life cycle (PLC) theory, when the products enter the mature stage in the home market, firms will transfer the production bases to the host countries with cheaper inputs in order to cut down the cost and keep the price competitive. Most of these products will be re-exported to other countries. Thirdly, the vast networks of foreign-invested companies with their home countries can help the local firms to open the door of these countries. Through these networks, the local firms can also benefit from reduction in trade barriers.

Kojima (1973, 1975 and 1982) is a pioneer in developing a systematic macroeconomic approach to foreign direct investment, and integrating FDI and international trade theory. He distinguished FDI from international money capital movements, and thought that FDI not only transferred capital, but also transferred advanced technology, management skills and marketing knowledge. Johnson (1973) pointed out that FDI was the transfer to the host country of a 'package' of capital, managerial skills and technology. The transfer can be extended to other industries in the host country, thus increase the productivity of local firms and ultimately expand the export capability of the host country.

Kojima (1973, 1985) divided FDI into two types, namely, anti-trade oriented and export-oriented. He predicted that export-oriented FDI occurred when FDI was invested in those industries in which the host country had a comparative advantage. Export-oriented FDI is therefore characterized as being welfare improving and trade creating since it can promote both host and source countries' exports.

Bende-Nabende (1999) argued that FDI leads to more international trade by providing opportunities to expand and improve the production of goods and services. According to the product life cycle theory, for the developing countries where production inputs are cheaper, it is efficient to relocate production from the developed countries particularly in the later stages of the production cycle life when technology related to production becomes standardized and readily available in most countries. Such FDI creates exports of finished products to the investing countries and third-party countries, as well as imports of parts and components from investing countries.

Hogendorn (1992) stated in her book that MNCs sought new sources of inputs including minerals and oil to offset declining reserves at home and to capture part of the rents on especially valuable deposits. Labor can be an attraction, as when a multinational corporation moves an operation overseas in search of cheaper wages, thereafter exporting the product back to the home market and elsewhere.

Stern (1997) considered the complementary nature of inward FDI and the trade of the host country. He believes that inward FDI brings the expertise of the foreigners in promoting exports in the international markets, and consequently enhances the host country's export performance.

Muchielli and Chedor (1999) presented the reason that foreign investment might bring in international market knowledge and global distribution networks which would benefit the local partner. The domestic partner would also benefit from new technology, physical capital, and managerial expertise when it provides an opportunity for the foreign firm to enter the domestic market. The foreign invested enterprises (FIEs) are often attracted by cheaper labour costs, which give them a competitive advantage in their export markets.

Generally, foreign-invested firms are more export-oriented than their domestic counterparts. They are not merely focused on the domestic market in the host countries. Studies of South Asia have shown that foreign firms do export a higher proportion of their output than their local counterparts. However, foreign-invested firms can also influence their domestic counterparts to be export-oriented. A case study of FDI in Singapore concluded that foreign firms had successfully stimulated local suppliers to become effective exporters, and had generated a substantial number of spin-offs as employees of multinational corporations (MNCs) became successful entrepreneurs, and often became suppliers to their former employers (Lim and Pang, 1991).

Most of the studies stated above focused on the effects of FDI on exports. However, it is also reasonably possible to find the effect of exports on inward FDI. The first reason is the agglomeration effect. Export expansion of a country will make the country known to the foreign investors. When making investment decisions, foreign investors prefer to choose a familiar destination. Later investors will be influenced by earlier investors in choosing an investment destination. Secondly, the trade competition intensified by the emerging economies' export growth will increase the pressure on their governments to liberalize their local markets. With liberalizations, the limits to foreign investment will certainly be relaxed.

Hein's (1992) studies on the Latin American and East Asian regions implied that the economies which employ the export-promotion policy could attract inward FDI. The Hein's results suggest that export-oriented domestic firms are subject to the high competition in the international markets. Competition induces the improvement in managerial skills and innovation, which can be attractive to foreign companies. In addition, competition also increases the productivity of the host country's exports. Porter (1990) argued that productivity improvements would lower the production costs or differentiate the exported products that might require higher international prices. Hence, the productivity improvements caused by the host country's exports can attract inward FDI.

However, exports can also hinder the increase in inward FDI. Firstly, exports increase the national savings and consequently cut down the demand for foreign capital. Secondly, the emerging economies can achieve technology advances through exports instead of inward FDI. This will keep down the emerging economies' passion for inward FDI.

The linkage between FDI and exports has been the topic of many empirical studies. Jun and Singh (1996) explored the causal relationship between exports and FDI in 11 high FDI recipient countries over the period 1969-1993. In four cases, there were evidence of causality running from exports to FDI, and in only one case the results supported the causality from FDI to exports. In the remaining cases there was no evidence of causality between exports and FDI. Zhang and Felmingham (2001) evaluated the causal links between inward FDI and exports in the case of PRC as a whole and its provinces. In the national study, they used cointegration/error correction modelling (ECM) techniques on a monthly time series for the years 1986 to 1999. The results showed the evidence of the bidirectional causality between inward FDI and exports.

In this study, we hope to find the evidence of bi-directional positive causal effects between exports and inward FDI. Actually, the current studies on the causalities between them are rare. We hope that our study will add to the literature in this field.

Hypothesis 3a: the causality between inward FDI and exports is bi-directional.

Hypothesis 3b: export expansion has a positive effect on inward FDI, and inward FDI also has a positive effect on export expansion.

Chapter 3: Economies of South Korea, Taiwan and Mainland China

3.1 South Korea

As one of the "gang of four" East Asian economies (South Korea, Taiwan, Singapore and Hong Kong), Korea has experienced rapid economic growth in the past three decades. Before we discuss the factors for this success, it is necessary to review Korea's industrialization history.

The official name of South Korea (founded in 1948) is the Republic of Korea. In the first decade, Korea's economy did not change a lot. There are two main reasons, namely, the Korean War (1950-53) and the inefficient governance of Rhee's regime. The Korean War devastated South Korea, with the results of a great loss of life and property. It also led to the military confrontation between the North and the South. To a certain extent, the confrontation retarded Korea's economic development because the government had a large military expenditure in the following years after the war. The postwar economy was also marred by the inept governance of Rhee's government. Corruption prevailed over the country, and the government lacked effective economic policies to solve many postwar economic problems. The inflation was soaring, people's living conditions did not change much and the society was in a state of unrest.

Korea's image began to change after 1962 when the Park government was established and consolidated. In 1962, the Park government embarked on the First Five Year Plan (1962-1966) to encourage economic growth, symbolizing the new era of economic growth in Korea. In four decades, Korea achieved a big economic achievement which has been known as the "economic miracle on the Hangang River", a river that runs through Seoul.

Real GDP have increased radically since 1962. As indicated in Table 3-1, the growth rate of real GDP averaged 8.68% in the period 1962-71, 7.21% in the period 1972-81, 8.92% in the period 1982-91, and 5.61% in the period 1992-02. The average annual growth rate of real GDP from 1962 to 2002 is 8.4%.

In the mean time, per capita gross national income (GNI) also increased rapidly in the last forty years. After the Korean War, Korea was originally regarded as one of the world's poorest countries, and the per capita national income was very low. However, per capita GNI increased from US$ 249 in 1970 to US$11,385 in 1996. Per capita GNI grew at an average rate of 12.24 % in the period 1972-2002.

Korea's economic structure also changed in its development process. In 1957, Korea was still an agrarian society relying on agricultural production. Primary industries (agriculture, fishery, etc.) employed almost 65% of labor while the secondary and tertiary industries were not playing an important role in the whole economy (Rhee, 1973). However, the share of primary industries (mainly referring to agriculture, forestry and fishery) in the total GDP has decreased in the last forty years. As indicated in Table 3-2, it reduced from 26.96% in 1972 to 7.44% in 1992 and further to 3.96% in 2002. Meanwhile, the share of manufacturing industries increased from 22.28% in 1972 to 29.22% in 2002. In addition, the share of the service industries stood at 51.6% in 1998, by far the leading growth sector in the economy (Korean Information Service, 2001).

The structural adjustment was caused by the government's economic focus. Park government planned to establish the economic foundations for modernization by setting up and strengthening chemical, iron steel and machine tool industries in order to increase the level of industrial production. This ambitious goal was also pursued by the subsequent governments. Korea completed its industrialization dream rapidly in a short time.

There are various reasons for the rapid change in Korea's economy. These include economic structural adjustment, a strong emphasis on education, a high saving rate, improvement of infrastructure, and a high investment rate. However, one of the most important reasons is the export-led growth strategy taken by Korea's governments. Since 1962, Korea has taken a number of direct and indirect measures to promote exports and actively promoted international commerce worldwide. These incentive measures included tax exemption, devaluation of the currency, finance support for exports, simplifying customs procedures, exchange priority on export earnings, discounts on the fees for railway, land tenure and electricity, and easy access to loans with low interest rates from the commercial banks. According to Kuznets (1985), the measures also include an import-link system that permits exporters to obtain otherwise prohibited imports for inclusion in exports or domestic sale, and import licensing that only exporters meeting some minimum export quotas are allowed to import.

The results of these incentive measures were a radical expansion of exports in Korea. The amount of exports increased sharply from US$ 56 million in 1962 to US$ 162,470 million in 2002. The average annual growth rate was 22.06%. After removing the impact of inflation measured by GDP deflators in this period, the real exports grew at an average annual rate 9.75%. And the share of exports of goods and services in the total GDP expenditure increased from 1.68% in 1955 to 40.01% in 2002. In the past six years, it has been kept at around 42.31%.

The increase in economic growth and exports of goods and services provoked the increase in imports. The amount of imports was US$ 341 million in 1955 and its share in the GDP expenditure was only 10.08%. However, the amount increased to US$ 152,126 million in 2002 and the share rose to 38.58%. The nominal imports grew at an average annual growth rate of 15.86%.

Although there was a rapid growth of national income and external trade in Korea, inward FDI grew slowly. Firstly, inward FDI was restrictively regulated by Korean governments before 1992. In order to preserve the ability to control the economy, Korea governments discouraged FDI even though FDI could benefit the domestic capital formation and technology advancement. The Foreign Capital Inducement Law was passed in 1960, but inward FDI was still restricted. For example, in the early 1960s, Korea allowed foreign investment in light industries, but imposed strict restriction in the heavy industries. Secondly, inward FDI in 1980s was also impeded by the increasing wages, land rental, interest rates, and more frequent labor unrests.

However, in the middle 1990s the constraints to inward FDI began to relax. In 1993, to make Korea more attractive to foreign investments, the government planned to further open up the domestic market. In 1994, the government announced it would expand the ratio of sectors open to inward FDI. The Act on Foreign Investment and Foreign Capital Promotion was revised in 1998 and paved the way for further liberalization of the financial sector and for attracting more FDI inflow.

The government was also committed to creating an attractive investment environment for foreign investors. Various incentive policies, including financial, tax, land and investment measures, have been adopted to promote FDI. The government recognized that the strict protection of intellectual property rights was essential to attract foreign investments. Consequently, in 1990s the government strengthened the protection of intellectual property rights and a new copyright law was enacted to protect against intellectual property infringement.

The different policies for inward FDI before and after 1992 brought different results. The inactive policies for inward FDI before 1992 resulted in a small scale of inward FDI, while the active policies after 1992 caused a radical growth of inward FDI. In 1970, the value of inward FDI flow was US$ 73 million, and the value of the stock was US$184.3 million. In 1994, the flow reached US$ 810 million and the stock increased to US$ 8753.2 million. However, inward FDI flow has increased more substantially since 1995. The flow increased to US$ 2326 million in 1996, and continued increasing to US$ 9333.4 million and US$ 9283.4 million, respectively in 1999 and 2000. The stock also increased substantially to US$ 45227.7 million, much more than the amount in 1994.

3.2 Taiwan

According to Li, Kuo-Ting (1995), the economic growth experience of Taiwan in the forty postwar years can be divided roughly into three main stages, namely, the import substitution stage (1950-1962), the externally oriented stage (1962-80), and a technology-oriented stage (after 1980).

In the first stage, Taiwan's economy began to grow at high rates. From 1952-1961, the average annual growth rate of real GDP was 7.92%. Per capital national income also increased rapidly. In 1952, per capita national income was NT$1,912.54 (US$185.68), but it achieved NT$ 5,665.86 (US$141.65), about triple of that in 1952. After removing the effect of inflation, per capita national income still posed an average annual growth rate 4.27% in this period.

The economic growth in this period also led to a change of its economic structure. In 1953, agriculture accounted for 34.45% of gross domestic product, industries had a share of 19.39%, and services had 46.15%. In 1962, the proportion of agriculture reduced to 24.97%, industries rose to 28.22%, and services were kept around 46.81%.

The external trade expanded in this period. In 1952, the value of exports was NT$ 1,386 million, and the value of imports was NT$ 2,439 million. In 1962, the value of exports increased to NT$10,498 million, about seven times the value in 1952, and the import value was NT$ 14,615 million, about six times the value in 1952. After removing the impact of inflation, the average annual growth of real exports in this period was 10.22%, and that of real imports was 9.87%.

The reasons for the great economic achievements in the first stage were mainly the land reform, the U.S. aid and the import substitution policies. The land reform from late 1949 to 1953 converted the previous landlord–dominated agriculture system to the owner-cultivator system in which concentration of land ownership was prohibited. This reform stimulated the farmers to work harder, to make investments, and to adopt new farming techniques, and helped the government to move some capital resources from agriculture to the rest of the economy, especially industries (Samuel P.S. Ho, 1987). The U.S. aid attributed partly to Taiwan's successful economic development from 1952 to 1962. Between 1949 and 1967, Taiwan received in total about U.S. $4.1 billion in aid, nearly 60 percent of which was in the form of military assistance (Samuel P.S. Ho, 1987). The U.S. aid helped to stabilize Taiwan's economy and society, and was one important source of foreign exchange for the import of some necessary equipment and natural resources. Taiwan also adopted a package of import substitution policies, namely, overvaluation of the currency, control of exports and imports, and control of foreign exchange transaction.

The import substitution policies helped the government to control its high rates of inflation in the early 1950s.

Beginning from the early 1960s, Taiwan began to relax its government's control over the economy and try to liberalize the foreign trade. The government began to implement the export-oriented strategy. Many incentive measures were taken to liberalize foreign trade, for example, the tax rebate on exports, the relaxation of import quotas, the reduction of tariff, slight devaluation of currency, the simplification of the foreign exchange procedure, and introduction of export processing zones. In the later part of the 1960s, emphasis shifted from focusing on labour intensive industries such as textiles and processed food to diversifying into increasingly sophisticated products such as electronic goods that involved more capital and higher value-added by manufacturers.

The incentive measures stimulated the economic growth and foreign trade in Taiwan. Taiwan experienced a high-speed economic growth in this period. From 1962 to 1980, Taiwan's real GDP grew at an average annual rate of 10.25%. Per capita national income increased from US$ 151.40 in 1962 to US$ 2154.85 in 1980, with an average annual growth of 15.90%. After removing the inflation, the growth averaged 7.18% per year. In the mean time, the economic structure continued to change in the two decades. As indicated in Table 3-4, the proportion of agriculture to GDP reduced sharply from 24.97% in 1962 to 7.68% in 1980 while the proportion of industries increased from 28.22% in 1962 to 45.75% in 1980. The proportion of services was kept at around 46% in this period.

Foreign trade increased at a faster rate in contrast to economic growth. The annual growth of real exports averaged 23.29% between 1962 and 1971, and 14.25% between 1972 and 1981. Real imports increased at average annual growth rates of 18.26% and 12.19% respectively in the above two ten-year periods. The proportion of exports to the expenditure of GDP increased greatly from 13.61% in 1962 to 52.53% in 1980. The proportion of imports changed from 18.94% to 53.72% in the same period.

The third stage of Taiwan's economic development ran from 1981 until now. In this period, economic condition inside and outside of Taiwan continued to change. Taiwan's economic growth has slowed down. As showed in Table 3-3, the average annual growth rate of real GDP was 8.06% between 1982 and 1991, and further fell to 5.25% between 1992 and 2002. In the last five years, the new government did not have good economic policies and was unable to stimulate economic growth. Between 1998 and 2002, the growth rates of real GDP were under 6% and even fell to -2.18% in 2001, the first negative growth rate in postwar Taiwan.

In the third stage, Taiwan maintained a mild inflation and low unemployment rates. As showed in Table 3-4, from 1982 to 1991, the consumer price index averaged an annual increase of 1.87%, and the wholesale price index averaged an annual decrease of 1.25%. On average, from 1992 through 2002, the consumer price index went up annually by 1.99% and the wholesale price index by 0.27%. In addition, unemployment rates were controlled at 3% before 2000. In 2001, the unemployment rate rose to 4.57% and further to 5.16% in 2002.

In the third stage, the share of agriculture sector in GDP continued to decrease from 7.68% in 1980 to 1.86% in 2002. Meanwhile, the economic focus of Taiwan also slightly shifted from the industrial sector to the service sector. The GDP share of industrial sector reduced from 45.75% in 1980 to 31.05% in 2002, while that of services increased from 46.57% to 67.10%.

In the third stage, foreign trade continued growing, although the growth rates slowed down slightly. Between 1982 and 1991, the annual growth of real exports averaged 10.75%, and that of real imports averaged 11.50%. From 1992 to 2002, the average annual growth rate of real exports decreased to 7.21% and that of real imports was 6.16%. Meanwhile, the proportion of exports to the GDP expenditure rose to 50.13% in 1982, achieved the peak of 58.10% in 1986, and was kept at around 50% in the following years. The proportion of imports was also approximately at 50%.

After learning basic economic development history of Taiwan, we began to discuss inward FDI in Taiwan. Taiwan adopted a FDI promotion policy very early, which made it become one of the most attractive destinations for foreign investors in the 1960s and 1970s. In 1960, Taiwan passed the Statute of Encouragement of Investment (SEI), a law stipulating the treatment of foreign firms' ownership and profit remittances. The SEI encouraged FDI into Taiwan by offering a broad range of incentive measures, including wholly ownership, permission to free remittance, a lower corporate tax and so on. Although the government began to control inward FDI in 1970 by limiting industries, raising local content requirements, and imposing import controls, the restrictive policy for inward FDI did not last for a long time. Beginning in 1984, the government re-employed a FDI promotion policy by cutting taxes and then by abolishing local content requirements in most industries.

In the late 1980s, foreign investment in Taiwan began to focus on technology-related and service industries. FDI in the labor-intensive industries were transferred to some other countries which had a cheaper labor than Taiwan, such as China. On January 1, 1991, the Statute for Upgrading Industries (SUI) replaced the SEI. The SUI aimed at restructuring and improvement of the existing industries. FDI in Taiwan turned to high-tech, capital intensive industries such as electronics, computers, chemicals, banking and finance.

3.3 Mainland China

The modern China can be divided into two main periods due to contrasting economic policies, namely, the close-door period before 1979 and the open-door period after 1979. Before 1979, the economy of mainland China fluctuated due to various political and historical factors. Although China's economy has been very successful since 1979, it is important for us to know the economic history before 1979 to better understand China's economic development after 1979.

Mainland China's economy was marred by World War II and further ravaged in the civil war from 1946 to 1949. The wars resulted in a great loss of life and property and the establishment of the People's Republic of China in 1949. From 1949, mainland China began to pursue socialism under the governance of the Communist Party of China (CPC), and pursue a Soviet-style centrally planned economy. In 1950, CPC embarked on economic recovery and conversion from capitalism to socialism. Although PRC was also involved in the Korea War (1950-53) and suffered a great loss of life and property once again, the economic rebuilding had been completed by 1956. The country set up the foundation of industrialization and completed the "Land Revolution" in the countryside to ensure that farmers have their own land. In this period the economy grew at a rapid rate firstly because of very low base in 1949 and secondly the economic policies and measures were generally on the right track for economic growth. From 1953 to 1956, the average annual growth rate of real GDP was 10.29%. However, the high economic growth rates did not change the national economic structure very much. The society was mainly an agrarian one in which agriculture output played a key role in the whole economy. In 1952, the share of primary industry was 50.5% and that of secondary industry was 20.9%.

Though the share of primary industry reduced to 43.2% and that of secondary industry rose to 27.3% in 1956, the change is slight and insignificant.

However, the normal economic development was constantly disrupted in the period of 1957-1976. In 1958, the “Great Leap Forward” was launched with expectations to surpass the advanced western countries in a short time period. In the countryside, “Agriculture Communes” were established and private ownership of land was absolutely forbidden. These policies retarded economic development. Although some measures were taken to correct the wrong policies in the following years, the economy was again in trouble because the relation with Moscow was soured in 1960 and a natural disaster broke out. The hardship persisted for three years. According to the official estimates, the negative real GDP growth rates (indicating depression) in these years were -0.3% in 1960, -27.3% in 1961 and -5.6% in 1962. From 1963 the economy resumed a high growth, but it was soon completely disrupted by the infamous “Great Proletarian Cultural Revolution” launched in 1966. This political campaign lasted for ten years and slowed economic growth. As presented in Table 3-5, the average annual growth rate from 1957 to 1965 was only 4.20% and the growth rate from 1966 to 1976 was 5.66%. However, in the slow-growth period, the national economic structure changed significantly. As showed in Table 3-6, the proportion of primary industry to GDP reduced from 43.2% in 1956 to 32.8% in 1976, while that of secondary industry rose from 27.3% in 1956 to 45.4% in 1976. The share of secondary industry was getting bigger in the whole economy and secondary industry began to play an important role in the economy.

In the period of 1949-1976, foreign direct investment was absolutely forbidden in China and foreign trade was also strictly under the control of the CPC government. The CPC government exported at a low level to get some foreign currency which was used to import some necessary goods for domestic production. Although export licenses were first introduced in 1951, they were abandoned soon in 1958.

The "Great Proletarian Cultural Revolution" was brought to an end in 1976. The focus of the government has shifted to economic growth. Beginning from 1979, the government embarked on political and economic reforms, including an open-door policy.

In the early 1980s, China focused on modernization and economic growth. In order to achieve this, the government embarked on a so-called "Four Modernizations Program" that emphasised on agriculture, industry, education, science and technology, and defense. In the rural areas, land was redistributed to the farmers under the "responsibility system", which allowed certain remaining surplus after the farmers handed in an agreed quota of agricultural harvests. The authorities allowed the growth of the private sectors gradually by encouraging a wide variety of small-scale enterprises in services and light manufacturing. Though the economy system still followed the old centrally planned economic model, the central control was gradually relaxed.

In the late 1980s, the government began to transform the old centrally planned economic model to a market-oriented economy ("Socialist commodity economy"). Further reforms occurred after 1992 when Deng Xiaoping expressed publicly the "socialist market economy" idea in his South Tour in the summer. The speech on the tour established the direction for China's further economic reform. The goal for "socialist market economy" system was officially determined at the 14th National Congress of the Communist Party of China (CPC) in 1992. The congress paved the way for further liberalizing foreign trade and foreign investment.

The successful economic reforms resulted in a high economic growth rate, a further change in the economic structure and a radical expansion of exports. The average annual growth rate of real GDP was 9.43% in the period of 1979-2002. The share of primary industry further dwindled to 15.2% in 2001, the share of secondary industry was kept at around 50%, and the share of tertiary industry rose to 33.6%. The real exports expanded at an average annual growth rate of 19.01% from 1977 to 1992, and kept growing at 12.77% from 1993 to 2001.

One of the most important factors that fuelled China's economic growth is the reform in the foreign trade system. In the early 1980s, China's government began to reform the old foreign trade system to decentralize the power of controlling the foreign trade. The provinces were granted more independence to operate their foreign trade. Due to the permission granted for foreign investment, foreign-invested companies were allowed to be integrated into foreign trade directly. In 1987, the state-authorized foreign trade corporations were cut free from the government's direct supervision and required to be responsible for their own profits and losses. In the middle 1990s, China further liberalized the international trade. For example, the control over imports was relaxed. China gradually abolished or decreased the range of import licenses, import quotas and other import control. Tariffs were also gradually cut down. Furthermore, the foreign trade sector was also opened up to private companies.

China's government also adopted the same incentive measures for exports, for example, tax reimbursement or exemption, loan priority, financial compensation for exporters, setting up a reward system to promote exports, diversifying the trade forms, setting up foreign exchange centres, priority of foreign exchange for exporters, devaluation of exchange rate, and setting up Special Economic Zones with more economic freedom.

Another important factor for economic growth is the reforms in foreign direct investment in China. In 1979, China passed the Joint Venture Law which provided a basic framework for foreign investment. However, China restricted FDI inflow mainly to four Special Economic Zones (SEZs) (Shenzhen, Shantou, Xiamen and Zhuhai) in the 1980s. The authorities gave the foreign companies more preferential treatment through their tax and administrative policies. In 1986, the Wholly Foreign-Owned Enterprise Law was enacted and allowed for foreign invested enterprises with sole foreign ownership. In the 1990s, China began to open up more cities to foreign investors, and granted more incentives for foreign-invested companies. In October 1995, the Chinese government announced "Provisional Regulations on Guiding Foreign Investment" and "Guidelines on the Industrial Catalog for Foreign Investment". The regulation lists the industries in which China encourages, restricts, and forbids foreign investment. The range of industries opened up to foreign investors was wider than the past.

As the results of these reforms, FDI into China increased rapidly. In 1991, the amount of the actual foreign direct investment achieved was US$ 4366 million. The stock of inward FDI reached US$ 23345 million. However after 1992, FDI began to “take off”. In 1992, the actual inward FDI flow reached US$ 11007 million, half of the inward FDI stock in 1991. In 2001, it reached US$ 46,878 million and the stock value totalled US$ 393512 million, 16.86 times the value in 1991. China has been one of the world’s largest hosts of FDI.

Chapter 4: Methodology and Data

4.1 The Granger Causality Test

Empirical studies often use a set of pair-wise Granger causality tests between economic variables. Granger (1969) developed a simple causality model showed as follows to test the possible causal relationships:

$$X_t = a_0 + \sum_{j=1}^{m} \alpha_j X_{t-j} + \sum_{j=1}^{m} \beta_j Y_{t-j} + \varepsilon_t \quad (4.1)$$

$$Y_t = b_0 + \sum_{j=1}^{m} \phi_j X_{t-j} + \sum_{j=1}^{m} \theta_j Y_{t-j} + \mu_t \quad (4.2)$$

where ε_t and μ_t are uncorrelated random error terms, X_t and Y_t are two economic variables, a_0 and b_0 are intercepts, α_j, β_j , ϕ_j and θ_j are parameters to be estimated and tested, and m is the number of lags, which is decided in terms of Schwarz Criterion (SC). . In this study, the above two economic variables can be any two series of real GDP, real exports, and real inward FDI.

The null test hypotheses are:

1. $\sum_{j=1}^{m} \beta_j = 0$
2. $\sum_{j=1}^{m} \phi_j = 0$

The Granger causality tests provide the results of causal relation in the following conditions:

(1) Unique causality running from Y to X if $\sum_{j=1}^{m} \beta_j \neq 0$ and $\sum_{j=1}^{m} \phi_j = 0$;

(2) Unique causality running from X to Y if $\sum_{j=1}^{m} \beta_j = 0$ and $\sum_{j=1}^{m} \phi_j \neq 0$;

(3) Bi-directional causality between FDI and exports if $\sum_{j=1}^{m}\beta_j \neq 0$ and $\sum_{j=1}^{m}\phi_j \neq 0$.

4.2 The Unit Root Test

Granger causality test is based on the assumption that the time series variables are stationary. If they are non-stationary, the regression results may give rise to the so-called spurious regression problem and lead to incorrect statistical inferences. Therefore, prior to the causality tests, it is required to test the stationarity of these time series variables. If they are non-stationary, we can make them stationary by taking their difference.

The terms non-stationarity, random walk, and unit root can be treated as synonymous (Gujarati, 2003). Hence, the unit root test that captures the order of integration of the time series can be utilized to examine the stationarity. The unit root tests are carried out on inward FDI, exports and GDP in real terms by using the augmented Dickey-Fuller (ADF) test. The ADF test for one unit root is based on the following regression:

$$\Delta X_t = \alpha + \delta X_{t-1} + \theta t + \sum_{i=1}^{n}\psi_i \Delta X_{t-i} + \xi_t \qquad (4.3)$$

where X_t can be real inward FDI, real exports and real GDP, t represents time, ξ_t is random error term, and n is the number of lag, selected in terms of Schwarz Criterion (SC).

The null hypothesis is δ = 0. If this null hypothesis is not rejected, the corresponding time series will be non-stationary; otherwise, the time series will be regarded as stationary and said to be integrated of order zero, denoted as I(0). If non-stationary, the following ADF test is employed to test for two unit roots where Δ^2 is the second differencing symbol.

$$\Delta^2 X_t = \alpha + \delta \Delta X_{t-1} + \theta t + \sum_{i=1}^{n}\psi_i \Delta^2 X_{t-i} + \xi_t \qquad (4.4)$$

The null hypothesis is still $\delta = 0$. If it is rejected, the first difference of the time series will be stationary and the time series is said to be integrated of order 1, denoted as I(1).

4.3 A Simultaneous Equation Model

In this study, we develop a simultaneous equation model to estimate the impacts of economic growth, inward FDI and exports. Firstly, we derive the regression equation from the economic theories and models. Secondly, based on the arguments for simultaneity, a test approach for simultaneity will be employed.

4.3.1 The Growth Equation

The estimation of impacts of FDI and exports on economic growth is based on the following regression equation:

$$\ln Y_t = c_0 + c_1 \ln F_t + c_2 \ln X_t + c_3 \ln L_t + c_4 \ln K_t + c_5 \ln M_t + \mu_t \qquad (4.5),$$

where Y_t denotes real gross domestic production (GDP), F_t denotes inward foreign direct investment (FDI) in real terms, X_t denotes the value of exports in real terms, L_t denotes the input of labor, K_t denotes the capital stock in real terms, M_t denotes the value of imports in real terms, and u_t is a random error. We use the real terms in order to eliminate the effect of inflation on nominal economic growth.

Equation (4.8) is derived from the conventional neo-classical production function. The production function represents the relationship between output and input factors under a certain technological condition. In macroeconomics, one form of the function can be written as:

$$Y = y\,[K, L, T],$$

where Y denotes the output, measured by real GDP in this study, K and L denote capital input and labor input respectively, T denotes the production technology, and y symbolises some form of mathematical function. In many textbooks, T is initially assumed to be constant so that it is easy for us to study the production function of inputs. When technology factor is omitted in the function, output is deemed to depend on the quantities of inputs. This is what classical economists argued.

However, technology always keeps on moving forward. Technology advancement increases the production through the improvement of productivity. Diverse factors may lead to technology advance, for example, investment in human resource, national economic structure, technology transfer and so on. In this study we focus on foreign trade and inward FDI. Following some empirical studies (Feder, 1983; Park and Prime, 1997; Agrawal, 2000), we add exports and imports as additional variables because both of them can lead to technology advancement through technology transfer. We also introduce inward FDI as an additional variable in the production function, because inward FDI can bring advanced technology and management skills which will benefit technology advancement in the host countries. Thus, the new production function can be written as

$$Y = y\,[K, L, F, X, M],$$

where the additional F, X, and M denote inward FDI, exports and imports, respectively.

Economists widely use the Cobb-Douglas production function because it represents many production properties. This form of production function is written as follows,

$$Y = A_0 K^a L^b,$$

where A_0 denotes the technological multiplicator under a certain technology level, while a and b are the corresponding input elasticity coefficients. As technology advancement is influenced by exports, imports and FDI, we can have $A_0=A_1X^{\alpha}M^{\beta}F^{\gamma}$, where A_1 is the new multiplicator influenced by other factors, and α, β and γ are the corresponding technology elasticity coefficients. Then the above production function is transformed to

$$Y=A_1X^{\alpha}M^{\beta}F^{\gamma}K^{a}L^{b}.$$

When we estimate the Cobb-Douglas function, we usually convert it into a linear equation by taking the logarithm of each term. That is,

$$logY=logA_1+\alpha logX+\beta logM+\gamma logF+alogK+blogL.$$

After some mathematical adjustments, Equation (4.5) is derived. In Equation (4.5), $c_{(1)}$ and $c_{(2)}$ are supposed to be positive, because we hypothesized that both inward FDI and exports have a positive impact on economic growth in Chapter 2. As we argued in Chapter 2, inward FDI and exports can stimulate economic growth through technology transfer, job creation, capital formation, and economies of scales. However, the sign of $c_{(5)}$, the coefficient of imports, is unable to be determined. Although imports benefit the output growth through technology transfer, imports enter the GDP tally with a negative sign, indicating a negative effect on economic growth. In addition, an increase in imports induces a decrease in national savings.

In Equation (4.5), the signs of $c_{(3)}$ and $c_{(4)}$ depend on the marginal product of labor and capital. According to the production function, the increase in the quantities of inputs does not necessarily induce the increase in output. If the marginal product of an input is negative, output will reduce if more of this input is added. Thus, the signs of $c_{(3)}$ and $c_{(4)}$ will be positive if the marginal products of labour and capital are positive; otherwise, the signs will be negative.

4.3.2 The Export Equation

We use the following regression equation to estimate the effects of FDI and economic growth on exports:

$$\ln X_t = c_6 + c_7 \ln Y_t + c_8 \ln F_t + c_9 \ln ER_t + c_{10} \ln Y^f{}_t + \xi_t \qquad (4.6),$$

where *X, Y,* and *F* indicate real exports, real GDP and real inward FDI respectively, *ER* denotes real effective exchange rates, and Y_f denotes the total real GDP of trade partner countries.

Equation (4.6) is derived from the demand function and supply function. The determinants of demand for a product can be based a wide variety of factors, such as the price of the product, the prices of other substitute or complementary goods, consumers' tastes and preferences, advertising and promotional efforts for this product and other substitute or complementary products, consumers' income, and so on. The supply function is based on the profit maximizing mechanism, which combines the factors such as price and production capability. An equilibrium model requires that demand equals supply.

Some researchers have applied the demand and supply theory to international trade and developed a reduced form of export function (Yue and Hua, 2002; Goldstein and Khan, 1978). In this study, we follow Yue and Hua's reduced form of export function. This reduced form of export function includes both demand factors and supply factors.

Following Yue and Hua's studies, we specify the export demand equation to include the relative price of exports and the world demand for exported goods of countries included in our study. The relative price of exports here is measured by the ratio of the price of alternative foreign goods to the export price of countries included in our study.

The world demand is represented by the real GDP of the trade partners. The export demand equation is written as

$$ln(x_t^d)=a_0+a_1ln((p_t^f \times EN_t)/p_t^x)+a_2ln(Y_t^f),$$

where x^d is the value of exports demanded in real terms, p^f is the price of alternative foreign goods expressed in foreign currencies of the country's export partners, p^x is the export price, *EN* indicates the nominal effective exchange rate in terms of the local currency values per unit of the foreign currencies, and Y^f is real GDP of the country's export partners.

The export supply equation is specified to include the ratio of export prices to domestic prices and an index of the production capability of the country (Goldstein and Khan, 1978). Yue and Hua (2002) took real GDP as a measure of the production capacity and augmented Goldstein-Khan's equation by including some comparative advantage indices. In this study, we continue to employ real GDP as an index of the production capacity, but augmented Goldstein-Khan's equation by including inward FDI. As we have stated in Chapter 2, inward FDI brings the advanced technology and management skills which benefit the local exporters. In addition, inward FDI also lead to re-export and thus stimulated the exports of the host country. Hence, like GDP, inward FDI is added into the export supply function as a supply factor. We write the export supply equation as

$$\ln(x_t^s)=b_0+b_1\ln(p_t^x/p_t^d)+b_2\ln(Y_t)+b_3\ln(F_t),$$

where x^s is the export value of supply in real terms, p^d is the consumer price index of the country, *Y* is the real GDP of the host country, and *F* is real inward FDI.

Assuming equilibrium, we set $x^d=x^s=x$ and $ER=(p_t^f \times EN_t)/p_t^x$ to obtain the reduced-form equation (4.6) by solving p^x, where *ER* is the real effective exchange rate. The relations among the coefficients are written as follows.

$$c_6 = \frac{a_0 b_1 + a_1 b_0}{a_1 + b_1}; c_7 = \frac{a_1 b_2}{a_1 + b_1}; c_8 = \frac{a_1 b_3}{a_1 + b_1}; c_9 = \frac{a_1 b_1}{a_1 + b_1}; c_{10} = \frac{a_2 b_1}{a_1 + b_1}.$$

In Equation (4.6), the signs of $c_{(7)}$ and $c_{(8)}$ are expected to be positive. As an index of production capability, the growth of real GDP will induce an increase in exports. Furthermore, an increase in inward FDI, which brings advanced technology and management skills, will lead to an increase in exports, as we have stated in Chapter 2.

The coefficient of real effective exchange rate is expected to be positive. It is a well known theory that a depreciation of exchange rate induces an increase in exports. In this study, we simply use the exchange rate in terms of the value of local currency per US dollar. So an increase in the real effective exchange rate means a depreciation of exchange rate, and consequently induces an increase in exports.

In Equation (4.6), Y^f is a demand factor and is measured by the total real GDP of OECD countries expressed in 1995 US dollars. OECD countries, especially U.S. and Japan, have been the main trading partners of Korea, Taiwan and China. Korea, as a new member of OECD, has a close trade relationship with other OECD countries. Hence, the GDP growth of OECD countries indicates the increase in the world demand for exported goods of the countries included in our study, and consequently induces the increase in exports. So its coefficient $c_{(10)}$ is expected to have a positive sign.

4.3.3 The Inward FDI Equation

The inward FDI function in this study is specified as

$$\ln F_t = c_{11} + c_{12} \ln Y_t + c_{13} \ln X_t + c_{14} \ln Wg_t + c_{15} IR_t^d + c_{16} \ln Y_t^f + c_{17} IR_t^f + \varepsilon_t \quad (4.7),$$

where F, Y and X denote a country's real inward FDI, real GDP and real exports respectively, Wg denotes the real relative wage ratio, IR^d denotes the domestic interest rate in real terms, Y^f denotes the total real GDP of OECD countries, and IR^f denotes the average real interest rate outside the country.

Equation (4.7) is derived from the profit maximizing mechanism. Profits *(π)* equal to revenue minus costs. The revenue equals to the price times the quantity of output, and the costs are the sum of input costs. Under a certain technology possibility, all the inputs can be grouped into capital and labor. Then the profit function can be written as:

$$\Pi = P \times Y - Wg \times L - c \times K \quad ,$$

where P is the price of output, Y is the quantity of output, Wg is the wage rate, L is the employed labor, c is the cost of capital, and K is the capital. The profits are maximized subject to the production function under a certain technology possibility,

$$Y = y[K,L].$$

Set the derivative Π with respect to K and L respectively to zero, and then we get:

$$\frac{\partial \Pi}{\partial K} = PY_K - c = 0$$

$$\frac{\partial \Pi}{\partial K} = PY_L - Wg = 0$$

where Y_K is the marginal product of capital, and Y_L is the marginal product of employed labor. These two equations are the condition where profits are maximized. The condition can be further simplified as

$$\frac{Y_K}{c} = \frac{Y_L}{Wg}$$

This is the familiar profit maximizing rule for two inputs. This means that at the point where the profits are maximized, the marginal product per last dollar spent on each input are equal. If the ratios are unequal, the firm will increase the profit by transferring a dollar from the factor with a lower ratio to the factor with a higher ratio. This progress is accompanied by the capital flow. As this progress continues, the ratios will eventually be equal. Therefore, the demand for capital depends on the production function, the cost of capital, the wage rate and the price of output (Meyer, 1980).

$$K^{*}=K[c, P, Wg, Y].$$

The above derivation is based on the assumption that price is exogenous and there is no difference in the unit costs of inputs in all the countries. However, the assumption does not hold in reality. The price usually depends on the quantity of production and the unit costs of inputs are different in different countries. Barrell and Pain (1996) developed a reduced-form equation for U.S. outward FDI. Their profit function was specified as

$$\Pi = P_1(X_1)X_1 + P_2(X_2)X_2 - TC_1(Q_1) - TC_2(Q_2)$$

Subjective to

$$X_2 > 0; X_1 + X_2 = Q_1 + Q_2;$$
$$Q_1 = f(L_1, K_1); Q_2 = f(L_2, M, N) : TC_1 = w_1 L_1 + c_1 K_1; TC_2 = w_2 L_2 + c_{2M} M + c_{2N} N;$$

where P_i denotes price in market i, X_i denotes sales in the market i, (i=1 for the domestic market and 2 for the foreign market), Q_i denotes the total output in the country i, K_i and L_i denote the capital and labor inputs in the country i, TC_i denotes total costs, w_i denotes the wage rate (i=1 for the home country U.S. and 2 for the host countries), c_1 denotes the cost of capital in the home country, c_{2j} denotes the cost of capital for type of investment j (*M* or *N*) in the host countries, *M* denotes inputs abroad financed by means of foreign direct investment, and *N* denotes other inputs financed by borrowing from third parties located outside the home country. Barrell and Pain (1996) finally derived the following outward FDI function:

$$M = f(\overset{+}{\psi_1}, \overset{+}{\psi_2}, \overset{+}{c_1}, \overset{\mp}{c_{2N}}, \overset{-}{c_{2M}}, \overset{+}{w_1}, \overset{-}{w_2}).$$

where $\Psi_1 and \Psi_2$ represent the overall level of demand in the home and host countries.

Following the work by Barrell and Pain, we develop an inward FDI function similar to their outward FDI function. Consider the case of a firm whose markets can be grouped into two broad categories, namely, the market in a host country and the market outside the host country. We use subscript 1 to denote the market in the host country and 2 to denote the market outside the host country. Then, profits are given by

$$\Pi = P_1(X_1)X_1 + P_2(X_2)X_2 - TC_1(Q_1) - TC_2(Q_2)$$

Subjective to

$$X_1 > 0; X_1 + X_2 = Q_1 + Q_2;$$
$$Q_1 = f(L_1, K_1); Q_2 = f(L_2, K_2) : TC_1 = w_1 L_1 + c_1 K_1; TC_2 = w_2 L_2 + c_2 K_2;$$

Maximize the profits with these restrictive conditions, we get a reduced form of inward FDI function like Barrell and Pain's outward FDI function:

$$K_2 = f(\overset{+}{\Psi_1}, \overset{+}{\Psi_2}, \overset{-}{c_1}, \overset{+}{c_2}, \overset{-}{w_1}, \overset{+}{w_2}) \qquad (4.7.1)$$

In Equation (4.7.1), the demand $\Psi_1 and \Psi_2$ can be measured by real GDP of the host country and real GDP outside the host country. The latter is measured by the total real GDP of OECD countries in this study. Our difficulty lies in calculating the average wage rates outside the host country. In this study, we resolve this by using the real relative wage ratio, defined here as ratio of the average monthly real salary expressed in US dollars in the host country to the average monthly real salary in US. The unit cost of capital in the host country is measured by the deposit interest rate and the unit capital cost outside the country is measured by the rate of remuneration in real terms released by International Financial Statistics database. Finally, like Barrell and Pain, we also include exports in our empirical work. Barrell and Pain (1996) argued that exports can stimulate foreign investment in downstream services. After we substitute the real relative wage rate for w_1 and w_2 in Equation (4.7.1), add the variable of exports, and take the logarithm form of all the variables, we derive Equation (4.7).

In Equation (4.7), the coefficients of real GDP of the host country and OECD countries are supposed to be positive. The GDP growth of the host country indicates an increase in the market size of the country which attracts inward FDI. The GDP growth of OECD countries indicates an increase in global market demand which induces an increase in investment. The coefficients of real relative wage ratio and domestic real interest rate are expected to be negative because an increase in input costs induces a decrease in profits and consequently evokes a decrease in inward FDI. That is, the low wage rate and interest rate cut down total production costs, and attract inward FDI. The coefficient of average real interest rate outside the country is supposed to be positive. An increase in average real interest rate outside the country indicates an increase in unit capital cost, and pushes foreign investment into the host country. However, the sign of $c_{(13)}$ is difficult to determine. Although Barrell and Pain (1996) argued that exports have a positive effect on foreign investment, exports may also have negative effects on inward FDI by decreasing the demand of foreign capital, as we have stated in Chapter 2.

4.3.4 The Hausman Test for Simultaneity

The above three equations, however, are not independent. FDI, exports and economic growth are considered to have an inherent simultaneity problem. In other words, there is a simultaneity existence among the three equations. If there is a real simultaneity among them, these equations cannot be estimated independently by using OLS. As Shan (2002) pointed out that failure to consider either direction of such causality can lead to an inefficient estimation of the model and hence subject the model to simultaneity bias.

In econometrics, the simultaneity problem can be examined by using the Hausman test. Considering a proposed simultaneous equation model that has three equations, we assume that one of the equations is

$$Y_1 = \alpha_1 + \alpha_2 Y_2 + \alpha_3 Y_3 + \beta_1 X_1 + \beta_2 X_2 + u_1$$

Then we change the other two equations in the model into their reduced form, and estimate them. We will obtain the predicted values for Y_2 and Y_3, denoted as $\hat{Y}_2$ and $\hat{Y}_3$. The two equations can be

$$Y_2 = \hat{Y}_2 + \hat{u}_2$$
$$Y_3 = \hat{Y}_3 + \hat{u}_3$$

We then obtain the expanded regression equation:

$$Y_1 = \alpha_1 + \alpha_2 Y_2 + \alpha_3 Y_3 + \beta_1 X_1 + \beta_2 X_2 + \gamma_1 \hat{Y}_2 + \gamma_2 \hat{Y}_3 + u_1$$

Estimate the equation by OLS and test the hypothesis: $H_0 = \gamma_1 = \gamma_2 = 0$. If the null hypothesis is rejected, we say that simultaneity exists in the model.

In our case, Y_1 is the logarithm form of real GDP (*ln Y*). Firstly, we obtain the following reduced form of export function and FDI function:

$$\ln X_t = a_0 + a_1 \ln L_t + a_2 \ln K_t + a_3 \ln M_t + a_4 \ln ER_t + a_5 \ln Y^f{}_t + a_6 \ln Wg_t + a_7 IR_t^d + a_8 IR_t^w + \zeta_t$$

$$\ln F_t = c_0 + c_1 \ln L_t + c_2 \ln K_t + c_3 \ln M_t + c_4 \ln ER_t + c_5 \ln Y^f{}_t + c_6 \ln Wg_t + c_7 IR_t^d + c_8 IR_t^w + \zeta_t$$

After we obtain the predicted values of *lnX* and *lnF*, denoted as $\hat{\ln} X$ and $\hat{\ln} F$, we estimate the following expanded regression equation and test the hypothesis $H_0 = \gamma_1 = \gamma_2 = 0$.

$$\ln Y_t = \alpha_0 + \alpha_1 \ln F_t + \alpha_2 \ln X_t + \alpha_3 \ln L_t + \alpha_4 \ln K_t + \alpha_5 \ln M_t + \gamma_1 \hat{\ln} X_t + \gamma_2 \hat{\ln} F_t + \mu_t \quad (4.8).$$

4.3.5 Estimation Methods

If the Hausman test results suggest the existence of simultaneity, we will utilize the two-stage least square procedure to estimate the three-equation model. In the first stage, we obtain the estimated values of two proposed endogenous variables in the regression on the exogenous variables. In the second stage, we substitute the estimated values of these variables for their actual values in the original equation, and estimate the coefficients.

In the regression, we have to satisfy the conditions for OLS residual, namely, normality, heteroskedasticity and autocorrelation. Hence, we have to examine the residuals estimated by the OLS. In the examination, we firstly test the autoregressive conditional heteroskedasticity (ARCH) by using a Lagrange multiplier (LM) test. If the test results suggest an evidence of ARCH, we will use the ML-ARCH (Marquardt) estimation method to eliminate this problem. If the ARCH LM test suggests no evidence of ARCH, we will examine the residuals for serial correlation by using Breusch-Godfrey (BG) Serial Correlation LM test. If the test results show the evidence of serial correlation, we will use ARMA (n,m) to adjust the OLS method in order to eliminate the effect of serial correlation. Once the BG LM test shows no serial correlation in the residues, we will test for heteroskedasticity. In the case of heteroskedasticity, we use White Heteroskedasticity-Consistent Standard Errors & Covariance to modify the estimated standard errors obtained by OLS. Finally, we test the residuals for the normality by using the Jarque-Bera statistic.

4.4 Data and Measurement Issues

4.4.1 Data Sources

In the case of Korea, we get the annual data from the website of Korea National Statistical Office (KNSO): http://www.nso.go.kr/eng/. However, this database covers only a period of 1970-2003. We also refer to the data in World Development Indicators (CD-ROM, 2002) and International Financial Statistics (CD-ROM, 2003), where most of the data after 1970 are completely consistent with those found in KNSO. As a result, we can use the data backward to 1960 in World Development Indicators and the data backward to 1950 in International Financial Statistics.

As for the quarterly data, we mainly refer to International Financial Statistics (CD-ROM, 2003). However, the quarterly data for employment are not available until 1993. Hence we use annual data instead of quarterly data before 1993. Furthermore, there is only monthly earning index in terms of the base year 1995 in International Financial Statistics. We calculate the quarterly data on salary by using the annual figure in 1995 and the index.

In the case of Taiwan, the yearly data are available on the website of Director-General of Budget, Accounting and Statistics (DGBAS): http://www.stat.gov.tw/main.htm and Statistical Yearbook of The Republic of China (various years from 1975 to 2001). The final collected data set covers the period of 1956-2002.

In the case of China, data collection is difficult. In the period before the reform in 1979, China used the system of material product balances (MPS). In the early 1980s, the National Bureau of Statistics of China (NBS) began to reform the national account system and implement the United Nations System of National Accounts (SNA) in 1992. Based on historical statistical data in NSB, the authorities estimated the main national economic indicators backward to 1952, in terms of SNA. Hence, the annual data are available at the official China Statistical Yearbook (CD-ROM, 2002) and Ministry of Finance PRC (MOF).

Most of the quarterly official data for China are not available. In this study, we use the data from different data sources, but most of the data are extended from the official annual data. International Financial Statistics (CD-ROM, 2003) has the quarterly data for exports, imports, domestic interest rates, and exchange rates. We use the quarterly real

GDP estimates given by Abeysinghe and Gulasekaran (1999) who used the official figures to extend the series in terms of year-on-year growth rates. Quarterly data on inward FDI after 1997 in China are available at ARIC Database, but those data before 1997 are extended from the annual figures divided by four. The other quarterly series are extended from the official annual data. We use the annual figures as the quarterly ones for employed labor, monthly earnings, GDP deflators and consumer prices. The quarterly data for gross fixed capital formation are extended from the annual figures divided by four.

The annual data and quarterly data on GDP and GDP deflators of OECD countries are provided by International Financial Statistics (IFS). IFS also provided the average rates of remuneration and consumer prices at the world level. The consumer prices in U.S can also be found in IFS. The data for average monthly earnings in U.S. are available at EconStats Database website: http://www.econstats.com/ .

4.4.2 Measurement Issues

In order to remove the effect of inflation, we use real terms at 1995 prices of GDP, exports, imports, inward FDI flow, wages, interest rates, capital, and exchange rates. Real GDP and real inward FDI flow are calculated in terms of the GDP deflators. Real exports and real imports are obtained in terms of import prices and export price, but they are obtained by using the GDP deflators in the case of China where import prices and export prices are unavailable. Real interest rates are obtained by subtracting the inflation in terms of consumer prices from the nominal interest rates. The calculation of real effect exchange rates relies on $(p_t^f \times EN_t)/p_t^x$, where p^f is the consumer prices in U.S., p^x is the consumer prices in a country, and EN is the nominal effect exchange rates of local currency values against one U.S. dollar.

In the following parts, we will investigate the special measurement issues of capital stock, inward FDI stock and real relative wage ratio.

Capital Stock

We use the standard perpetual inventory approach to estimate the real capital stock. We use the national investment data from the above databases. The investment series used is gross fixed capital formation (GFCF) at current prices. We transform the nominal GFCF series to the real one by using the GFCF deflators. If the GFCF deflators are not available, we employ the GDP deflators in the calculation.

Before we calculate capital stock, we need to know the depreciation rates. In this study, we adopted an average depreciation rate of 5% as Perkins (1988) did. We also conduct a sensitivity analysis of our capital stock calculation, using 5%, 10%, and 15% as depreciation rates. As indicated in Table 4-2, the results turn out that the growth rates of real capital stock calculated by different depreciation rates do not differ very much. Hence, the depreciation rate of 5% used in our study will not cause a serious problem.

We then begin to construct a time series of capital stock from real investment flows. Because of the difficulty in estimating the initial level of capital stock in the developing countries, we obtain the data of real capital stock by adding up real GFCF over years with adjustment for depreciation.

Inward FDI Stock

The calculation of the real inward FDI stock is performed in a two-step procedure. In the first step, we obtain the real inward FDI flow deflated by the GDP index. Secondly, the data of real inward FDI stock are obtained by adding up the real inward FDI flow over years.

Real Relative Wage Ratio

The construction of real relative wages is done in a three-step procedure. First, we obtain the data on real wages in the selected country and U.S respectively. Second, we unify the money units to U.S. dollar in terms of the average exchange rates. Third, we calculate the ratio of the real wages in the selected country to the figures in U.S.

Chapter 5: Results and Discussion

5.1 The Descriptive Analysis of the Time Series

Before we carry out the tests and estimate the simultaneous equation model, we compute the Pearson correlations summarized in Table 5-4. According to the results, we find that exports, inward FDI and GDP are highly correlated in all three cases. Their correlations are larger than 0.90 and are significant at the 5% level. These results indicate the presence of high level of inter-linkages among them.

5.2 The Unit Root Test Results

Firstly, we consider the salient features of the data used in this study. Figure 5.1 to Figure 5.3 present the time graphs of real GDP, real export, and FDI of Korea, Taiwan and China respectively. Real GDP and real exports in all the cases appear non-stationary, as reflected by the obvious positive trends indicated in Figure 5-1 to Figure 5-3. China's FDI also seems to be non-stationary, because there is an obvious trend in Figure 5-3. However, we are unable to judge the stationarity of real FDI in the case of Korea and Taiwan, whose graphs do not show any obvious trends.

The graphs have given us some hints about the stationarity of each series. However, the final conclusions of stationarity are based on the unit root test results. We subject each of the series to a unit root test to check for stationarity. The Augmented Dickey-Fuller values of the unit root test are presented in Table 5-1.

In the case of Korea, the results based on annual data and quarterly data suggest the presence of one unit root in all the three series. As shown in Table 5-1, the null hypothesis that the level of each series is non-stationary is not rejected. However, the null hypothesis is rejected at the 10% level of significance when the first difference of the series is taken. These results indicate that these series are integrated of order one, $I(1)$.

In the case of Taiwan, the results are based on annual data covering a period of 1956-2002. The results support the existence of one unit root in each series. This is confirmed by the fact that the null hypothesis of non-stationarity is not rejected at the level of each series. However, the hypothesis is rejected at the 1% level of significance at the first difference of each series. Thus, all the series are integrated of order one, I (1).

In the case of China, the unit root test results are complex. The results from the annual data set support the presence of two unit roots in both series of real GDP and real exports. As indicated in Table 5-1, the null hypothesis of non-stationarity is not rejected at both the level and the first difference of each series. But it is rejected at the 1% level of significance when we take the second difference of each series. Thus, we conclude that, both series of real GDP and real exports are integrated of order two, I (2). Therefore, we need to take the second difference to make them stationary.

The results from China's quarterly data indicate two unit roots in the series of real GDP and one unit root in the series of real exports and real inward FDI flow. The null hypothesis that the series of real GDP is non-stationary is not rejected at both its level and first difference, but it is rejected at the 1% significance level at its second difference. However, the hypothesis is rejected at the 1% significance level at the first difference of real exports and real inward FDI flow, while it is not rejected at the level. Hence, there is a mix of series which are integrated of order one and order two.

5.3 The Granger Causality Test Results

The results of Granger causality tests are summarized in Table 5-2. The first difference of each time series depicts its growth, and the second difference indicates the change of its growth. According to the unit root test results, either the first difference or the second difference is stationary.

The lag length selection results in terms of SC in the causality test are presented in Table 5-3. Insofar as the sample size is concerned, the tests were carried out from lag length one to lag length five in the annual data set and to lag length 10 in the quarterly data set.

Causality between GDP and exports

From Table 5-2, we find the evidence of bi-directional causal links between real GDP and real exports. In the case of Korea, the results based on annual data and quarterly data suggest that both the null hypotheses of no causality from the growth of real GDP to the growth of real exports and the reverse one of no causality from the growth of real exports to the growth of real GDP are rejected at the 1% significance level. In the case of Taiwan, the above null hypotheses are also rejected at the 1% significance level. These results suggest that economic growth and export growth affect each other in these two economies.

In the case of China, the evidence of bi-directional causality is weak. The results based on the quarterly data starting from 1982 suggest one-way causality from the growth of real exports to the change of economic growth. The null hypothesis that the second difference of real GDP does not cause the first difference of real exports is not rejected. However, the results based on the annual data indicate one-way causality from the change of economic growth to the change of export growth. The null hypothesis of no causality from the second difference of real exports to that of real GDP is rejected. These results support the presence of internally-driven export growth in the period of 1952-2002 and export-led growth in the period of 1982-2002.

Causality between GDP and FDI inflow

The results in Table 5-2 indicate the existence of bi-directional causality between economic growth to inward FDI in the case of Taiwan and China. In the case of Taiwan, both the hypotheses of no causality from the first difference of real GDP to the first difference of real inward FDI and the reverse hypothesis are rejected at the 10% level of significance. In the case of China, both the hypothesis that the second difference of real GDP does not cause the first difference of real inward FDI and the reverse hypothesis are also rejected at the 1% significance level.

However, the results in Table 5-2 suggest only one-way causality from economic growth to inward FDI in the case of Korea. The hypothesis of no causality running from the first difference of real GDP to the first difference of real inward FDI is rejected at the 10% significance level, but the reverse one that the first difference of real inward FDI does not 'Granger cause' the first difference of real GDP is not rejected.

The main reason why there is no evidence of causality from inward FDI to economic growth in the case of Korea while such causality is supported in the case of Taiwan and China is the different attitude of the governments to inward FDI. As we described in Chapter 3, Korea's government controlled the financial market for a long period. Hence, the government limited the entrance of inward FDI, dismissing its positive effects on economic growth. The government did not implement incentive policies to attract FDI inflow until 1990s. In contrast, the governments of Taiwan and China have a positive attitude towards FDI inflow. In China, the positive attitude resulted in China becoming the largest host of FDI inflow in the world in 2002.

Causality between exports and FDI inflow

The bi-directional causal links between exports and inward FDI are supported by the results in all the cases. This is confirmed by the fact that the null hypothesis that the first difference of real inward FDI does not cause the first difference real exports is rejected at the 5% significance level and the reverse one of no causality from the difference of real exports to the first difference of real inward FDI is also rejected at the 5% significance level in each case.

5.4 The Hausman Test Results for Simultaneity

The Hausman test results for simultaneity are summarized in Table 5-5. We use quarterly data in the cases of Korea and China, and annual data in the case of Taiwan.

In the case of Korea, the results suggest the existence of simultaneity. Firstly, we use the ML-ARCH estimation method to eliminate the ARCH problem. Secondly, we subject the null hypothesis "$\gamma_1 = \gamma_2 = 0$" to the Wald coefficient test. The P values of F statistic and Obs*R-squared statistic, equal to 0.0010 and 0.0006 respectively, indicate that the null hypothesis is rejected at the 1% significance level.

In the case of Taiwan where the ARCH problem is also detected, the results of the ML-ARCH regression support the existence of simultaneity among three equations. As presented in Table 5-5, the P values of the Wald coefficient test are small, indicating that the null hypothesis "$\gamma_1 = \gamma_2 = 0$" is rejected at the 1% significance level.

In the case of China, the results also support the presence of simultaneity. In this case, we find the evidence of serial correlation and heteroskedasticity in the OLS residuals, but no evidence of ARCH problem. We solve the detected problems by using an MA (5) adjustment approach in the regression. Finally, the small P values of the Wald coefficient test reject the null hypothesis "$\gamma_1 = \gamma_2 = 0$" at the 10% significance level.

In summary, we have found the evidence of simultaneity among the equations in all three cases: Korea, Taiwan, and China. So we set up a simultaneous equation model as follows.

$$\ln Y_t = c_0 + c_1 \ln F_t + c_2 \ln X_t + c_3 \ln L_t + c_4 \ln K_t + c_5 \ln M_t + \mu_t \quad (4.5),$$
$$\ln X_t = c_6 + c_7 \ln Y_t + c_8 \ln F_t + c_9 \ln ER_t + c_{10} \ln Y^f{}_t + \xi_t \quad (4.6),$$
$$\ln F_t = c_{11} + c_{12} \ln Y_t + c_{13} \ln X_t + c_{14} \ln Wg_t + c_{15} IR_t^d + c_{16} \ln Y_t^f + c_{17} IR_t^f + \varepsilon_t \quad (4.7).$$

5.5 The Model Estimation Results

The estimation results of the above simultaneous equation model are summarized in Table 5-6 to Table 5-8. In the following sections, we analyze these results case by case.

Some scholars think that the cointegration test should be carried out to support the existence of long-run relationship. However, we argue that we do not need to carry out such a test because each equation in our model is derived from the acknowledged theories, indicating a long-run relationship between the dependent variable and the independent variables. Assuming that the long-run relationship may be questionable, we address the concern on cointegration in Appendix A and find some evidence of long-run relationship.

Korea

Firstly, let us discuss some problems in the regression. In estimating the growth equation, the results of the ARCH LM test and the BG-LM test support the absence of ARCH problem and serial correlation problem in the OLS residuals. But we find the evidence of heteroskedasticity. Thus, we modify the standard errors of the coefficients by using White heteroskedasticity-consistent standard errors & covariance. We also find the evidence of non-normality in the Jarque-Bera test, which leads us having to interpret the results cautiously. In estimating the export equation, we did not find the ARCH problem and the heteroskedasticity problem. However, the results suggest the presence of serial correlation. This problem is solved after we use an AR (5) adjustment approach. In estimating the inward FDI equation, we employ the ML-ARCH method to eliminate the detected ARCH problem.

In the regression results, we find the evidence of a positive relationship between exports and economic growth. In the growth equation, the coefficient of exports is positive and statistically significant at the 1% level. In the export equation, the coefficient of real GDP is also positive and statistically significant at the 1% level. These results suggest that exports and economic growth reinforce each other in Korea.

However, the results in Table 5-6 and Table 5-8 show that inward FDI and economic growth affect each other negatively. The coefficient of inward FDI in the growth equation is negative (-0.315131) and the P value of its t statistic is small (0.0568). In addition, the coefficient of real GDP in the inward FDI equation is also negative and statistically significant at the 1% level. These results do not support our earlier hypothesis that inward FDI and economic growth affect each other positively.

The relationship between exports and inward FDI is also complex. In the export equation, the negative coefficient of inward FDI which is statistically significant at the 10% level indicates a negative effect of inward FDI on economic growth. However, in the inward FDI equation, the positive coefficient of real exports which is statistically significant at the 1% level supports the presence of a positive effect of exports on inward FDI.

In the growth equation, we also find that the coefficient of labor is negative and not statistically significant, indicating that more input of labor does not have a significant effect on the increase in output. The negative sign implies that the marginal product of labor is negative. However, the coefficient of capital stock is positive and statistically significant at the 5% level. This result implies that the increase in capital stock has indeed stimulated economic growth in Korea. In this regression, the coefficient of imports is negative and statistically significant at the 1% level. Thus, the increase in imports does not stimulate the economic growth through technology transfer in Korea. On the contrary, it has a negative effect on economic growth.

In the export equation, the coefficient of real effective exchange rate is found to be negative and statistically significant at the 1% level, indicating that an increase in the real effective exchange rate induces a decrease in exports. As mentioned in Chapter 4, an increase of the real effective exchange rate means a depreciation of exchange rate in our study. Thus, the negative coefficient indicates that a depreciation of real effective exchange rate induces a decrease in exports, coming into conflict with the well known theory that a depreciation of exchange rate can cause an increase in exports. In the regression, the coefficient of the total real GDP of OECD countries is positive and statistically significant at the 1% level, implying that the economic growth of OECD countries brings forth the increase in Korea's exports. The result suggests OECD countries' economic growth has a stimulating effect on the demand for Korea's goods and services.

In the inward FDI equation, the coefficient of real relative wage ratio has a negative sign and is statistically significant at the 1% level, indicating that the increase in the average salary retards the growth of FDI into Korea. In the regression, the coefficient of domestic real interest rate is also negative and statistically significant at the 1% level, indicating that the capital cost in Korea has been a determinant of inward FDI. The negative sign of this coefficient suggests that a decrease in capital cost will attract FDI into Korea. However, the coefficient of the average interest rate outside Korea is not statistically significant. This suggests that the increase of capital cost outside Korea should not necessarily induce FDI into Korea. Even if there is an international capital movement caused by the increase in capital cost outside Korea, FDI may move to some other countries with a lower labor and capital cost, for example, China. Finally, the coefficient of the total real GDP of OECD countries is positive and statistically significant at the 1% level, indicating that the world economic growth influences the growth of FDI into Korea.

Taiwan

There are some problems needed to be discussed in estimating the simultaneous equation model. In the growth equation, the results of the ARCH LM test, BG-LM test and White Heteroskedasticity test indicate the presence of ARCH, serial correlation and heteroskedasticity in the OLS residuals. However, these problems have been solved after we use AR (1) approach to adjust the regression. In the export equation, we found the existence of serial correlation in the OLS residuals and solved the problem by using AR (1) to adjust the regression. In the inward FDI equation, the hypothesis of no ARCH problem is rejected at the 1% significance level. Thus, we employ the ML-ARCH approach to re-estimate the equation.

The adjusted regression results support the argument that economic growth and exports do reinforce each other. The coefficient of exports in the growth equation is found to be positive as hypothesized and statistically significant at the 5% level. In addition, the coefficient of real GDP in the export equation is also positive and statistically significant the 5% level.

Inward FDI is also found to be positively related to economic growth in the case of Taiwan. In the growth equation, the coefficient of inward FDI stock is positive (0.112787) and has a small P value (0.0127). In the inward FDI equation, the coefficient of real GDP has a positive sign and is statistically significant at the 1% level. All these results indicate that inward FDI and economic growth induces each other in Taiwan.

The relationship between exports and inward FDI, however, is found to be complex in Taiwan. On the one hand, the coefficient of inward FDI in the export equation is negative but not statistically significant. Thus, we conclude that inward FDI does not stimulate export growth in Taiwan. On the other hand, the coefficient of real exports in the inward FDI equation is negative and statistically significant at the 1% level, indicating an impeditive effect of the export expansion on the FDI into Taiwan.

In the growth equation, we also find a positive effect of labor on economic growth. This is confirmed by the fact that the coefficient of labor is positive and statistically significant at the 5% level. In this equation, the coefficient of capital stock is also positive and statistically significant at the 1% level. These results imply that the increase in capital stock and labor has indeed stimulated economic growth in Taiwan. However, there is no significant effect of imports on economic growth.

In the export equation, the coefficient of real effective exchange rate is negative but not statistically significant, indicating that Taiwan's export growth has not benefited from a depreciation of exchange rate. In the equation, the coefficient of the total real GDP of OECD countries is positive but not statistically significant, implying that the economic growth of OECD countries does not have a significant effect on export expansion in Taiwan.

In the inward FDI equation, all the coefficients of real relative wage ratio, domestic real interest rate and the average interest rate outside Taiwan are not statistically significant. These results indicate that the costs of labor and capital do not have an inductive effect on FDI into Taiwan, and an increase in the average interest rate outside

Taiwan does not necessarily push FDI toward Taiwan. However, the coefficient of the total real GDP of OECD countries is positive and statistically significant at the 1% significance level, indicating that world economic growth has a positive effect on FDI into Taiwan.

China

In all three equations, the results of the ARCH LM test indicate the presence of ARCH in the OLS residuals. Thus, we employ the ML-ARCH approach to adjust the regression.

The results in the case of China support the positive relationship between exports and economic growth. In the growth equation, the coefficient of exports is positive and statistically significant at the 1% level, indicating the export-led growth hypothesis may contribute to economic growth in China. In the export equation, the coefficient of real GDP which is positive and statistically significant at the 1% level, suggests the presence of a positive effect of economic growth on export expansion.

Inward FDI is also found to be positively related to economic growth. In the growth equation, the coefficient of inward FDI stock is positive and has a small P value (0.0000), indicating the presence of a positive effect of inward FDI on economic growth in China. The coefficient of real GDP is also positive and statistically significant at 1% level of significance, implying the attractive force of economic growth upon inward FDI.

However, inward FDI is found to be negatively related to export growth in the case of China. The coefficient of inward FDI stock in the export equation and the coefficient of real exports in the inward FDI equation are both negative and statistically significant at the

1% level. These results suggest that exports and inward FDI weaken each other in China, though it is not true in reality.

In the growth equation, the coefficient of labor input is negative and not statistically significant, indicating that more input of labor does not contribute to economic growth in China. The negative sign indicates that the large population in China may retard economic growth. The coefficient of capital stock is also negative and statistically significant at the 1% level. We believe that this is caused by the statistical inaccuracy for the following two main reasons. Firstly, China has been regarded as one of the countries that have a large demand for capital in economic growth. Secondly, as a small part of capital formation, inward FDI has been found to have a positive effect on economic growth. Considering the fact that the quarterly data for capital stock is extended by dividing the annual figures over four, of course we can not reject the possibility that the unqualified data could cause the wrong sign of this coefficient. In the regression, the coefficient of imports is positive and statistically significant at the 5% level, implying that the expansion of imports has indeed benefited the output growth in China.

In the export equation, the coefficient of real effective exchange rate has a positive sign as we have expected, but it is not statistically significant. In China, the official exchange rate has been kept unchanged for about ten years. Hence, it is understandable that the depreciation of exchange rate did not happen and did not have a significant effect on export growth. In the regression, the coefficient of the total real GDP of OECD countries is positive and statistically significant at the 1% level, indicating that the economic growth of OECD countries induces China's export growth.

In the inward FDI equation, the coefficient of real relative wage ratio has a negative sign and is statistically significant at the 1% level, supporting the presence of a negative effect of wage level on inward FDI. The real relative wage ratio in China decreased from 7.69% in 1981:1 to 3.02% in 1994:4 and then slightly increased to 5.43% in 2001:4. The data indicate that China's wage level has been kept low in the past twenty years. The negative sign of its coefficient suggests that the low wage level induces FDI into China. In this equation, the coefficient of domestic real interest rate is also negative and statistically significant at the 1% level, indicating that the low capital costs also attract FDI into China. In the regression, the coefficient of the average interest rate outside China is positive and statistically significant at the 10% level. Thus, the increase in capital cost outside China has indeed pushed FDI into China. This conclusion is very different from those in the case of Korea and Taiwan. Finally, the statistically significant positive coefficient of the total real GDP of OECD countries indicates that world economic growth induces an increase in FDI into China.

Chapter 6: Conclusions

According to the results presented in Chapter 5, the evidence of bi-directional causality between exports and economic growth is found for the case of Korea and Taiwan. For the case of China, the results based on the annual data support the one-way causality from economic growth to exports, but the results based on the quarterly data support the one-way causality from exports to economic growth. However, the results from the model estimation showed positive signs for the abovementioned coefficients, supporting that exports and economic growth reinforce each other in all three cases.

The Granger causality test results support the bi-directional causal links between inward FDI and economic growth in the case of China and Taiwan. In addition, the model estimation results in the two cases support the positive relationship between inward FDI and economic growth. In the case of Korea, the Granger causality test results suggest one-way causality from economic growth to inward FDI, but no causal effect of inward FDI on economic growth. The reason for the one-way causality is Korea's discouraging policies toward FDI. In this case, the model estimation results suggest that inward FDI is negatively related to economic growth.

Finally, we find that the relationship between exports and inward FDI is more complex than we argued in the hypothesis section. Although the Granger causality test results support the existence of bi-directional causality between exports and inward FDI in all three cases, the signs of the coefficients in the model estimation differ very much. Inward FDI is found to have a negative effect on export growth in all three cases, even though the negative effect is not significant in the case of Taiwan. However, the effect of exports on inward FDI is found to be significantly negative in the case of China and Taiwan, and significantly positive in the case of Korea.

Therefore, most of our hypotheses in Chapter 2 are strongly supported by the econometric results. Only the final hypothesis on the relationship between exports and inward FDI is questionable. As we have stated in Chapter 2, it is possible that a negative effect of exports on inward FDI occurred because exports can decrease the demand of foreign capital and suppress the emerging economies' passion for inward FDI. Our difficulty lies with the interpretation of the negative effect of inward FDI on exports. There may be some other mechanisms that we are not aware of behind the relationship between exports and inward FDI. Of course, the negative signs may also be caused by the statistical inaccuracy or the inaccuracies in the data collection process.

The results of this study contribute to the growing studies on economic growth, international trade and international capital movement. Certainly, we notice some limitations in this study. Firstly, the series of Taiwan's annual data are not long enough and China's quarterly data are not all obtained from the official sources. Secondly, we simply use the two-stage least square approach to estimate the simultaneous equation model under the assumption that the variables in each equation have a long-run relationship.

Hence, the next steps for research in this field would be to use more reliable data and develop an ECM model based on our simultaneous equation model. Better quality data may improve the quality of the findings. Furthermore, we can also examine both the short-run relationship and the long-run relationship among economic variables by using an ECM model.

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Tables

Table 3- 1: Average Annual Growth (%) of Korea's Main Economic Indicators, 1954-2002

	1954-61	1962-71	1972-81	1982-91	1991-02
Real GDP	4.06	8.68	7.21	8.92	5.61
Real output of agriculture, forestry and fishery	NA	NA	2.55	2.00	1.55
Real output of mining & quarry	NA	NA	5.49	0.94	-1.23
Real manufacturing output	NA	NA	14.66	11.25	7.40
Real construction output	NA	NA	9.91	12.70	1.40
Per Capita GNI	NA	NA	19.85	14.56	3.57
FDI inflow	NA	NA	9.25	27.74	4.78
FDI stock	NA	NA	15.65	21.20	19.08
Real Gross Fixed Capital Formation	10.31[a]	20.96	12.16	13.78	2.31
Real exports of goods and services	17.10[a]	20.39 [a]	23.29	9.86	11.16
Real imports of goods and services	9.62 [a]	14.64 [a]	13.15	11.55	6.16
Real exports (f.o.b.)	-16.81[a]	17.83 [a]	17.37	9.27	5.47
Real imports (c.i.f.)	-17.98 [a]	4.15 [a]	5.42	10.50	0.26
Real Wages	NA	NA	7.77	7.94	4.83
Nominal exchange rate	27.38	10.77	6.97	0.74	4.98
Real exchange rate	NA	NA	-0.90	-0.25	3.13
Labor	NA	2.98[b]	3.50	2.67	1.65
Employment	NA	3.48[b]	3.49	2.89	1.58
Employment rate	NA	0.49[b]	-0.01	0.22	-0.06
Implicit GDP deflator	20.59	17.57	21.46	6.87	3.82
Wholesale prices	19.93	11.96	19.48	1.83	3.54
Consumer prices	NA	NA	17.03	5.16	4.40
Population	2.55	2.61	1.65	1.12	0.90[c]

Table 3- 2: Korea's Main Economic Ratios (%), 1955-2002

	1955	1962	1967	1972	1977	1982	1987	1992	1997	2002
Economic Structure:										
Agriculture, forestry and fishery	NA	NA	NA	26.96	22.40	14.47	10.08	7.44	5.35	3.96
Mining & quarry	NA	NA	NA	1.26	1.65	1.46	1.14	0.55	0.42	0.35
Manufacturing	NA	NA	NA	22.28	26.73	27.88	31.19	28.74	28.89	29.22
Construction output	NA	NA	NA	4.08	5.44	7.45	7.17	12.03	11.65	8.46
Expenditure on GDP:										
Gross Fixed Capital Formation	10.34	13.79	21.81	20.89	28.46	28.63	29.32	36.96	35.10	26.74
Exports of goods and services	1.68	5.11	11.48	19.54	30.98	33.93	39.54	27.65	34.73	40.01
Imports of goods and services	10.08	16.77	22.19	24.23	31.66	36.48	32.13	29.14	35.75	38.58
Other Ratios:										
FDI inflow to GDP	NA	NA	NA	0.60	0.25	0.09	0.46	0.23	0.60	0.41
FDI inflow to Gross Capital Formation	NA	NA	NA	2.82	0.88	0.32	1.51	0.62	1.74	1.59
Total external trade to GDP	11.76	21.88	33.67	43.77	62.64	70.40	71.67	56.79	70.47	78.59
Unemployment rate	NA	NA	6.06	4.47	3.78	4.34	3.08	2.51	2.61	3.09

Sources: Based on data in Korea National Statistical Office (KNSO), Korea Statistical Yearbook (various years from 1975 to 2000), International Financial Statistics (CD-ROM, 2003), and World Development Indicators (CD-ROM, 2002).

Note: a) The real values are calculated by using GDP deflators. b) 1964-71 c) 1992-2001

Table 3- 3: Average Annual Growth (%) of Taiwan's Main Economic Indicators, 1952-2002

	1952-61	1962-71	1972-81	1982-91	1992-02
Real GDP	7.92	10.25	9.07	8.06	5.25
Per capita real national income	4.27	7.50	6.17	7.33	4.02
FDI inflow	15.61 [a]	18.43	11.34	23.74	12.45 [d]
Real Gross Fixed Capital Formation	12.25	16.89	11.80	7.10	4.34
Real exports of goods and services	10.22	23.29	14.25	10.75	7.21
Real imports of goods and services	9.87	18.26	12.19	11.50	6.16
Real Wages	NA	4.94	3.98	7.86	2.10
Nominal exchange rate	14.60	-0.01	-0.57	-3.76	2.76
Real exchange rate	NA	0.18	-3.37	-1.63	3.34
Labor	NA	3.36 [b]	3.45	2.39	1.38
Employment	NA	3.76 [b]	3.48	2.38	1.07
Employment rate	NA	0.39 [b]	0.03	-0.02	-0.31
Implicit GDP deflator	10.24	3.56	10.93	2.25	1.32
Wholesale prices	9.55	1.64	10.80	-1.25	0.27
Consumer prices	NA	2.88	11.57	1.87	1.99
Population	3.53 [c]	3.00	2.03	1.29	0.84

Table 3- 4: Taiwan's Main Economic Ratios (%): 1953-2002

	1953	1962	1967	1972	1977	1982	1987	1992	1997	2002
Economic Structure:										
Agriculture	34.45	24.97	20.61	12.21	10.60	7.74	5.31	3.60	2.55	1.86
Industries:	19.39	28.22	32.95	41.65	43.96	44.34	46.68	40.08	35.32	31.05
Manufacturing	12.63	19.95	24.94	34.28	34.21	35.21	38.89	31.82	27.80	25.85
Construction	4.08	3.93	4.18	3.96	6.09	5.02	3.89	4.92	4.70	2.56
Services	46.15	46.81	46.43	46.14	45.44	47.92	48.02	56.33	62.13	67.10
Expenditure on GDP:										
Gross Capital Formation	14.04	17.80	24.61	25.64	28.10	25.22	20.60	25.52	24.61	16.87 [a]
Gross Fixed Capital Formation	11.67	15.06	20.59	23.71	25.64	25.84	19.23	24.14	22.76	17.73
Total Exports	8.64	13.61	22.14	42.26	48.92	50.13	57.32	43.55	48.26	53.81
Total Imports	13.81	18.94	24.19	36.01	44.04	44.98	39.97	41.76	46.12	46.40
Other Ratios:										
FDI inflow to GDP	NA	0.47	0.73	0.30	0.21	0.22	0.63	0.42	0.88	0.52
FDI inflow to Gross Capital Formation	NA	2.62	2.95	1.17	0.74	0.87	3.06	1.64	3.64	3.05
Total external trade to GDP	22.45	32.55	46.33	78.27	92.96	95.11	97.29	85.31	94.39	100.21
Unemployment rate	NA	NA	2.29	1.47	1.76	2.13	1.97	1.52	2.71	5.16

Sources: Based on data in Director-General of Budget, Accounting and Statistics (DGBAS), and Statistical Yearbook of The Republic of China (various years from 1975 to 2001).

Note: a) 1957-61
b) 1965-71
c) 1956-61
d) 1992-2001

Table 3- 5: Average Annual Growth (%) of China's Main Economic Indicators, 1953-2002

	1953-56	1957-65	1966-76	1977-92	1993-01
Real GDP	10.29	4.20	5.66	9.42	9.31 [c]
FDI inflow	NA	NA	NA	38.30 [a]	17.47
FDI stock	NA	NA	NA	40.26 [a]	31.12
Real Gross Fixed Capital Formation	NA	NA	NA	9.80 [b]	12.30 [c]
Real exports	19.05	-0.20	7.79	19.01	12.77
Real imports	8.41	-1.11	8.68	18.94	12.30
Real Wages	6.03	-1.50	-0.10	4.55	11.05
Nominal exchange rate	NA	NA	NA	11.29 [a]	4.14 [c]
Real exchange rate	NA	NA	NA	7.82 [a]	2.17
Labor	NA	NA	NA	3.87 [a]	1.21
Employment	NA	NA	NA	3.86 [a]	1.10
Employment rate	NA	NA	NA	-0.01 [a]	-0.11
Implicit GDP deflator	0.58	1.60	-0.60	4.88	4.67
Retail prices	1.67	1.32	-0.14	5.38	5.08
Consumer prices	NA	NA	NA	8.96 [d]	6.17 [c]
Population [c]	2.25	1.61	2.36	1.47	0.92

Table 3- 6: China's Main Economic Ratios (%):,1952-2002

	1952	1956	1965	1967	1976	1981	1986	1991	1996	2001
Economic Structure:										
Primary Industry	50.5	43.2	37.9	40.3	32.8	31.8	27.1	24.5	20.4	15.2
Secondary Industry:	20.9	27.3	35.1	34.0	45.4	46.4	44.0	42.1	49.5	51.1
Industry	17.6	21.9	31.8	30.7	40.9	42.1	38.9	37.4	42.8	44.4
Construction	3.2	5.4	3.2	3.3	4.5	4.3	5.2	4.7	6.7	6.7
Tertiary Industry	28.6	29.5	27.0	25.8	21.7	21.8	28.9	33.4	30.1	33.6
Expenditure on GDP:										
Gross Capital Formation	NA	NA	NA	NA	NA	32.5	37.7	34.8	39.6	39.0
Gross Fixed Capital Formation	NA	NA	NA	NA	NA	25.8	30.4	27.5	34.4	38.4
Total Exports	4.0	5.4	3.7	3.3	4.6	7.6	10.6	17.7	18.5	23.0
Total Imports	5.5	5.2	3.2	3.0	4.4	7.6	14.7	15.7	17.0	21.0
Other Ratios:										
FDI inflow to GDP	NA	NA	NA	NA	NA	0.15 [e]	0.6	1.1	5.1	4.0
FDI inflow to Gross Capital Formation	NA	NA	NA	NA	NA	0.46 [e]	1.7	3.1	12.9	10.4
Total external trade to GDP	9.5	10.6	6.9	6.3	9.0	15.1	25.3	33.4	35.6	44.0
Unemployment rate	NA	NA	NA	NA	NA	1.0	0.5	0.9	1.2	1.9

Sources: Based on data in Ministry of Finance PRC (MOF), China Statistical Yearbook (CD-ROM, 2002), and International Financial Statistics (CD-ROM, 2003).

Note: a) 1983-92
b) 1979-92
c) 1993-2002
d) 1985-1992
e) 1982

Table 4- 1: Sensitivity Test: Capital Stock Growth with Alternative Depreciation Rates

Depreciation Rate (%)	***Growth Rate***				
	Korea	***Korea***	***Taiwan***	***China***	***China***
	% per year	***% per quarter***	***% per year***	***% per year***	***% per quarter***
	1954-2002	***1976:1-2002:4***	***1952-2002***	***1979-2002***	***1982:1-2002:4***
5	17.916	2.687	15.694	19.865	3.592
10	17.092	2.542	14.934	18.617	3.365
15	16.428	2.440	14.334	17.603	3.198

Table 4- 2: Coefficient Signs Expected

Growth Equation		***Export Equation***		***Inward FDI Equation***	
Coefficient	***Sign***	***Coefficient***	***Sign***	***Coefficient***	***Sign***
C(0)	+/-	C(6)	+/-	C(11)	+/-
C(1)	+	C(7)	+	C(12)	+
C(2)	+	C(8)	+	C(13)	+/-
C(3)	+/-	C(9)	+	C(14)	-
C(4)	+/-	C(10)	+	C(15)	-
C(5)	+/-			C(16)	+
				C(17)	+

Note: +/- means that the sign is unable to determine.

Table 5- 1: The Unit Root Test Results

	Annual data			Quarterly data		
	lags	ADF test statistic	P value @	lags	ADF test statistic	P value @
Korea:	1960-2002			1976:1-2002:4		
Real GDP (Level)	0	-0.160016	0.9920	6	-1.698605	0.7449
Real GDP (1st difference)	1	-6.412857***	0.0000	5	-5.744975***	0.0000
Real Exports (Level)	6	1.701599	1.0000	5	-3.028353	0.1298
Real Exports (1st difference)	0	-5.135241***	0.0008	6	-5.860594***	0.0000
Real FDI (Level)	9	-0.810452	0.9490	11	-1.054568	0.9305
Real FDI (1st difference)	8	-4.456023***	0.0097	12	-4.805672***	0.0009
Taiwan:	1956-2002			NA		
Real GDP (Level)	0	-0.853474	0.9526			
Real GDP (1st difference)	0	-5.787040***	0.0001			
Real Exports (Level)	2	2.246948	1.0000			
Real Exports (1st difference)	1	-7.069204***	0.0000			
Real FDI (Level)	9	0.840939	0.9997			
Real FDI (1st difference)	8	-5.536799***	0.0003			
China:	1952-2001			1982:1-2002:4		
Real GDP (Level)	2	2.690893	1.0000	5	-0.188881	0.9923
Real GDP (1st difference)	0	-2.326335	0.4122	4	-2.951599	0.1526
Real GDP (2nd difference)	1	-6.097677***	0.0000	3	-20.31802***	0.0001
Real Exports (Level)	2	-4.520541***	1.0000	7	4.630655	1.0000
Real Exports (1st difference)	2	-2.231035	0.4617	6	-5.419653***	0.0001
Real Exports (2nd difference)	7	-4.382909***	0.0063			
Real FDI (Level)				5	-2.756170	0.2179
Real FDI (1st difference)				3	-4.023166**	0.0117

@ MacKinnon (1996) one-sided p-values.
***. Statistic value is significant at the 0.01% level.
**. Statistic value is significant at the 0.05% level.
*. Statistic value is significant at the 0.10% level.

Table 5- 2: The Granger Causality Test Results

Korea: Annual data (1971-2002)											
No. of lags	$\Delta Y \rightarrow \Delta X$ [c] F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta Y$ [c] F value/(Prob.)	No. of lags	$\Delta Y \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta Y$ F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta X$ F value/(Prob.)
3	24.4300 (2.1E-08)***	5	87.63387 (0.00016)***	3	13.9663 (3.1E-05)***	1	0.36439 (0.55112)	2	5.03323 (0.01495)**	3	7.52980 (0.00132)***
Korea: Quarterly data (1976:1-2002:4)											
No. of lags	$\Delta Y \rightarrow \Delta X$ F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta Y$ F value/(Prob.)	No. of lags	$\Delta Y \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta Y$ F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta X$ F value/(Prob.)
5	6.08446 (6.6E-05)***	5	5.16720 (0.00032)***	1	3.41611 (0.06743)*	5	1.04721 (0.39502)	7	6.46355 (4.1E-06)***	5	4.11344 (0.00206)***
Taiwan: Annual data (1956-2002)											
No. of lags	$\Delta Y \rightarrow \Delta X$ F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta Y$ F value/(Prob.)	No. of lags	$\Delta Y \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta Y$ F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta X$ F value/(Prob.)
1	14.7860 (0.0004)***	1	35.9484 (4.0E-07)***	3	2.62385 (0.0654)***	3	23.5353 (1.3E-08)***	2	4.60097 (0.0161)***	5	11.3000 (3.5E-06)***
China: Annual data (1952-2002)											
No. of lags	$\Delta^2 Y \rightarrow \Delta^2 X$ F value/(Prob.)	No. of lags	$\Delta^2 X \rightarrow \Delta^2 Y$ F value/(Prob.)								
5	3.28786 (0.05787)*	1	0.04692 (0.83109)								
China: Quarterly data (1982:1-2001:4)											
No. of lags	$\Delta^2 Y \rightarrow \Delta X$ F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta^2 Y$ F value/(Prob.)	No. of lags	$\Delta^2 Y \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta^2 Y$ F value/(Prob.)	No. of lags	$\Delta X \rightarrow \Delta F$ F value/(Prob.)	No. of lags	$\Delta F \rightarrow \Delta X$ F value/(Prob.)
4	1.29824 (0.27934)	4	4.75920 (0.00189)***	3	19.4358 (2.5E-09)***	4	3.80445 (0.0075)***	4	4.67046 (0.0021)***	8	2.55855 (0.01841)**

***. Statistic value is significant at the 0.01% level.
**. Statistic value is significant at the 0.05% level.
*. Statistic value is significant at the 0.10% level.

Note: 1) Figures in parentheses are the probability values which show the chances to accept the null hypotheses, i.e., A does not Granger cause B.
2) A→B: A Granger causes B.
3) Y denotes real GDP, X denotes real exports, F denotes real FDI inflow, Δ denotes the first difference, and Δ^2 denotes the second difference.
c) In the period of 1960-2002.

Table 5- 3: Lag Length Selection for Causality Test

No. of lags						
Korea: Annual data (1971-2002)						
No. of lags	$\Delta Y \rightarrow \Delta X^{c}$	$\Delta X \rightarrow \Delta Y^{c}$	$\Delta Y \rightarrow \Delta F$	$\Delta F \rightarrow \Delta Y$	$\Delta X \rightarrow \Delta F$	$\Delta F \rightarrow \Delta X$
	SC	SC	SC	SC	SC	SC
1	21.26056	21.85865	17.04802	22.11574 ♪	17.31927	21.56021
2	20.64846	21.77193	16.88875	22.36915	16.73351 ♪	20.98209
3	19.79978 ♪	21.70150	16.18011 ♪	22.50740	16.84654	20.74716 ♪
4	19.98895	21.51666	16.45846	22.72347	17.11975	20.98979
5	20.21125	21.27807 ♪	16.57369	22.74450	17.36353	20.80069
Korea: Quarterly data (1976:1-2002:4)						
No. of lags	$\Delta Y \rightarrow \Delta X$	$\Delta X \rightarrow \Delta Y$	$\Delta Y \rightarrow \Delta F$	$\Delta F \rightarrow \Delta Y$	$\Delta X \rightarrow \Delta F$	$\Delta F \rightarrow \Delta X$
	SC	SC	SC	SC	SC	SC
1	18.41408	20.69430	14.51257 ♪	20.69211	14.54139	18.53726
2	18.38851	20.53787	14.58013	20.72360	14.63878	18.54640
3	18.18433	18.98381	14.63191	19.41246	14.72029	18.52716
4	18.23631	18.16343	14.72108	18.36374	14.69535	18.42833
5	18.17948 ♪	18.09507 ♪	14.67711	18.28904 ♪	14.70217	18.26413 ♪
6	18.22558	18.16975	14.74988	18.31863	14.77902	18.35894
7	18.28836	18.25064	14.71868	18.38895	14.53759 ♪	18.31641
8	18.32711	18.20726	14.80475	18.32315	14.63208	18.35313
9	18.40466	18.25768	14.73045	18.35991	14.59617	18.38650
10	18.48367	18.27789	14.78237	18.43995	14.68423	18.40616
Taiwan: Annual data (1956-2002)						
No. of lags	$\Delta Y \rightarrow \Delta X$	$\Delta X \rightarrow \Delta Y$	$\Delta Y \rightarrow \Delta F$	$\Delta F \rightarrow \Delta Y$	$\Delta X \rightarrow \Delta F$	$\Delta F \rightarrow \Delta X$
	SC	SC	SC	SC	SC	SC
1	27.01172 ♪	26.09355 ♪	16.14576	26.51941	16.14078	27.31003
2	27.06194	25.17364	15.94314	25.86477	15.85907 ♪	26.73905
3	27.13471	26.24355	15.88150 ♪	25.64348 ♪	15.90268	26.62134
4	27.33734	26.29487	16.08555	25.82777	15.90760	26.64046
5	27.42957	26.35003	16.30147	25.82025	16.10062	26.52961 ♪
China: Annual data (1952-2002)						
No. of lags	$\Delta^2 Y \rightarrow \Delta^2 X$	$\Delta^2 X \rightarrow \Delta^2 Y$				
	SC	SC				
1	13.42612	12.09048 ♪				
2	13.01391	12.11721				
3	13.27937	12.40936				
4	13.50042	12.66960				
5	12.66730 ♪	12.67610				
China: Quarterly data (1982:1-2002:4)						
No. of lags	$\Delta^2 Y \rightarrow \Delta X$	$\Delta X \rightarrow \Delta^2 Y$	$\Delta^2 Y \rightarrow \Delta F$	$\Delta F \rightarrow \Delta^2 Y$	$\Delta X \rightarrow \Delta F$	$\Delta F \rightarrow \Delta X$
	SC	SC	SC	SC	SC	SC
1	20.62810	14.69359	17.69628	14.66164	17.66878	20.60010
2	20.60494	14.56456	17.81906	14.77251	17.71477	20.61188
3	19.64003	10.58453	16.89869 ♪	10.64182	17.23998	19.96933
4	19.26970 ♪	10.00855 ♪	17.01204	10.05290 ♪	17.09733 ♪	19.30095
5	19.34446	10.09541	17.10348	10.17579	17.14193	19.35173
6	19.40946	10.22440	17.23376	10.23844	17.27052	19.39188
7	19.48417	10.32521	17.32801	10.35402	17.37223	19.44507
8	19.43810	10.45600	17.35045	10.49210	17.50625	19.24510 ♪
9	19.50777	10.56837	17.39159	10.57494	17.61876	19.28748
10	19.61493	10.67916	17.44686	10.70075	17.74180	19.30959

Note: 1) $A \rightarrow B$: Test for causality from A to B

3) Y denotes real GDP, X denotes real exports, F denotes real FDI inflow, Δ denotes the first difference, and Δ^2 denotes the second difference.

4) ♪: least values of Schwarz Criteria

c) In the period of 1960-2002.

Table 5- 4: Pearson Correlations

Korea: 108 observations											
	ln Y	*ln X*	*ln F*	*ln M*	*ln L*	*ln K*	*ln ER*	*ln* Y^w	*ln Wg*	IR^d	IR^w
ln Y	1.000	.977**	.932**	.881**	.974**	.977**	.378**	.983**	.961**	.160	.151
ln X		1.000	.920**	.936**	.972**	.954**	.259**	.967**	.961**	.184	.148
ln F			1.000	.797**	.929**	.929**	.473**	.959**	.874**	.166	.324**
ln M				1.000	.906**	.852**	-.040	.864**	.930**	.144	-0.07
ln L					1.000	.983**	.312**	.985**	.979**	.213*	.109
ln K						1.000	.415**	.992**	.969**	.219*	.152
ln ER							1.000	.422**	.187	.354**	.469**
ln Y^w								1.000	.959**	.217*	.187
ln Wg									1.000	.139	.019
IR^d										1.000	.153
IR^w											1.000

Taiwan: 47 observations											
	ln Y	*ln X*	*ln F*	*ln M*	*ln L*	*ln K*	*ln ER*	*ln* Y^w	*ln Wg*	IR^d	IR^w
ln Y	1.000	.992**	.982**	.997**	.995**	.997**	-.692**	.995**	.992**	-.188	-.317*
ln X		1.000	.981**	.997**	.997**	.997**	-.691**	.997**	.879**	-.219	-.357*
ln F			1.000	.984**	.978**	.986**	-.605**	.991**	.858**	-.212	-.319*
ln M				1.000	.996**	.997**	-.700**	.997**	.901**	-.226	-.343*
ln L					1.000	.997**	-.710**	.995**	.896**	-.216	-.370*
ln K						1.000	-.679**	.998**	.890**	-.209	-.332*
ln ER							1.000	-.672**	-.777**	.288*	.551**
ln Y^w								1.000	.887**	-.212	-.332*
ln Wg									1.000	-.086	-.286
IR^d										1.000	.310*
IR^w											1.000

China: 80 observations											
	ln Y	*ln X*	*ln F*	*ln M*	*ln L*	*ln K*	*ln ER*	*ln* Y^w	*ln Wg*	IR^d	IR^w
ln Y	1.000	.965**	.971**	.894**	.933**	.972**	.799**	.970**	-.618**	-.011	.293**
ln X		1.000	.909**	.902**	.884**	.921**	.734**	.931**	-.504**	.041	.311**
ln F			1.000	.831**	.968**	.998**	.840**	.992**	-.681**	-.033	.249*
ln M				1.000	.772**	.835**	.744**	.833**	-.431**	-.155	.272*
ln L					1.000	.967**	.871**	.971**	-.740**	-.002	.122
ln K						1.000	.827**	.997**	-.642**	-.007	.276*
ln ER							1.000	.820**	-.781**	-.105	-.115
ln Y^w								1.000	-.634**	.015	.275
ln Wg									1.000	.238*	.277*
IR^d										1.000	.371**
IR^w											1.000

**. Correlation is significant at the 0.01% level (2-tailed).

*. Correlation is significant at the 0.05% level (2-tailed).

Table 5- 5: Hausman Test Results for Simultaneity

	Korea: 1976:1-2002:4		Taiwan: 1956-2002		China: 1982:1-2001:4	
ARCH LM Test of OLS Residuals						
Test Statistic	Value	Probability	Value	Probability	Value	Probability
F statistic	3.210739	0.076037*	8.234561	0.006349***	0.526609	0.470265
Obs*R-squared	3.174815	0.074782*	7.232525	0.007159***	0.536748	0.463784
Breusch-Godfrey Serial Correlation LM Test and White Heteroskedasticity Test of OLS Residuals						
Test Statistic	BG-LM test	White test	BG-LM test	White test	BG-LM test	White test
	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)
F statistic	0.143830 (0.866217)	2.667495 (0.002576)***	11.98756 (0.000102)***	2.876189 (0.006993)***	3.353670 (0.040741)**	2.237454 (0.015292)**
Obs*R-squared	0.316086 (0.853813)	30.94292 (0.005646)***	18.38855 (0.000102)***	25.99064 (0.025958)**	6.999056 (0.030212)**	25.96004 (0.026191)**
Adjusted Regression Results						
Method:	ML-ARCH (Marquardt)		ML-ARCH (Marquardt)		MA(5) adjusted OLS	
	Convergence achieved after 18 iterations		Convergence achieved after 14 iterations		Convergence achieved after 40 iterations	
	Coefficient (std. Error)	z Statistic (Probability)	Coefficient (std. Error)	z statistic (Probability)	Coefficient (std. Error)	t statistic (Probability)
α_0	3.276490 (2.303100)	1.422644 (0.1548)	-5.720365 (0.676757)	-8.452608 (0.0000)***	2.973376 (0.863358)	3.443967 (0.0010)***
α_1	0.010027 (0.082075)	0.122163 (0.9028)	0.104863 (0.107539)	0.975118 (0.3295)	0.598098 (0.175837)	3.401433 (0.0011)***
α_2	0.477906 (0.109016)	4.383799 (0.0000)***	0.009523 (0.153095)	0.062201 (0.9504)	0.518080 (0.091112)	5.686181 (0.0000)***
α_3	-0.015474 (0.343011)	-0.045112 (0.9640)	1.852397 (0.078379)	23.63387 (0.0000)***	-0.558046 (0.122083)	-4.571023 (0.0000)***
α_4	0.188710 (0.074574)	2.530514 (0.0114)**	0.297872 (0.073673)	4.043133 (0.0001)***	-0.674471 (0.170761)	-3.949785 (0.0002)***
α_5	-0.631150 (0.154016)	-4.097958 (0.0000)***	0.477218 (0.090043)	5.299913 (0.0000)***	-0.041238 (0.052667)	-0.782997 (0.4363)
γ_1	1.069113 (0.277621)	3.850976 (0.0001)***	-0.589503 (0.177112)	-3.328416 (0.0009)***	0.203098 (0.095597)	2.124531 (0.0372)**
γ_2	-0.366960 (0.146517)	-2.504552 (0.0123)**	0.029944 (0.113613)	0.263564 (0.7921)	-0.003828 (0.206786)	-0.018511 (0.9853)
Obs.	108		46		79	
R^2	0.981257		0.996729		0.989276	
Adj.R^2	0.979325		0.995795		0.988050	
DW statistic	2.022168		0.595092		1.755062	
Normality Test						
Jarque-Bera	3.628386		1.671015		2.244341	
Probability	0.162969		0.433654		0.325572	
Breusch-Godfrey Serial Correlation LM Test and White Heteroskedasticity Test						
Test Statistic	BG-LM test	White test	BG-LM test	White test	BG-LM test	White test
	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)
F statistic					0.456209 (0.635607)	0.893081 (0.569809)
Obs*R-squared					0.571026 (0.751629)	12.91120 (0.533527)

Wald Coefficient Test for $\gamma_1 = \gamma_2 = 0$

Test Statistic	Value	df	Prob.	Value	df	Prob.	Value	df	Prob.
F-statistic	7.421714	(2, 97)	0.0010***	8.026532	(2, 35)	0.0014***	2.983631	(2, 71)	0.0570*
Chi-square	14.84343	2	0.0006***	16.05306	2	0.0003***	5.967262	2	0.0506*

***. Statistic value is significant at the 0.01% level. **. Statistic value is significant at the 0.05% level.
*. Statistic value is significant at the 0.10% level.

Table 5- 6: Two-Stage Estimation Results of Growth Equation

		Korea: 1976:1-2002:4		Taiwan: 1956-2002		China: 1982:1-2001:4	
ARCH LM test of OLS Residuals							
Test Statistic		Value	Probability	Value	Probability	Value	Probability
F statistic		0.473617	0.492846	7.480881	0.009023***	7.140672	0.009216***
Obs*R-squared		0.480471	0.488209	6.668656	0.009812***	6.699157	0.009646***
Breusch-Godfrey Serial Correlation LM Test and White Heteroskedasticity Test of OLS Residuals							
Test Statistic		BG-LM test	White test	BG-LM test	White test	BG-LM test	White test
		Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)
F statistic		0.315555 (0.730108)	3.351601 (0.000878)***	12.31930 (0.000075)***	3.497712 (0.002811)***	3.044257 (0.053894)*	2.715163 (0.007255)***
Obs*R-squared		0.677324 (0.712723)	27.73398 (0.001991)***	18.09388 (0.000118)***	22.99248 (0.010774)**	6.239485 (0.044169)**	22.54274 (0.012566)**
Adjusted Regression Results							
Method:		OLS		AR(1) adjusted OLS		ML - ARCH (Marquardt)	
		White Heteroskedasticity-Consistent Standard Errors & Covariance		Convergence achieved after 20 iterations		Convergence achieved after 32 iterations	
Var.	Coeff.	Coefficient (std. Error)	t Statistic (Probability)	Coefficient (std. Error)	t statistic (Probability)	Coefficient (std. Error)	z statistic (Probability)
C	C(0)	3.031956 (2.613926)	1.159924 (0.2488)	0.162427 (2.193463)	0.074051 (0.9414)	1.227606 (1.313484)	0.934618 (0.3500)
ln F	C(1)	-0.315131 (0.163587)	-1.926376 (0.0568)*	0.112787 (0.043124)	2.615427 (0.0127)**	0.593883 (0.104309)	5.693514 (0.0000)***
ln X	C(2)	1.442330 (0.323866)	4.453481 (0.0000)***	0.141716 (0.060558)	2.340174 (0.0246)**	0.578349 (0.094363)	6.129001 (0.0000)***
ln L	C(3)	-0.006621 (0.411034)	-0.016109 (0.9872)	0.802720 (0.380880)	2.107542 (0.0417)**	-0.328681 (0.205977)	-1.595719 (0.1106)
ln K	C(4)	0.217552 (0.087401)	2.489121 (0.0144)**	0.282844 (0.088603)	3.192264 (0.0028)***	-0.708507 (0.201789)	-3.511124 (0.0004)***
ln M	C(5)	-0.591313 (0.190729)	-3.100274 (0.0025)***	0.026576 (0.059333)	0.447908 (0.6568)	0.158915 (0.077303)	2.055746 (0.0398)**
Obs.		108		45		79	
R^2		0.974641		0.999696		0.978356	
Adj.R^2		0.973397		0.999648		0.975882	
DW statistic		2.119859		1.577592		1.880286	
Normality test							
Jarque-Bera		9.146110		1.164442		2.117495	
Probality		0.010326***		0.558656		0.346890	
Breusch-Godfrey Serial Correlation LM Test and White Heteroskedasticity Test							
Test Statistic		BG-LM test	White test	BG-LM test	White test	BG-LM test	White test
		Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)
F statistic		0.315555 (0.730108)	3.351601 (0.000878)***	1.336134 (0.275582)	0.978044 (0.479958)		
Obs*R-squared		0.677324 (0.712723)	27.73398 (0.001991)***	3.109517 (0.211240)	10.05289 (0.435866)		

***. Statistic value is significant at the 0.01% level. **. Statistic value is significant at the 0.05% level.
*. Statistic value is significant at the 0.10% level.

Table 5- 7: Two-Stage Estimation Results of Export Equation

		Korea: 1976:1-2002:4		Taiwan: 1956-2002		China: 1982:1-2001:4	
ARCH LM Test of OLS Residuals							
Test Statistic		Value	Probability	Value	Probability	Value	Probability
F statistic		0.605923	0.438094	0.039839	0.842736	2.950169	0.089941*
Obs*R-squared		0.613998	0.433286	0.041654	0.838281	2.914663	0.087778*
Breusch-Godfrey Serial Correlation LM Test and White Heteroskedasticity Test of OLS Residuals							
Test Statistic		BG-LM test	White test	BG-LM test	White test	BG-LM test	White test
		Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)
F statistic		29.04793 (0.000000)***	0.578332 (0.793479)	5.535938 (0.007650)***	1.569818 (0.167524)	14.47569 (0.000005)***	2.013504 (0.057210)*
Obs*R-squared		39.31955 (0.000000)***	4.823815 (0.776230)	10.17150 (0.006184)***	11.65678 (0.167187)	22.65605 (0.000012)***	14.77835 (0.063601)*
Adjusted Regression Results							
Method:		AR(5) adjusted OLS		AR(1) adjusted OLS		ML - ARCH (Marquardt)	
		Convergence achieved after 12 iterations		Convergence achieved after 26 iterations		Failure to improve Likelihood after 9 iterations	
Var.	Coeff.	Coefficient (std. Error)	t Statistic (Probability)	Coefficient (std. Error)	t statistic (Probability)	Coefficient (std. Error)	z statistic (Probability)
C	C(6)	-9.078391 (3.799234)	-2.389532 (0.0189)**	-12.28691 (5.206636)	-2.359856 (0.0234)**	-19.59059 (0.121579)	-161.1347 (0.0000)***
ln Y	C(7)	0.487515 (0.088992)	5.478194 (0.0000)***	1.082103 (0.447614)	2.417492 (0.0204)**	1.333045 (0.033831)	39.40308 (0.0000)***
ln F	C(8)	-0.336543 (0.195253)	-1.723630 (0.0881)*	-0.043382 (0.142578)	-0.304271 (0.7625)	-0.562668 (0.018922)	-29.73665 (0.0000)***
Ln ER	C(9)	-0.893558 (0.115780)	-7.717736 (0.0000)***	-0.092667 (0.141710)	-0.653918 (0.5170)	0.033418 (0.071702)	0.466059 (0.6412)
$\ln Y^{w}$	C(10)	2.676050 (0.677472)	3.950051 (0.0002)***	1.102664 (0.944747)	1.167153 (0.2502)	3.110149 (0.012347)	251.9005 (0.0000)***
Obs.		102		45		79	
R^2		0.988447		0.998452		0.955911	
Adj.R^2		0.987317		0.998254		0.951565	
DW statistic		1.999640		2.049799		0.796052	
Normality Test							
Jarque-Bera		2.204996		1.230620		1.898316	
Probality		0.332041		0.540473		0.387067	
Breusch-Godfrey Serial Correlation LM Test and White Heteroskedasticity Test							
Test Statistic		BG-LM test	White test	BG-LM test	White test	BG-LM test	White test
		Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)	Value (prob.)
F statistic		1.064660 (0.349148)	1.206952 (0.303596)	0.076474 (0.926523)	1.058917 (0.412567)	---	---
Obs*R-squared		2.357454 (0.307670)	9.593953 (0.294689)	0.185251 (0.911535)	8.572041 (0.379673)	---	---

***. Statistic value is significant at the 0.01% level. **. Statistic value is significant at the 0.05% level.
*. Statistic value is significant at the 0.10% level.

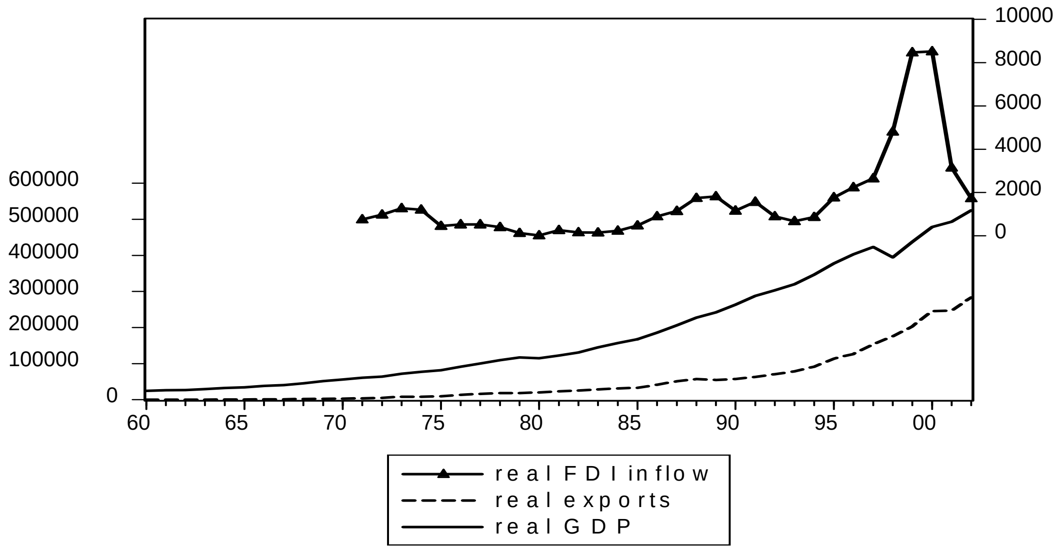
Table 5- 8: Two-Stage Estimation Results of Inward FDI Equation

		Korea: 1976:1-2002:4		Taiwan: 1956-2002		China: 1982:1-2001:4	
ARCH LM Test of OLS Residuals							
Test Statistic		Value	Probability	Value	Probability	Value	Probability
F statistic		32.26993	0.000000***	32.50185	0.000001***	49.40606	0.000000***
Obs*R-squared		25.10174	0.000001***	19.37149	0.000011***	30.72956	0.000000***
Adjusted Regression Results							
Method:		ML-ARCH (Marquardt)		ML-ARCH (Marquardt)		ML-ARCH (Marquardt)	
		Convergence achieved after 78 iterations		Failure to improve Likelihood after 31 iterations		Failure to improve Likelihood after 27 iterations	
Var.	Coeff.	Coefficient (std. Error)	z Statistic (Probability)	Coefficient (std. Error)	z statistic (Probability)	Coefficient (std. Error)	z statistic (Probability)
C	C(11)	-22.48146 (1.009577)	-22.26820 (0.0000)***	-47.43363 (0.671586)	-70.62931 (0.0000)***	-44.87731 (2.019231)	-22.22495 (0.0000)***
$ln\ Y$	C(12)	-0.481280 (0.079370)	-6.063740 (0.0000)***	0.460981 (0.048708)	9.464198 (0.0000)***	1.340064 (0.129792)	10.32469 (0.0000)***
$ln\ X$	C(13)	0.546313 (0.059981)	9.108132 (0.0000)***	-1.088021 (0.045782)	-23.76503 (0.0000)***	-0.947530 (0.097084)	-9.759928 (0.0000)***
$ln\ Wg$	C(14)	-0.458040 (0.029594)	-15.47761 (0.0000)***	-0.028595 (0.053159)	-0.537916 (0.5906)	-0.259302 (0.064463)	-4.022525 (0.0001)***
IR^d	C(15)	-0.008319 (0.001537)	-5.411469 (0.0000)***	0.001461 (0.002513)	0.581241 (0.5611)	-0.008107 (0.001546)	-5.242888 (0.0000)***
$\ln Y^w$	C(16)	3.983860 (0.188710)	21.11101 (0.0000)***	6.576120 (0.079129)	83.10662 (0.0000)***	6.593532 (0.279259)	23.61085 (0.0000)***
IR^w	C(17)	-0.000951 (0.001489)	-0.638978 (0.5228)	-0.007137 (0.004573)	-1.560756 (0.1186)	0.004888 (0.002465)	1.982992 (0.0474)**
Obs.		107		46		79	
R^2		0.960999		0.991373		0.994243	
Adj.R^2		0.957380		0.989216		0.993492	
DW statistic		0.260902		1.146278		0.530561	
Normality Test							
Jarque-Bera		3.939412		1.941793		3.963673	
Probality		0.139498		0.378743		0.137816	

***. Statistic value is significant at the 0.01% level. **. Statistic value is significant at the 0.05% level.
*. Statistic value is significant at the 0.10% level.

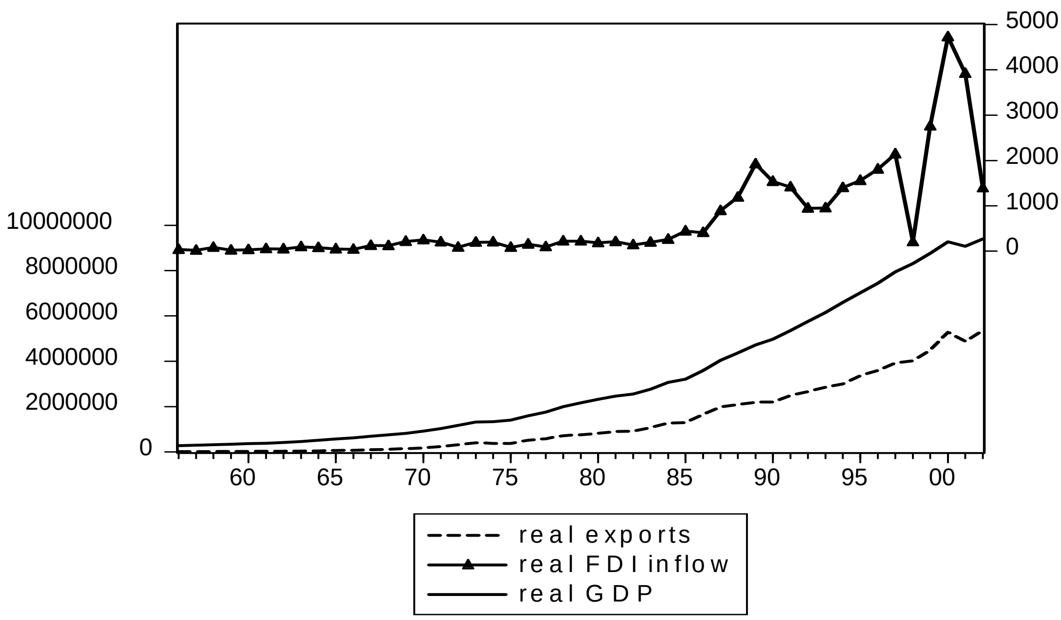
Figures

Figure 5-1: Real GDP, Real Exports and Real FDI Inflow at 1995 Prices (Korea)



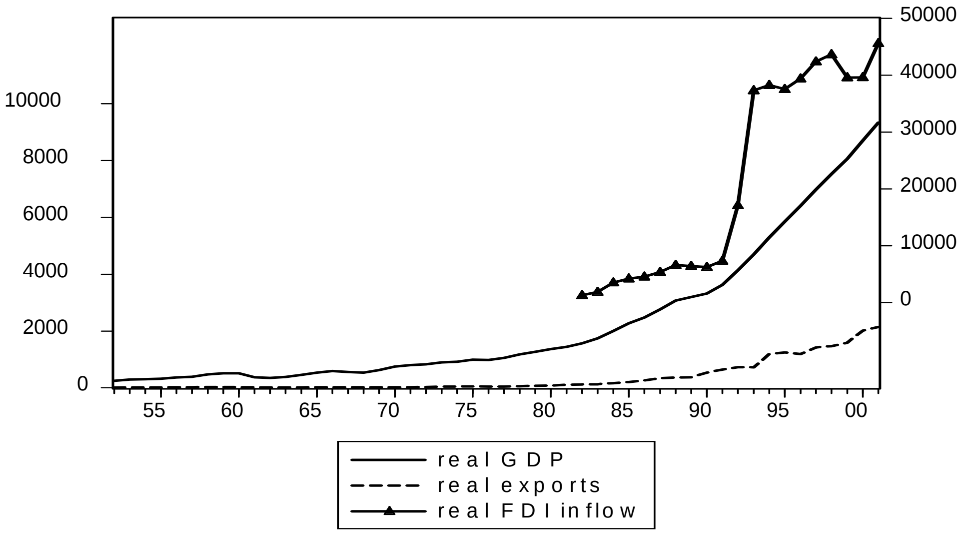
Note: Real GDP and real exports are scaled by the left axis with billion won as the unit, while real FDI is scaled by the right axis with million US$ as the unit.

Figure 5-2: Real GDP, Real Exports and Real FDI Inflow at 1995 Prices (Taiwan)



Note: Real GDP and real exports are scaled by the left axis with million new Taiwan dollars as the unit, while real FDI is scaled by the right axis with million US$ as the unit.

Figure 5-3: Real GDP, Real Exports and Real FDI Inflow at 1995 Prices (China)



Note: Real GDP and real exports are scaled by the left axis with billion yuan as the unit, while real FDI is scaled by the right axis with million US$ as the unit.

Appendix A: Cointegration Issues

The Methodology

If the time series variables are non-stationary, in regressing one variable on other variables, the phenomenon of spurious regression may occur. The problem of spurious regression is the situation in which we obtain a very high R^2 in the regression even though there is no relationship between the variables.

However, if the non-stationary variables are cointegrated, the problem of spurious regression will be solved. In this situation, these cointegrated variables will have a long-term relationship between them.

Firstly, let us consider the concept of cointegration. In the case of N non-stationary variables, say, I(d) where d denotes the common order of integration of these variables, we say that the N variables are cointegrated if a linear combination of them has a smaller order of integration (d-b), where b is greater than zero. According to Patterson (2000), these cointegrated variables can be written as CI(d,b), where b is the order of cointegration.

The testing procedure for cointegration involves two steps. First, test the order of integration of the time series in question by computing the augmented Dickey-Fuller (ADF) test statistics which has been interpreted in details in Chapter 4. Second, test the cointegration by using the augmented Engle-Granger (EG) (1987) approach or the Johansen (1988) maximum likelihood approach.

The augmented Engle-Granger (EG) (1987) approach is based on the ADF unit root test. We estimate a regression of the non-stationary variables and obtain the residuals.

Then we apply the ADF test to the residuals. If the results support the evidence of stationarity of the residuals, these variables are said to be cointegrated.

Johansen's (1988) test for a multivariate cointegration system is based on the error correction representation of the VAR process. The multivariate VAR reparameterised in ECM form is

$$\Delta y_t = \prod y_{t-1} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + \psi X_t + \varepsilon_t$$

where y_t is a k$\times$1 vector of non-stationary variables, $\prod = \alpha\beta'$ with rank of r (r$\leq$k), where α and β are k$\times$r matrices, and X_t is a d$\times$1 vector of stationary variables. In this case, X_t is a constant variable. The key decision variable is often the lag length p, which can be selected in terms of AIC and SIC. The null hypothesis is that $\prod$ has a reduced rank of r (r<k), where r is the number of cointegration combinations.

There are two types of Johansen's test statistics: trace test statistic and $\lambda_{\max}$ (Max-eigenvalue) test statistic.

$$Trace(r \mid k) = -n \sum_{j=r+1}^{k} \ln(1 - \hat{\lambda}_j)$$

$$\lambda_{\max} = -n \ln(1 - \hat{\lambda}_{r+1})$$

where λ_1 , …, λ_k can be obtained by solving the maximum of L(β) in Johanson's cointegration model. These values can be calculated by a computer software. A larger value of trace test statistic is the evidence against the null hypothesis and a small value of trace statistic does not reject the null hypothesis.

The implications of a particular cointegration rank are summarized as follows.

Cointegration Rank	**Implications**
r = k (maximum)	The time series are stationary
$1 \leq r \leq k-1$	r cointegration linear combinations
r = 0	The time series are not cointegrated

Johansen's cointegration test begins from the null hypothesis that the rank is 0. The tests are summarized below.

λ_{max} tests			Trace tests		
null	alternative	λ_{max} test statistic	null	alternative	Trace test statistic
r=0	r=1	$-n\ln(1-\hat{\lambda}_1)$	r=0	$r\geq 1$	$-n\sum_{j=1}^{k}\ln(1-\hat{\lambda}_j)$
$r\leq 1$	r=2	$-n\ln(1-\hat{\lambda}_2)$	$r\leq 1$	$r\geq 2$	$-n\sum_{j=2}^{k}\ln(1-\hat{\lambda}_j)$
$r\leq 2$	r=3	$-n\ln(1-\hat{\lambda}_3)$	$r\leq 2$	$r\geq 3$	$-n\sum_{j=3}^{k}\ln(1-\hat{\lambda}_j)$
…	…	…	…	…	…

The Results

All the unit root test results are summarized in Table C1, and the results of the Johansen cointegration test are presented in Table C2. In the following parts, we will discuss the unit roots and the cointegration tests in each case.

In the case of Korea, the series of *ln X* is stationary because one unit root hypothesis is rejected at the 10% significance level. However, it can be regarded as *I* (1) if we set 5% as the significance level. All the other series except *ln K* are integrated of order 1, *I* (1). The series of *ln K* has two unit roots at the 10% significance level. However, we can still regard it as *I* (1) at the 12% significance level.

Assuming the variables are all *I* (1), we carry out the augmented Engle-Granger (EG) approach and Johansen's approach. The results of the EG approach support the non-stationarity of the residuals, indicating the variables in each equation are not cointegrated. However, the results in Table C2 suggest that the hypothesis of no cointegration vector in each equation is rejected at the 1% significance level, indicating that the variables in each equation are cointegrated.

In the case of Taiwan, *ln Y, ln X, ln L, ln ER,* and $ln\ Y^f$ are found to have two unit roots, *ln K* has two unit roots, and other series are stationary. Assuming that they are all *I* (1), we carry out the cointegration test. The results of the EG approach indicate that the variables in the export equation and inward FDI equation are cointegrated, but the variables in the growth equation are not cointegrated. However, the results of Johansen's approach support the cointegration relationship between the variables in each equation.

In the case of China, the time series of *ln Y, ln K,* and *ln F* have two unit roots, the time series of IR^d and *ln X* are stationary, and other variables are all *I* (1). Assuming that they are all *I* (1), we carry out the cointegration test. The results of the EG approach indicate that the variables in the export equation and growth equation are cointegrated, but the variables in the inward FDI equation are not cointegrated. However, the results of Johansen's approach support the cointegration relationship between the variables in each equation.

Table A 1: The Unit Root Test Results

	Korea: Quarterly data			Taiwan: Annual data			China: Quarterly data		
	lags	ADF test statistic	P value @	lags	ADF test statistic	P value @	lags	ADF test statistic	P value @
Series	1976:1-2002:4			1956-2002			1982:1-2001:4		
ln Y (Level)	8	-1.387925	0.8587	0	1.330521	1.0000	5	-3.504997**	0.0462
ln Y (1st difference)	7	-3.666674**	0.0293	3	-4.148252**	0.0112	4	-2.324695	0.4155
ln Y (2nd difference)							3	-14.53205***	0.0001
ln X (Level)	4	-3.228003*	0.0848	0	-0.129776	0.9928	4	-3.449372*	0.0526
ln X (1st difference)				0	-6.410280***	0.0000			
ln F (Level)	4	-2.891503	0.1696	1	-6.403507***	0.0000	7	-1.915033	0.6365
ln F (1st difference)	1	-3.440953*	0.0515				6	-3.030488	0.1313
ln F (2nd difference)							3	-3.951081**	0.0146
ln L (Level)	4	-2.328979	0.4146	0	1.764808	1.0000	1	-1.049876	0.9302
ln L (1st difference)	3	-3.622982**	0.0327	1	-4.896531***	0.0014	0	-4.873530***	0.0008
ln K (Level)	4	-2.306959	0.4262	1	-0.471432	0.9814	6	-3.159606	0.1008
ln K (1st difference)	6	-3.089054	0.1146	0	-2.136544	0.5121	5	-1.970294	0.6074
ln K (2nd difference)	2	-14.90375***	0.0000	0	-6.077186***	0.0000	1	-10.56674***	0.0000
ln ER (Level)	1	-2.348587	0.4042	0	-2.762182	0.2181	0	-2.436865	0.3582
ln ER (1st difference)	0	-7.793344***	0.0000	0	-7.084993***	0.0000	0	-7.660573***	0.0000
$ln\ Y^f$ (Level)	0	-2.957894	0.1491	0	-0.832797	0.9548	0	-1.549835	0.8036
$ln\ Y^f$ (1st difference)	0	-12.90195***	0.0000	0	-5.418174***	0.0003	0	-11.34215***	0.0001
ln Wg (Level)	4	-2.498692	0.3283	1	-3.910969**	0.0196	0	-0.723420	0.9675
ln Wg (1st difference)	3	-3.362268*	0.0623				0	-9.058676***	0.0000
IR^d (Level)	4	-3.002124	0.1368	0	-5.941826***	0.0001	1	-3.605380**	0.0358
IR^d (1st difference)	3	-4.406108***	0.0033						
IR^f (Level)	4	-1.537900	0.8101	0	-3.639168**	0.0373	5	-1.816443	0.6868
IR^f (1st difference)	3	-9.938866***	0.0000				4	-4.757582***	0.0013
The Unit Root Test of the Residues									
Residue(1) (Level)	4	-3.095802	0.1129	0	-2.594750	0.2845	4	-4.705647***	0.0015
Residue(2) (Level)	4	-3.012151	0.1340	0	-3.742503**	0.0292	4	-4.864695***	0.0009
Residue(3) (Level)	1	-2.227909	0.4691	0	-5.316745***	0.0004	4	-3.109163	0.1118

***. Statistic value is significant at the 0.01% level. **. Statistic value is significant at the 0.05% level.
*. Statistic value is significant at the 0.10% level.

Table A 2: The Johansen Cointegration Test Results

		Korea (1976:1-2002:4)		Taiwan (1956-2002)		China (1982:1-2001:4)	
	Hypothesized No. of CE(s)	Trace Statistic	Max-Eigen Statistic	Trace Statistic	Max-Eigen Statistic	Trace Statistic	Max-Eigen Statistic
Growth Equation	None	60.5064**	61.36186**	178.4268**	72.68265**	282.0621**	186.7961**
	At most 1	99.14451**	41.44574**	105.7441**	41.28537**	95.26594**	36.10473**
	At most 2	57.69876*	25.61088	64.45873**	29.25539*	59.16122*	30.18798*
	At most 3	32.08789	16.98146	35.20334*	17.43339	28.97323	15.13217
	At most 4	15.10642	8.816232	17.76995	11.28903		
Export Equation	None	98.14676**	41.20190**	162.8446**	73.83062**	136.1163**	67.28761**
	At most 1	56.94486*	28.12559	89.01400**	33.59033**	68.82867**	29.68458*
	At most 2	28.81928	4.37439	55.42368**	28.36362**	39.14409*	21.50717
	At most 3	14.44489	10.86102	27.06006**	20.52624**	17.63692	9.894560
	At most 4	3.583866	3.583866	6.533818	6.533818		
Inward FDI Equation	None	163.5160**	41.98388	251.4066**	94.01461**	238.2671**	108.8332**
	At most 1	121.5321**	37.05485	157.3919**	48.36990**	129.4339**	43.61718*
	At most 2	84.47728**	31.28352	109.0220**	35.84300*	85.81674*	35.07612*
	At most 3	53.19376*	19.44325	73.17905**	29.82450*	85.81674	24.51636
	At most 4	33.75051	18.44213	43.35455**	24.46763*		
	At most 5			18.88692	14.59104		

**. Statistic value is significant at the 0.01% level.
*. Statistic value is significant at the 0.05% level.